Studies in Applied Financial Economics

by

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Abstract

This thesis contains three studies in financial economics. The first study explores the relationship between CEO compensation, bank performance and risk taking in European banks using a panel data set of 63 banks in 15 countries during 1992 to 2010. The major finding is a positive relationship between performance and compensation, but also a negative relationship between short time incentive and risk. We argue that such relationship is not causative, and bonus may not induce risk taking. The second study examines the efficient market hypothesis and forward premium puzzle using high frequency daily data from 31 countries including both developed and emerging economies during 1990 to 2013. The study provides evidence covers 9 different time horizons of forward exchange rates. We show that the predictive power of forward rates decreases in longer time horizons in a way that similar to the term structure of interest rate. The third study investigates whether financial liberalization plays a role in explaining the current crisis. Our sample consists of 12 developed countries for the period 2000 to 2013. Our results support that financial liberalization contributes to crisis, and suggest that reregulation is needed after deregulation.

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Chapter 1 Introduction

This thesis contains three studies in financial economics. The first study explores the relationship between CEO compensation, bank performance and risk taking in European banks using a panel data set of 63 banks in 15 countries from 1992 to 2010. The second study examines the efficient market hypothesis and forward premium puzzle using high frequency daily data from 31 countries including both developed and emerging economies from 1990 to 2013. The study provides evidence covering 9 different time horizons of forward exchange rates. The third study investigates whether financial liberalization plays a role in explaining the current crisis. Our sample consists of 12 developed countries from the period 2000 to 2013.

Agency theory states that the separation of ownership and control in modern corporations leads managers to pursue their private benefits rather than those of the shareholders. Since the general acceptance of the Agency theory, there has been increasing interest in the relationship between CEO compensation and firm performance. This topic remains timely and contemporary today. The executive pay package has increased rapidly in the past two decades, along with the increasing public anger towards it. Since the global financial crisis in 2007, social media has criticised bankers' extraordinary high pay despite theirs poor performance. Many blamed their compensation practices as a contributing factor to the crisis because it attracts excessive risk taking. This motivates us to revisit the relationship between CEO compensation, performance and risk taking in the banking sector.

To our knowledge, no one has done any study in this area using European Union data. In Chapter 2, we manually collected data of CEO compensation of EU banks from their annual reports. Ultimately we narrowed down our sample to 63 banks in 15 countries for the time period 1992 to 2010. We use panel estimation technique in this study. To account for endogeneity, we applied the 3SLS system panel estimation. We used the estimated parameters to simulate the steady-state solution in the system. Our major finding is that while there is a positive relationship between performance and compensation, however the relationship between short term incentive (bonus) and risk is not causative, which lays doubt about the public perception that risk taking and bankers' paid is positively correlated.

Chapter 3 studies the market efficiency and forward premium puzzle. The efficient market hypothesis states that if the foreign exchange market is competitive, frictionless, with all information available and used rationally by risk, then there will be no speculations because the expected returns will be zero. We investigate the implication of the efficient market hypothesis – the forward exchange rate should be an unbiased predictor of the corresponding future spot exchange rate. We also investigate the forward premium puzzle, the negative relationship between the forward rate and the corresponding future spot rate return. The puzzling implication is that domestic currency is expected to appreciate when domestic nominal interest rates exceed foreign interest rates.

While most of the previous literature focuses on the developed economies, we also include some of the major emerging economies in our investigation. More importantly, not only did we compare vertically between developed and economies countries, we also compare it horizontally using different time horizons. To our knowledge no one has looked at this problem from our perspective. While most of the studies used only one time horizon, we use high frequency daily data covering 9 time horizons, namely 1 day, 1week, 1 month, 2 months, 3 months, 6 months, 9 months, 1 year and 2 years. We provide a comprehensive examination of spot and forward rates, spot return and forward premium in different time horizons. We used the traditional ADF test for each time series to account for cross-section independence and serially correlated errors. We applied cointegrating regressions by using FMOLS and DOLS estimators. Forward rate is an unbiased predictor of future spot rate according to efficient market hypothesis. Our hypothesis is that forward rate prediction power decreases in the longer time horizon. This study provides a more complete picture of forward rate unbiasedness and forward premium puzzle.

In the literature of bank CEO compensation and risk, many researchers investigated the effect of bank deregulation on bank CEO compensation. While the compensation package is criticized as being a contributing factor to crisis, we also want to find out whether financial liberalization also contributes to crisis. Previous studies have measured liberalisation by employing 0-1 dummy variables. In Chapter 4 we use panel data on the liberalization index, which captures various liberalization policies taken as well as the extent of liberalisation. Further, my focus is on current and the most serious crisis rather that looking at all types of financial crisis in general. The proxy for the current crisis is the 10-year government bond yield spread relative to Germany, as bond yield increases significantly in most of the EMU countries since crisis happened in 2007 except Germany. We employed SUR and 2SLS in the panel estimation to account for endogeneity. Our results show that past financial liberalization is responsible for the current financial crisis.

Chapter 2 Banker's Compensation and Risk Taking in EU banks

2.1 Introduction

Banker's pay has received considerable attention in the media in recent years and particularly since the global financial meltdown of 2007 - 2008. Popular opprobrium relating banker's compensation to risk-taking as expressed in the media has influenced policy makers resulting in regulatory injunctions to cap banker's compensation. President Barack Obama and key advisers introduced a series of regulatory proposals in June 2009, in which they capped executive pay at $500,000 per year for companies receiving extraordinary financial assistance from the U.S. taxpayers.

The popular view is that bank CEOs receive upside rewards for risk-taking but are protected from the downside cost. Allegedly pay arrangements provide significant incentives to take risks beyond optimal levels. It is considered that the excessive risk taking contributes to the financial crisis. In a statement by US Treasury Secretary Tim Geithner on Compensation 2009, he stated that "This financial crisis had many significant causes, but executive compensation practices were a contributing factor." The US Treasury Department created the Office of the Special Master for Troubled Asset Relief Program (TARP) Executive Compensation that has the responsibility of reviewing compensation structures of senior executive officers at financial institutions that received financial assistant under the TARP. The special Master determines whether the compensation structures of senior executives at the financial institution may result in payments that are contrary to the public interest, that it should avoid incentives which encourage employees to take unnecessary or excessive risks that could threaten the value of the bank.

The concern of CEOs being over paid is widely felt throughout Europe. One statistic shows that in 1978 the CEO of British Aerospace was paid £29,000 a year. In 2010, the CEO of BAE System, Ian King, was paid over £2.3m, a rise of 8,000%[1]. Yet BAE is making up to 3,000 workers redundant, which under government defence procurement rules, the state will pay for. The question being raised is whether it is fair to pay Ian King millions while the taxpayer bears the cost of sacking the worker? In January 2012, Business Secretary Vince Cable unveiled plans designed to curb executive pay in a speech to MPs[2]. He said "We cannot continue to see chief executives' pay rising at 13% a year, while the performance of companies on the stock exchange well behind. We can't accept top pay rising at 5 times the rate of the average workers' pay as it did last year." Bell and Van Reenen (2010) document that about 60% of the increase in pre-crisis extreme wage inequalities in the U.K. was due to the financial sector.

Bankers and legislators in the UK are also aware that the inappropriate CEO payment scheme may have led to the financial crisis. According to a BBC news report in September 2008, few bankers have stood up and admitted that remuneration in the banking industry was one of the causes of the credit crunch. Stephen Green, the chairman of HSBC concedes in the interview that some bankers were paid too much for deals that may have yielded short term profits but ended up costing their institutions a fortune. He said "What has been blindingly obvious to those outside his industry for some time – that bankers pay must be reformed, so that bankers only receive fat rewards as and when their transactions yield sustainable long term profits."[3] A report by the Financial Services Authority (FSA) in the UK also admitted

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[1] Flint, Max. "Why Is Chief Executives' Pay Not Linked To Performance? ". *BBC News*. 9 February 2012. Retrieved from http://www.bbc.co.uk/news/business-16932043

[2] "Government Executive Pay Curbs Plans Announced". *BBC News.* 23 January 2012. Retrieved from http://www.bbc.co.uk/news/uk-politics-16688925

[3] Peston, Robert. "BBC - Peston's Picks: HSBC: Reform Bankers' Pay". *BBC News*. 13 September 2008. Retrieved from http://www.bbc.co.uk/blogs/thereporters/robertpeston/2008/09/hsbc_reform_bankers_pay.html

that “There is a strong prima facie case that inappropriate incentive structures played a role in encouraging behaviour which contributed to the financial crisis” (Turner 2009).

In July 2010, the European Parliament agreed EU-wide rules on bonus payments for banks, hedge funds and other financial institutions, designed to reduce risk-taking, but implementing them was left up to individual EU members and their regulators. FSA has announced plans to update its guidelines on bankers’ pay, following the agreement of new European rules. The plans include tighter restrictions on bonus payments and pension deals, and will now apply to more than 2500 City firms. Previously, only the biggest banks were subject to FSA pay rules. The changes also include deferring at least 40% of bonus payments over a period of three years, and paying at least 50% of bonuses in shares[4]. However Due to perceived regulatory failure of the banks during the financial crisis of 2007–2008, the UK government decided to restructure financial regulation and abolish the FSA. On 19 December 2012, the Financial Services Act 2012 received royal assent, abolishing the FSA with effect from 1 April 2013. Its responsibilities were then split between two new agencies: the Financial Conduct Authority (FCA) and the Prudential Regulation Authority (PRA) of the Bank of England. Proposals from the European Union in April 2013 were to cap bonuses at 100% of salary unless at least 65% of the firm's shareholders approve an increase to 200% salary or 75% of shareholders if there is no quorum. On 26 June 2013, the European Parliament and Council of the European Union passed the "EU banker bonus cap"[5], which took effect on 1 January 2014. However in September 2013, the United Kingdom sued over the cap. This chapter revisits the empirical evidence that links bank CEOs compensation to bank performance and bank risk. Most studies in regards to CEO compensation use the USA as their sample, due to data availability. Only a handful of studies have been carried out using

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[4] "FSA Tightens Bankers' Pay Rules". BBC News. N.p., 2016. Web. 13 Oct. 2016. *BBC News*. 29 July 2010. Retrieved from http://www.bbc.co.uk/news/business-10805903

[5] Position of the European Parliament - EP-PE_TC1-COD(2011)0203, Consolidated legislative document, page 201, 2013-04-16

data from other countries. I extend the scope of research by manually collecting compensation data from 63 banks across 15 European countries including the UK, and construct an unbalanced panel data over the period 1992 to 2010. I am interested in finding out results for European banks because of their major differences with US banks e.g. European bank chiefs are paid less than US rivals. As in 2014, European bank chief executives are being paid less than half the amount of their US counterpart. Also the proportion of long term payment is much higher in the US banks. In general US banks are more valuable than European banks. US banks have higher price to book value ratio, higher net income and higher net interest margin. European banks have higher leverage ratios (Tier I capital ratio to its total risk-weighted assets). The loan-to-deposit ratio of most European banks is far above that of its US rivals because there are many more banks, and thus more competition for deposits, and there are outside-bank competitors for deposits such as the National Post Office.

It could be argued that Europe has a stronger culture of 'too big to fail' (TBTF) than the US. The TBTF theory asserts that certain corporations, and particularly financial institutions, are so large and so interconnected that their failure would be disastrous to the greater economic system, and therefore they must be supported by the government when they face potential failure. The U.S. government is less motivated to bailout banks because the U.S. banking industry is less highly concentrated than the banking industries in Europe. For example, the banking industry concentration ratio (a measure of the cumulative percentage share of deposits or assets as a share of total industry deposits or assets) for the five largest banks in the U.S. was 26.6 percent in 1999. Concentration ratios for France (70.2 percent), and Switzerland (57.8 percent) far exceed the ratio for the U.S[6]. Also, many companies and

[6] "How Does The U.S. Banking System Compare With Foreign Banking Systems?". *Federal Reserve Bank of San Francisco*. April 2002. Retrieved from http://www.frbsf.org/education/publications/doctor-econ/2002/april/us-banking-system-foreign/#fn6

individuals in Europe have a cultural suspicion of risk-taking, entrepreneurialism and ‘Anglo-Saxon’ capital markets. This is also reflected in their savings habits: while Europeans save more than people in the U.S., far less of these savings are invested. Pension fund assets in Europe are just one third the size of the U.S. relative to GDP, and mutual funds are just over half as big[7]. There is less evidence that the Federal Reserve is stepping in to bailout banks. The Federal Reserve chose not to bail out Lehman Brothers citing a 'moral hazard'. In Europe, we see examples of the French government bailing out Credit Lyonnais, and UK government bailing out Northern Rock and RBS. The reality as expressed by Alistair Darling (the former Labour Chancellor during the crisis) is that the fear of systemic crisis means governments are reluctant to let even small banks fail let alone large ones[8]. During the Financial crisis, both the US and the UK released a rescue plan. The British rescue plan differed from the initial United States' $700bn bailout under the Emergency Economic Stabilization Act of 2008, which was announced on 3 October and entitled the Troubled Asset Relief Program (TARP). The £50bn being invested by the UK Government saw them purchasing shares in the banks, whereas the American program was primarily devoted to the U.S. government purchasing the mortgage backed securities of the American banks which were not able to be sold in the secondary mortgage securities market. The U.S. program required the U.S. government to take an equity interest in financial organisations selling their securities into the TARP[9] but did not address the fundamental solvency problem faced by the banking sector; rather was aimed at tackling the immediate funding shortfall. The UK package tackled both solvency, through the £50bn recapitalisation plan, and funding, through the government guarantee for banks' debt issuances and the expansion of the Bank of

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[7] Brecht, Kira. "How U.S. And EU Capital Markets Are Different ". *OpenMarkets*. 29 October 2015. Retrieved from http://openmarkets.cmegroup.com/10431/how-u-s-and-eu-capital-markets-are-different

[8] Perman R (2013), Hubris: How HBOS wrecked the best bank in Britain, Birlin: Edinburgh

[9] "Q&A: How will the UK bailout work?". CNN. 2008-10-08. 8 October 2008. Retrieved from http://edition.cnn.com/2008/BUSINESS/10/08/uk.bailout.questions/index.html

England's Special Liquidity Scheme. All these examples give evidence that European banking industry has a stronger culture of TBTF compare to the US. Although there are so many differences between US and European banks, it can be argued that at this high level of payments, there is a global market for CEOs. Consequently there is bound to be some infiltration of cultures. Although the cultures in European countries are different from the US, the people are influenced. Because of this cross fertilization, we may expect the results we get from Europe to be similar to that in the US, but perhaps not exactly the same coefficients or responses, which makes it worthy of study.

Given the context of a stronger TBTF culture in European banking industry, while most of the research in this area has been using US banking data, we are motivated to explore the incentive pay and risk taking relationship using European sample banks. Although researchers give different evidences to this relationship, the more popular view is that incentive pay and risk taking are positively related, which implies that incentive pay are designed to promote risk taking. In our study, we find a significant negative relationship between risk and bonus (short term incentive) for the whole sample. We also find that the negative relationship is prominent post-crisis, but in the pre-crisis period, risk and bonus are positively related. When a bank is TBTF, shareholders should find it optimal to approve larger bonuses because they benefit selectively from the upside of increased risk. We suggest that excess risk taking might have contributed to the crisis. We find that bonus is reduced substantially after crisis.

We also investigate the pay and performance relationship using European bank sample data. It is common to use compensation as the dependent variable and a performance indicator as the independent variable when investigating the pay-performance relationship. In this chapter we also look at this problem but in the opposite direction and have performance as the dependent variable. The literature mainly models salary and bonus together as cash compensation. We recognise the distinctive role played by salary and bonus during our research and model them in separate equations. Our result shows a significant positive bonus and performance relationship, but the relationship between salary and performance is insignificant.

There are two main branches of research regarding to CEO compensation, one is the pay-performance relationship, and the other one is risk and incentive relationship. We contribute to the existing literature to bring these two together. We investigate the relationship amongst pay, performance and risk. Because pay, performance and risk are endogenous and jointly determined[10], we use simultaneous system equations approach. It is well know that OLS estimation of simultaneous equations models yields estimators that are biased and inconsistent. 3SLS estimates all of the coefficients in a model simultaneously, while allowing for a correlation between the error terms across equations. The 3SLS estimate could avoid spurious inferences in OLS estimate and provide asymptotically consistent estimates of the standard errors (Sawa 1969).

Lastly we examine the dynamic properties and provide steady-state solution to the system equations. Using the steady-state solution and the 3SLS results, we are able to explain that the relationship between risk and bonus is driven by other exogenous factors. Although we observe a positive relationship between risk and bonus pre-crisis and negative post-crisis, it doesn't imply that the short term incentive may or may not induce risk taking, because any observed positive or negative relationship between short-term incentive payments and risk are caused by other exogenous factors and are not causally linked.

This chapter is organised as follows. Section 2.2 is the literature review. The first part reviews the literature on compensation and performance for both industrial and banking

[10] See Yang (2010), Chien and Wen (2013), and Livne et al. (2013)

sectors. The second part reviews the literature on risk and compensation. We discuss the conflict between shareholders and executives attitudes toward risk, and how compensation can be used as a tool to align the interests of both parties. Section 2.3 provides details of the manual data collecting process for compensation, and the method of obtaining different measure of risks, also describing and discussing the statistics of each variable used in the chapter. Section 2.4 outlines the base model and presents the technical discussion relating to the system estimation. Section 2.5 refines the base model from the empirical experiments, and presents empirical findings for both single equations and system estimation. Section 2.6 discusses the dynamic properties of the system and provides the steady-state solution. Section 2.7 concludes this chapter.

2.2 Literature review

2.2.1 CEO compensation and firm performance

2.2.1.1 Early literature

As a result of the separation of ownership and management in modern firms, conflicts of interest among different stakeholders, particularly the shareholders and the managers, have become an important issue that has been widely studied by academics. The relationship between shareholders and the managers can be traced back to Adam Smith (Smith 1776), which recognizes the contractual nature of the relationship between the masters and the workers. What are the common wages of labour depends everywhere upon the contract usually made between those two parties, whose interests are not the same. The workmen desire to get as much, the masters to give as little as possible (Smith 1776, bk. 1, chap. 7, p. 66). He stressed the lack of appropriate incentives for slaves: The work done by slaves, though it appears to cost only their maintenance, is in the end the dearest of any. A person, who can acquire no property, can have no other interest but to eat as much, and to labour as little as possible. (Smith 1776, bk. 1, chap. 8, p. 365)

However, Barnard (1938) is the one who can probably be credited with the first attempt to define a general theory of incentives in management, in chapter 11 (the economy of incentives) and chapter 12 (the theory of authority) of his celebrated book *The Functions of the Executive*. As it is quoted in Laffont and Martimort (2009): "An essential element of organizations is the willingness of persons to contribute their individual efforts to the cooperative system . . . Inadequate incentives mean dissolution, or changes of organization purpose, or failure to cooperate. Hence, in all sorts of organizations the affording of adequate incentives becomes the most definitely emphasized task in their existence". It is probably in this aspect of executive work that failure is most pronounced.

The separation of ownership and control in modern corporations is well recognized by Berle and Means (1932). They argue that the structure of corporate law in the US in the 1930s enforced the separation of ownership and control because the corporate person formally owns a corporate even while shareholders own shares in the corporate entity and elect corporate directors who control the company's activities. As property has been gathered under the corporate system, and as control has been increasingly concentrated, the power of this control has steadily widened. He asserts that the past century has seen the corporate mechanism evolve from an arrangement under which an association of owners controlled their property on terms closely supervised by the state to an arrangement which many men have delivered contributions of capital into the hands of a centralized control. This has been accompanied by grant of power permitting such control almost unexplored permission to deprive the grantors at will of the beneficial interest in the capital thus contributed.

This work is further extended by Ross (1973), who redefine it explicitly as an agency problem. Ross (1973) provides some of the micro foundations for such studies. It was once believed that the solution to the principal's problem would not be Pareto-efficient, which Ross finds it naive to take. He shows that for an interesting class of utility functions and for a very broad and relevant class of payoff structures, the need to motivate agents does not conflict with the attainment of Pareto efficiency. A better understanding of the phenomenon was only achieved when the economists reconsidered the problem in the context of the principal agent theory.

A pioneering work of executive compensation has done by Taussig and Barker (1925). They sent questionnaires to organizations by mail, from a fairly prosperous set of businesses for ten years pre-war period from 1904 to 1914. The survey reveals that during the war, business salaries in common with other money earnings were greatly increased, and they remain at the present time at a much higher level than that of the pre-war period. It also suggests that poor management leads to a change in personnel, not a decrease in salary. There is hardly a sign in any instance that salaries are adjusted upward year by year upon the basis of annual earnings, and none that they are adjusted downward in the survey. While earnings show the ebb and flow of changing business conditions, the salaries of the mangers remain unchanged.

Roberts (1956) shows that the level of executive compensation is related significantly only to corporate size. Its relationship to the level of profit is superficial and disappears when the influence of size upon both compensation and profit is taken into account. Within the area of manufacturing and retail trade, industrial differences in compensation are only a reflection of industrial differences in company size, and become statistically insignificant when the effect of such differences in size of company is removed. Roberts (1956) finds evidence that firms in the utility, railroad, airlines, insurance, banking and finance fields, where there is public regulation or close scrutiny, consistently pay less than similar firms in other lines of activity. In respect to changes as opposed to levels of compensation, he finds profit and size move together so frequently that little significance attaches to the independent affinities of compensation for profit and for size. But there is a minority of cases in which compensation moves contrary to both profit and size. The relationship that Roberts (1956) finds in his data is a logarithmic one.

Simon (1957) developed an alternative theory of a more sociological character. His explanation predicts not only a positive relation between size of company and compensation, but also the logarithmic form of the function. He argue that the larger firms have more hierarchical levels and, because firms attempt to insure adequate pay differentials between hierarchical levels, are therefore likely to pay more to CEOs. He further infers that the distribution of executive salaries is not unambiguously determined by economic forces, but is subject to modification through social processes that determine the relevant norms.

A notable early literature is from Baumol (1959). He perceives that executive salaries are far more closely correlated with the scale of operations of the firm than with its profitability. He also argues that in corporations which is characterized so often by separation of ownership from management, many executives find it prudent to avoid an absolute or relative decline in their operations. It is not unusual to find a profitable firm in which some segment of its sales can be shown to be highly unprofitable. He asserts that the typical oligopolies' objective can be characterized approximately as sales maximization subject to a minimum profit constraint. So long as profits are high enough to keep stockholders satisfied and contribute adequately to the financing of company growth, management will bend its efforts to the augmentation of sales revenues rather than to further increases in profits. Evidence from McGuire, Chiu et al. (1962) support the likelihood that there is a valid relationship between sales and executive incomes as Baumol (1959) assumed, but not between profits and executive incomes, although, because of the statistical problems involved, the tests employed do not completely rule out the possibility of a valid relationship between profits and executive incomes too.

Studies before 1970 obtained results which was decisive by the standards of applied economics, and reported in favour of the 'managerial theorists' arguments were dominating. The relation between size and pay was found to be positive and passed the usual statistical significance tests, whereas the relationship between profitability and pay earned only scorn (Meeks and Whittington 1975).

In 1970 this unanimity was disturbed by Lewellen and Huntsman (1970), who came to the conclusion that there is a statistically significant positive relationship between profit and compensation, and no sale-compensation relationship. He argues that there is a greater incentive for management to shape its decision rules in a manner in line with shareholder interests than to the alternative of pursuing the goal of revenue maximization. Subsequently additional studies emerged over the next few years. There has been a debate between managerialists who favour the corporate growth hypothesis and the neoclassical economists who support the profit maximization assumption. However there was no clear resolution.

Larner (1971) finds that despite the growing separation of ownership and control in the large corporation, compensation is most consistently linked to profit. Masson (1971) confirms the executive income/common stock performance hypothesis introduced by Lewellen. His results show that sales performance of the firm has no consistent positive or negative effect on executive financial return. It was found that firms with executives whose financial rewards more closely paralleled stockholders' interests performed better in the stock market over the post-war period. It was concluded that the hypothesis of present-value maximization better explains firm behaviour than the hypothesis of sales maximization. It is the conclusion of this author that the sales-maximization hypothesis does not usefully characterize the "typical oligopolist," as has been asserted by Baumol (1959). Ciscel (1974) supports and expands the findings of McGuire, Chiu et al. (1962). He finds a strong relationship among executive group compensation and company employment, and sales and assets indicated that growth and size, and not profitability, were the primary determinants of corporate financial reward. Smyth, Boyes et al. (1975) re-examine the Lewellen and Huntsman’s model, improving the corrections for multicollinearity and heteroscedasticity, and concluded that executive compensation is based on a utility function of both sales and profits. Cosh (1975) and also Meeks and Whittington (1975) support the managerialist position of a relationship between compensation and sales, but not profit. Study by Ciscel and Carroll (1980) is in conformity with both a neoclassical and a managerialist interpretation of firm behaviour. Executives are paid for increasing profits, whether through sales growth or cost control. He indicates that several aspects of corporate performance influence decisions concerning executives’ salary.

Only a handful of studies of executive compensation were published prior to 1980. The modern history of executive compensation research began with the general acceptance of agency theory in early 1980s. Murphy (1986) is one of the early influential papers on the topic of CEO compensation. Under the context of the principle-agent problem and incentive problem, he states that the level of managerial effort would depend on an executives' incentive contact. He develops two hypotheses that based on an incentive model and a learning model that explain the implication so managerial contractual arrangements. His incentive hypothesis states that a CEO's compensation depends on past performance, while his learning hypothesis states that incentives are unimportant and executive productivity depends on managerial ability which is initially unknown, but revealed over time. His finding is more consistent with the learning model, but there are significant results for both hypotheses. He states that cross sectional studies that analyse executive compensation across companies at a point in time cannot point out the correlation between pay and performance. Instead it is the correlation between pay and performance over time for a company that can provide insights into whether pay and performance are correlated. He argues that pay and performance of top executives are strongly and positively correlated. Many studies focused on testing pay-performance sensitivity empirically. In the most cited paper, Jenson and Murphy (1990), showed that a $1000 increase in shareholder wealth leads to a $3.25 increase in CEO pay, a sensitivity that many subsequent authors found surprisingly low given that agency problems are presumed to be important in affecting CEO behaviour and that compensation should therefore have a strong performance-based component. Jensen and Murphy (1990b) question the importance of excessive compensation in public debates. They instead propose the way that CEOs are paid should be analysed rather than just focusing on how much CEOs are paid. Based on information on salaries and bonuses for 2505 CEOs in 1400 publicly held companies from 1974 through 1988, they found that changes in compensation do not reflect changes in corporate performance because a $1000 change in market value of a company resulted in just 6.7 cents increase in the salary and bonus of the CEO. They further suggested that to align shareholder's interest, managers should be given big rewards for outstanding performance and suitable penalties for underperformance. They argued that the political forces in the public and private spheres regarding executive compensation has played a role in dampening the sensitivity of pay and performance of top managers in the corporate sector. This paper is widely cited both in academic papers and in popular press, since it raised doubts whether the U.S. companies are managed efficiently.

Studies often yielded the conclusion that the pay performance relationship was either short lived or non-existent. Leonard (1990) examines the effects of executive compensation policy and organizational structure on the performance of 439 large U.S. corporations between 1981 and 1985. The data reveal no strong association between managerial pay, equity and corporate performance. There is no significant correlation between the variance of managerial pay within a firm and the firm's subsequent change in ROE. Evidence from Riahi - Belkaoui (1992) does not support a positive relationship between executive compensation and social performance. He states that social performance does not appear to be a major external force considered by the executive compensation committee. Akhigbe, Madura et al. (1995) also offer little support for the maintained hypothesis that executive compensation has reduced executive-shareholder agency costs and in turn enhanced firm value. Their study does not find support for the prior that executive compensation and firm performance are strongly correlated. Davis and Shelor (1995) examine the relationship between financial performance and executive compensation among firms in the real estate industry. They find less evidence to support the relationship between total compensation and changes in financial performance. Ingham and Thompson (1995) find weak evidence to support a positive relationship between profit and pay but argue that the use of performance related pay is more important as an incentive device since other market based controls on CEO rent-seeking behaviour are absent. Miller (1995)'s results do not support a linear relationship between performance and CEO compensation changes, but find support for an increasing, convex relationship. A Study by Core, Holthausen et al. (1999) suggest that firms with greater agency problems receive greater compensation; and that firms with greater agency problems perform worse. Their predicted component of compensation arising from the board and ownership variables exhibits a negative correlation with subsequent firm operating and stock return performance. Attaway (2000) finds weak support for Agency theory, as it relates to the relationship between company performance and CEO compensation. The results suggest that there is a small but positive relationship between firm performance (stockholders equity) and CEO compensation. Other studies such as Aupperle, Figler et al. (1991), Mehran (1995) and Madura, Martin et al. (1996) all find weak relationship between performance and executive compensation.

In contrast, Murphy (1985) finds that executive compensation is strongly positively related to corporate performance as measured by shareholder return and growth in firm sales. The results are robust to the stock market performance measure utilized. Veliyath and Bishop (1995) support the existence of a relationship between components of CEO compensation and firm performance. Hall and Liebman (1998) argue that CEOs are not paid like bureaucrats. They stated that the relationship between pay and performance is almost entirely driven by changes is the value of stock and stock options. Because of increase in stock option grants, both the level of CEO compensation and the sensitivity of compensation to firm performance have risen dramatically since 1980. Stammerjohan (1996) suggests that greater reliance on stock options, as a form of CEO compensation, is positively correlated with superior subsequent firm performance, but greater personal stock ownership may not provide alignment of interest between CEO and stockholder. Murphy (1999) documents and updates several cross-sectional stylized facts, and has shown how executive compensation practices vary with company size, industry, and country. Regarding to pay-performance sensitivity, the study shows that levels of pay and pay-performance sensitivities are lower in larger firms; levels of pay and pay-performance sensitivities are lower in regulated utilities than in industrial firms; levels of pay and pay-performance sensitivities are higher in the US than in other countries. The study also documents that pay-performance sensitivities in the US are driven primarily by stock options and stock ownership and not through other forms of compensation.

Alshimmiri (2004) reports a negative relationship between cash managerial remuneration and firm performance, however he found that the relationship is negative only when board size is small, and it turns positive when board size grows. Brick, Palmon et al. (2006) find a significant positive relationship between CEO and director compensation, but they argue that this relationship could be due to unobserved firm complexity (omitted variables), and to excess compensation of directors and managers. The issue of pay-performance relationship is still attracting much comment and remains under debate.

2.2.1.2 Literature using data outside US

Mainly due to data availability, much of the academic research on executive compensation has been concentrated on the U.S. However, executive compensation has attracted much attention from economist worldwide in the past decade, though the amount of research done with non-US data is significantly less. Using comprehensive financial and accounting data on China's listed firms from 1998 to 2002, Kato and Long (2006) find statistically significant sensitivities and elasticities of annual cash compensation (salary and bonus) for top executives with respect to shareholder value. Their results show that sales growth is significantly linked to executive compensation. In addition, Chinese executives are penalized for making negative profit. Also as long as the executives are making positive profits, they are neither penalized for declining profit nor rewarded for rising profit. Firth, Fung et al. (2006) find that CEO compensation depends upon a firm's return on asset although this relationship mainly holds with foreign shareholders and in state-owned companies. The pay-performance relationship is stronger for return on assets than for stock returns.

Using Indian data, Bhattacherjee, Jairam et al. (1998) does not find a significant relationship between CEO pay and accounting based performance measures. However, they find that sensitivity of pay to performance was increased after economic liberalization. Ghosh (2006) studied the compensation of the board of directors along with CEO compensation to capture the effects of inefficient monitoring by the board. Using data from a large number of firms in the manufacturing sector in India, he finds that board compensation depends on current and past year performance while CEO compensation depends on only current year performance. The results indicate that firm size significantly explain the differences in compensation across firms. However executive characteristics such as education and experience are found to be ineffective in explaining CEO compensation. Parthasarathy, Menon et al. (2006) investigate the determinants of executive compensation using data which encompasses the entire range of industries that are found in the Indian corporate sector. They suggest that CEO compensation was a function of firm performance and shareholder wealth, firm specific characteristics and corporate governance parameters. Their results indicate that none of their profitability measures is a significant determinant of total CEO pay. But firm size is a significant variable in explaining both total CEO pay and the proportion of variable or incentive pay.

In Japan, Kubo (2005) explore the effect of pay policy on company performance in Japan. The main results in this paper show that in many Japanese companies, a one percent increase in company performance will lead to a zero to 0.33 percent increase in directors' pay. The proportion of firms with negative pay-performance sensitivity is large in Japan, showing the link between pay and performance is week. Evidences do not support the hypothesis of a positive relationship between the change of pay policy and performance, indicating that directors are not motivated by increases in performance-pay sensitivity. Kato and Kubo (2006) use panel data on CEO's salary and bonus of Japanese firms from 1986 to 1995, and find that CEO's cash compensation is sensitive to firm performance, especially on accounting measures. However, stock market performance is less important in explaining CEO's compensation. Abe, Gaston et al. (2005) combine elements of tournament model and agency model and show that the outsider who monitors the firm's activity will lower the sensitivity of pay to firm performance for top executives and reduce the importance of tournament-based incentives. They argue that bank-appointed board members help monitor top executives and tournament considerations are a particularly important feature of executive compensation in Japan. Mitsudome, Weintrop et al. (2008) find a significantly positive relation between changes in CEO compensation and short-term firm performance, which is measured by stock returns and changes in operating income. They also find a significantly positive relation between the changes in CEO compensation and the lagged performance measures. This implies that Japanese CEOs are rewarded for firm performance for more than one period.

Vittaniemi (1997) examines the issue of executive compensation and performance in Finland. He uses panel data on 70 non-listed firms and 48 listed firm over 5 years from 1989 to 1993. He uses once lagged variables to measure firm performance and finds a significant pay-performance relationship in executive compensation among listed firms but not in non-listed firms. Izan, Sidhu et al. (1998) find no linkage between CEO pay and performance from Australian evidence. The research by O'Neill and Iob (1999) also find an insignificant pay-performance relationship using Australian data. However Merhebi, Pattenden et al. (2006) examine a sample of 722 Australian firms for the years 1990-1999, suggesting a positive relationship between CEO pay and performance. In Norway, Firth, Lohne et al. (1996) explore the determinants CEO compensation in Norwegian stock exchange listed firms. The results indicate a positive relationship between CEO pay and corporate size but insignificant link between remuneration and corporate financial performance, as measured by accounting profitability and stock returns. In addition the study reports a positive and significant association between a CEO's compensation and the average wage level of the company. Sharma and Smith (2001) examine the determinants of the growth of executive compensation in Australia and Canada. They investigate the influences of growth of company performance (revenue growth and profit growth) on executive compensation. Their empirical findings indicated revenue growth rather than profit growth has a statistically significant effect on the growth of executive compensation. Gunasekargea and Wilkinson (2002) investigated the pay-performance relationship in New Zealand. They do not find firm performance to have any significant influence on CEO cash compensation. Instead, they find the size of the firm and the ownership concentration exert statistically significant influences on CEO cash compensation.

In Israel, Amzaleg and Mehrez (2004)'s findings, which is based on both financial statements and the correlation between the return on shares and that of the industry as a whole, support the hypothesis that there is a positive and significant relation between the CEO's compensation and performance. Laan (2009) uses a pooled time series cross-section dataset comprising most listed firms in the Netherlands for the period 2002-2006 found that corporate performance a predictor of the level of equity-based compensation.

2.2.1.3 Literature in the banking sector

Researchers especially in earlier studies did not look at the executive compensation and firm performance relationship in the financial sector. The literature focusing on the executive compensation practices of financial institutions has been limited. Recently the different nature of banking firm has been realised and thus attract more attention of researchers in this area. The impacts of regulation and deregulation provide a natural laboratory for investigating how firms adjust their executive compensation contract as the environment where they operate change. Moreover, commercial banks are different from manufacturing firms that they are regulated in a higher degree. In addition the variability in executive compensation that results purely from industry differences can be minimised.

One of the main focus of the banking literature is the pay ad performance relationship, Barro and Barro (1990) first document a positive relationship between pay and performance for commercial banks in USA. Their findings support the pay and performance relationship being an incentive alignment mechanism for banks. Houston and James (1995) find that CEOs in banking firms (with high leverage ratio) receive less cash compensation, and that they receive a smaller percentage of their total compensation in the form of options and stocks than do CEOs in other industries. He argued there is no difference in the pay-for-performance relationship between banks and non-banks and that banks use less incentive pay (stock options and stockholdings). However, the cash compensation of bank managers is more sensitive to firm performance than it is in nonbank firms. Crawford, Ezzel et al. (1995) document a dramatic increase in the relationship between CEO pay and commercial bank performance after 1981, they also find that CEOs of both high-capitalization and low-capitalization banks experienced significant increases in pay-performance relations. Tripp and Kenny (1995) using 25 largest US commercial banking from 1988 to 1992, document that the growth in executive compensation is highly sensitive to performance. Akhigbe, Madura et al. (1997) find a positive significant pay and performance relationship for both accounting performance proxies and market-based performance proxy. Sigler and Porterfield (2001) also find a strong positive and significant link between changes in CEO total compensation and bank performance using 31 publicly traded banks from Forbes during 1988 to 1997. A study by Joyce (2001) find that there is a small but positive relationship between firm performance and CEO salary and bonus compensation. Gregoriou and Rouah (2003) also find a positive relationship with CEO compensation and performance. Using 9 large German banks, Burhop (2004) find that pay-performance elasticity and sensitivity were high for the 19th century German joint-stock banks. During the 19th and early 20th century, the elasticity and the sensitivity became stronger. Frydman and Jenter (2010) point out, the sensitivity of CEO wealth to performance surged in the 1990s, mostly owing to rapidly growing option portfolios.

Some researchers aimed to find out what factors could have influenced the pay and performance relationship. Demsetz and Saidenberg (1999) conduct a research using 298 banks. They find that the structure of compensation varies substantially across firms, with executives at larger banks receiving a greater share of their compensation in the form of annual bonus, long-term compensation, and option-adjusted compensation, and a small share in the form of bas pay. Differences in the components of compensation translate into significant differences in pay-performance relationships across firms, with size being the distinguishing frim characteristic. John and Qian (2003) find that the CEO compensation in the banking industry has lower pay-for-performance sensitivity than manufacturing firms and that this difference is largely attributable to the difference in debt ratios between the two industries. Gregoriou and Rouah (2003) find that CEO compensation increases with the size of institution, and with the value of long-term incentive plans and CEO age. However, the study failed to find any effect of tenure on compensation. Ang, Lauterbach et al. (2002)

examine the compensation of the chief executive as well as the rest of the management team. Their finding suggests that CEOs receive not only great pay but also are rewarded more in relation to performance. Harjoto and Mullineaux (2003) find a strong link between growth options and CEO compensation in the 1990s. They also give evidence that leverage and variability in returns have positive effects on CEO incentive pay. Pay-performance sensitivity declines as return variability increases. Kose and Yiming (2003) comprise a sample of 120 commercial banks and 997 manufacturing firms. They find that pay-performance sensitivity of a firm is declining in debt ratio and frim size, and it is lower in regulated firm. Also, given their high debt ratio, banks have lower pay-performance sensitivities than manufacturing firms. Crumley (2008) find a strong relationship between sales, assets and number of employees and the level of CEO compensation. John et al. (2010) using a sample of 143 US bank holding companies during 1993 to 2007, find the pay-for-performance sensitivity of bank CEO compensation decreases with the leverage ratio; and it increases with the intensity of monitoring provided by subordinated debtholders and regulators.

The methodology used in the studies of compensation and performance in the banking sector and industrial firms are very similar. Though evidences stand on both sides whether there is a significant pay-performance relationship, most literature support a positive pay-performance relationship. Compare to the studies of the industrial firms, more studies of the banking sector focus on the following aspects. A branch of the literature focuses on the impact of changes in the structure of bank regulation (deregulation) on bank compensation policies. Hubbard and Darius (1995) find a stronger pay-for-performance relationship in deregulated interstate banking markets. CEO turnover increases substantially after deregulation, as does the proportion in performance-related compensation. Crawford (1995) also report evidence that bank executive compensation became more sensitive to performance as bank management became less regulated in 1982. Brewer, Hunter et al. (2003) document a significant increase of Equity-based component of bank CEO compensation after deregulation. Cunat and Guadalup (2004) find that deregulations substantially changed the level and structure of compensation. The variable components of pay increased along with pay and performance sensitivities, at the same time, the fixed component of pay fell. The overall effect on total pay was small. Another branch of the literature in the banking sector focuses on the question of whether pay policies prompt mangers to increase risk (Saunders, Strock et al. 1990, Houston and James 1995). This part of the literature is reviewed in the next section.

2.2.2 CEO compensation and firm risk

2.2.2.1 Conflict between the shareholders and the executives in their attitudes toward risk

Another strand of research on CEO pay has moved away from decades of attempts to find evidence of the value of incentive alignment that links apportion of executive pay to specific performance criteria. Instead, researchers are shifting their attention toward the identification of those conditions under which incentive alignment, thus, risk sharing with CEO, is most appropriate. Managers may differ greatly from shareholders in their attitudes toward risk. Shareholders are considered risk-neutral because they can diversify firm-specific risk (Smith and Watts 1992). Shareholders can, at low cost, diversify their investments over many firms and thereby lower the risk from any one investment (Gray and Cannella Jr 1997). In fact, this ownership of a diversified portfolio makes shareholders risk-neutral with respect to any particular investment. On the other hand, executives cannot effectively diversify the risk of their compensation payments because their close association with the firm, they are risk-averse in their actions. One of the risks that managers facing is compensation risk, which is the extent to which an executive's compensation depends upon ex post outcomes. It reflects the extent to which non-diversifiable risk is imposed upon the executive through the compensation. Executives have no control over their compensation structure and level, so this risk cannon be diversified. The greater the percentage of contingent pay forms within a pay system, or the greater the contingency of a specific pay form, there is a reduced likelihood of payment of the intended pay level, hence, the greater is the risk of that firm's pay system. For a risk-adverse executive of a more risky firm, he would prefer salary-based compensation rather than equity-based compensation. Further, if executives' firm incur large losses, there is a risk of being dismissed, and their own competence is likely to be assessed in reference to the performance of their organizations. There would be negative implications on executive careers, such as sharp declines in income, failure to find subsequent employment as so on. It is unlikely for executives to be risk-neutral with respect to their job.

It would be an advantage to the shareholders to place some of the risk associated with firm performance on the executives, because it provides incentives for them to engage in strategies that consistent with shareholders' preferences, however, if executives are subjected to too much risk, their decision making is likely to become too risk-averse. While Jensen and Meckling (1976) originally defined the magnitude of the agency problem in terms of the degree of separation between the interest of owners and managers, subsequent clarifications suggest that linking a manager's compensation too closely to firm performance might lead to risk-avoiding behaviour on the part of the manager. Smith and Stulz (1985) theoretically illustrate that executives' compensation is a concave (or not too convex) function of firm value, that they have incentives to reduce firm cash flow variability. The cost to them of the increased project risk is greater than the benefit from the increase in firm value. Hence, such executives might reject variance-increasing positive net present value (NPV) projects, and adopt low risk – low return strategies. But for risk-neutral shareholders who maintain well-diversified portfolios often seek to undertake all NPV projects, regardless of the risk level. This is the conflict between the shareholders and the executives in their attitudes toward risk.

2.2.2.2 Mitigate the risk-related incentive problem

Agency theory suggest that there may be an optimal level of risk sharing between principals and agents, and that compensation arrangements can be used to bring about risk sharing. Research has been looking for means of firms that would promote executive risk-taking behaviour and its evidences. Researcher pertinent to firm risk-taking focuses on four areas: ownership structure, the franchise value, capital level and lines of business operated, and executive compensation (Min-Ming and Chen 2008), but it becomes more common to argue that convex payoffs should be given to CEOs with increased incentives to take on risky projects. Milgrom and Roberts (1992) argue that by making adjustments to the slope and convexity of the wealth-performance relation, shareholders can reduce the likelihood that managers pass up valuable risky project. Holding the slope constant, greater convexity in the wealth-performance relation is expected to shrink the gap between the risk-aversion effect and the wealth effect. A body of theory posits that employee stock options offer incentives to risk-averse managers to invest in high-risk, high-return projects on behalf of risk-neutral shareholders (Jensen and Meckling 1976, Haugen and Senbet 1981, Smith and Stulz 1985, John and John 1993, Harikumar 1996, Hemmer, Kim et al. 1999). Smith and Stulz (1985) illustrate how shareholders can reduce this risk-related agency problem by using stock options or common stock to structure executives' wealth as a convex function of firm performance. Since risk-related investment problems are expected to be greatest for firms with substantial investment opportunities, the magnitude of convexity in executives' wealth-performance relation is predicted to be positively related to the proportion of assets that are growth options. On empirical evidence, (Rajgopal and Shevlin 2002)'s result shows that executive stock options provide managers with incentives to mitigate risk-related incentive problems in oil and gas firms. (Min-Ming and Chen 2008) has consistent result for the property/liability insurance industry.

However it is worth noticing that a growing number of authors have questioned the validity of the argument that stock options induce CEO risk-taking as a general rule. (Ross 2004) argues that a convex pay-off structure is a necessary, but not a sufficient condition to make an agent less risk-averse. He explores the duality between a fee schedule that makes an agent more or less risk averse, and gambles that increase or decrease risk. (Carpenter 2000) examines the optimal investment policy for a risk-averse fund manager compensated with a call option on the assets under his control. Her results indicate that the manager can choose a volatility of the asset portfolio below the level he would set if he were trading his own account. The paper suggests that equity-based compensation does not necessarily lead to increased risk-taking because it can increase the sensitivity of the manager's portfolio to firm stock price movements. (Lewellen 2006) shows that executives' incentives to increase risk depend on whether the stock options held by the manager are 'in the money' or 'out of the money' – a higher value of the option compensation to total compensation is not a precise indicator of the manager's degree of incentive to take on higher risks, and she finds that this has an impact on firms' leverage choices. Much empirical work has shown a positive relationship between equity based compensation and risk.

2.2.2.3 Risk in the banking industry

There has been a growing interest in the bank compensation literature on whether pay policies prompt managers to increase risk. This interest stems in part from bank regulatory concerns with moral hazard problems arising from the provision of fixed rate deposit insurance in United State. The Federal Deposit Insurance Corporation (FDIC) is a United States government corporation created by the Glass–Steagall Act of 1933. It provides deposit insurance, which guarantees the safety of deposits in member banks. (Merton 1977, Marcus and Shaked 1984, Ronn and Verma 1986) have argued that the system of levying fixed-price (risk-insensitive) deposit insurance premium results in a put-option-like subsidy to bank stockholders – the value of which also increases with bank risk. Insured depositors of banks have little or no incentive to monitor the risk taking of bank managers. Stockholders have an incentive to increase the risk of the firm resulting in a wealth transfer from bondholders to stockholders. Thus, stockholders can increase the value of their call-option-like equity by increasing bank risk (Saunders, Strock et al. 1990). Later in 1991, The Federal Deposit Insurance Corporation Improvement (FDICIA), passed during the Savings and loan crisis, strengthened the power of the FDIC. It allowed the FDIC to borrow directly from the

Treasury department and mandated that the FDIC resolve failed banks using the least-costly method available. It also ordered the FDIC to assess insurance premiums according to risk and created new capital requirements. Consequently bank shareholders will face greater risk-taking incentives than shareholders of other levered firms. (Houston and James 1995) refer to it as the *moral hazard hypothesis* that the compensation policies in banking are designed to encourage risk taking in order to maximize the put option feature of fixed rate of deposit insurance. They investigate whether compensation in the banking industry, relative to other industries, is also structured to promote risk-taking. They find little evidence that bank compensation is designed to encourage risk taking. Their results suggest that banks were less likely to employ incentive-based compensation than non-banks over the period 1980-1990. They find that bank CEOs receive less cash compensation, are less likely to participate in stock option plans, and receive a smaller percentage of their total compensation in the form of stock options than do their counterparts in other industries. Hence their results do not support the moral hazard hypothesis. (Chen, Steiner et al. 2006) using a sample of commercial banks during the period of 1992-2000 empirically supports his management risk-taking hypothesis that the structure of executive compensation induces risk-taking, and the stock of option-based wealth also induces risk-taking.

Furthermore, deregulation in the banking sector has drawn interest of the researchers in this area. Whether the greater incentives for risk taking are reflected in riskier operating strategies will depend upon the effectiveness of incentives provided to bank manager to increase risk, also it depends on the costs, constraints, and restrictions imposed on bank risk by regulators. Buser, Chen et al. (1981) regard such restrictions as deposit insurance premiums that get more stringent as bank risk taking increases. In periods of bank activity deregulation and forbearance over closure rules, bank stockholders have greater incentives and ability to increase risk taking than when regulations are tight and strictly enforced. A body of empirical analysis has investigated the effect of deregulation in banking industry on bank risk taking. Saunders, Strock et al. (1990) investigate the relationship between bank ownership structure and risk taking, and shows that stockholder controlled banks exhibit significantly higher risk taking behaviour than managerially controlled banks during the 1979-1982 period[11] of relative deregulation. In particular, they find that larger ownership positions by executive managers and the board of directors are associated with increased risk taking. They finding is inconsistent with the evidence from Houston and James (1995). Benston and Evan (2006) find that in the lenient period (pre-FDICIA, 1988-1992), low charter value banks (low market to book equity, weak banks) prefer short-term incentive pay (bonus) to long-term (stock-based) compensation, particularly when CEOs have a substantial amount of control as evidence by high insider ownership. In contrast, high charter banks with high insider ownership had less of a tendency to rely on bonus compensation in the lenient period. The bonus compensation induces CEOs of financially weak firms to shift risk to debt holders only if they do not have large insider ownership. Elijah, William et al. (2003) examine the relationships between equity-based compensation and risk, capital structure, and investment opportunity set. They find that after deregulation (Riegle-Neal Act 1994), the equity-based component of bank CEO compensation increases significantly on average for the industry. Additionally, more risky banks have significantly higher levels of equity-based compensation, as do banks with more investment opportunities, but more levered banks do not have higher levels of equity-based CEO compensation.

[11] The Fed changed its monetary policy operating targets away from interest rates toward non-borrowed reserve target in October 1979 and maintained this policy until October 1982. More3over, in 1980 and 1982 through, respectively, the DIDMCA and Garn-St. Germain Acts, comprehensive bank deregulation packages were passed by Congress.

2.2.2.4 Measures of risk

Recently, researches have taken more interests in measuring risk using *vega* and *delta* in this research area. In mathematical finance, the Greeks are the quantities representing the sensitivities of the price of derivatives such as options to a change in underlying parameters on which the value of an instrument or portfolio of financial instruments is dependent. The First-order Greeks include *delta* - the rate of change of option value with respect to changes in the underlying asset's price; *vega* – the sensitivity to volatility; *theta* - the sensitivity of the value of the derivative to the passage of time, and rho - sensitivity to the interest rate. (Black and Scholes 1973) formula is commonly used to calculate the value of European call option[12].

$$\text{Option value} = Se^{-dT}N(Z) - Xe^{-dT}N(Z - \sigma T^{1/2}) \qquad (2.1)$$

As in (Core and Guay 2002), the sensitivity with respect to a 0.01 change in stock-return volatility, *vega* is defined as:

$$\frac{\partial(\text{option value})}{\partial(\text{stock volatility})} \times 0.01 = e^{-dT}N'(Z)ST^{1/2} \times 0.01 \qquad (2.2)$$

It measures sensitivity of CEO wealth to risk; it is also been use as a measure of stock option risk incentive (Rajgopal and Shevlin 2002)

The sensitivity with respect to a 1% change in stock price, *delta* is defined as:

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[12] $Z = [\ln(S/X) + T(r - d + \sigma^2/2)]/\sigma T^{1/2}$

N = cumulative probability function for the normal distribution
S = price of the underlying stock
X = exercise price of the option
σ = expected stock-return volatility over the life of the option
r = natural logarithm of risk-free interest rate
T = time to maturity of the option in years
d = natural logarithm of expected dividend yield over the life of the option

$$\frac{\partial(\text{option value})}{\partial(\text{stock price})}\times(\text{price}/100)=e^{-dT}N(Z)\times(\text{price}/100) \qquad (2.3)$$

Thus it measures sensitivity of CEO wealth to share price performance.

Coles, Daniel et al. (2006) find that *vega* implements riskier policy choices, including relatively more investment in research and development (R&D), less investment in property, plant, and equipment (PPE), and higher leverage. They also find that riskier policy choices generally lead to compensation structures with higher *vega* and lower *delta*. Stock-return volatility has a positive effect on both vega and delta. (Rogers 2002) use the ratio of *vega*-to-*delta* as a measure of the relative risk-taking incentives of CEOs. He shows CEO risk-taking incentives provide by portfolios of stock and options are negatively related to derivative holdings for a broad cross-section of firms. In the banking industry (Low 2009) provides evidence that firms counter the reduced risk-taking incentives of managers by increasing CEO *vega* gradually after the regime shift. In contrast to *delta*, *vega* is a more efficient mechanism for mitigating managerial risk aversion. (Belkhir and Chazi 2008) find that larger BHCs with better investment opportunities and those that operate in a deregulated environment reward their CEOs with a compensation that has a higher sensitivity to risk.

The literature suggests that bank risk is dependent on several factors including *vega/delta*, compensation, growth opportunities (usually proxy by market to book ratio), leverage, firm size, and CEO ownership. It is common to use stock return volatility as a measure of bank risk (Houston and James 1995, Elijah, William et al. 2003, Benston and Evan 2006, Coles, Daniel et al. 2006). The other common risk measure in the banking literature is obtained from the two-factor market model (Saunders, Strock et al. 1990, Chen, Steiner et al. 2006, Belkhir and Chazi 2008).

$$R_j = \alpha + \beta_{mj}(R_m) + \beta_{Ij}(I) + u_j \qquad (2.4)$$

R_j is the daily stock return of bank j, R_m is the daily return on the CRSP database equally-weighted index, I is the daily 3-month T-bill yield, and u_j is a random error. I use Ordinary Least Square to estimate the above equation and obtain the standard deviation of the residuals σ_{uj}. Total risk σ_j is measure by the standard deviation of daily stock returns for a given year. σ_{uj} is idiosyncratic risk. β_{mj} and β_{Ij} are proxies for systematic risk and interest rate risk.

The majority of the literature use pooled OLS as the method of estimation. However (Low 2009) points out that empirical evidence on the effect of equity-based incentives on managerial risk-taking behavior is inconclusive, mainly because endogeneity issues often cloud the interpretation of the relation between equity-based incentives and firm risk. (Coles, Daniel et al. 2006) argue that empirical work needs to disentangle the effects of firm risk on incentives and of incentives on risk-taking, to avoid spurious inferences and to isolate causation. Regarding this problem, (Rajgopal and Shevlin 2002) use Two Stage Least Square (2SLS) to estimate firm risk and stock option incentive simultaneously. (Chen, Steiner et al. 2006) also use 2SLS estimate relation between risk measures and compensation structure. (Coles, Daniel et al. 2006) apply 3SLS and specify simultaneous regressions of investment measure (R&D, net capital expenditures scaled by assets), *vega* and *delta*.

Stock return volatility, *Vega* and *Delta* are the most common measure of risk.

2.3 Data collection and description

2.3.1 CEO compensation and other CEO characteristics

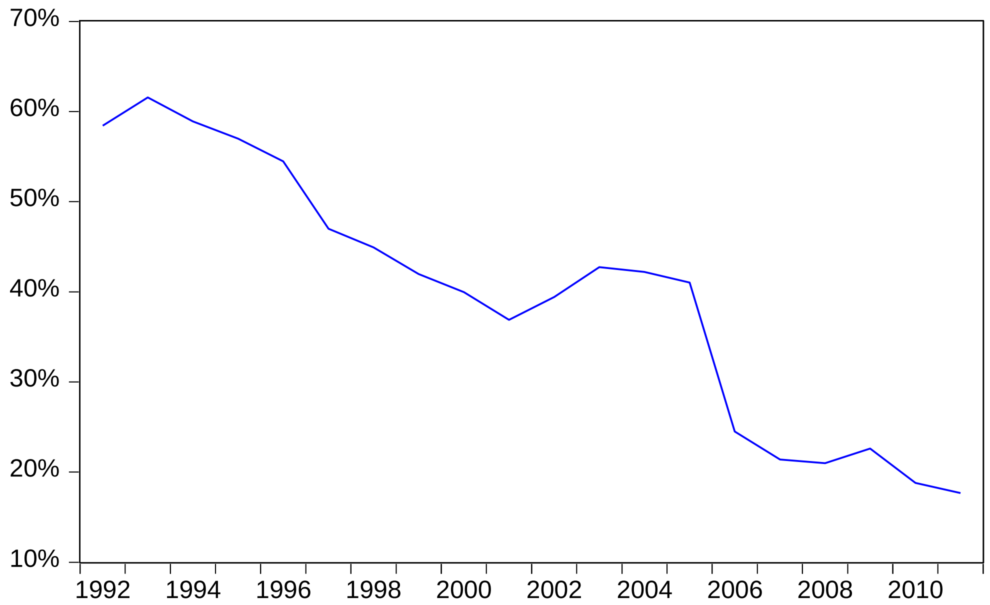
Enormous amounts of time and effort was expended to manually collect the data used in this research. Most of the modern literatures use the Standard & Poor's Execucomp data base for data on CEO compensation. Although this data base provides data of various compensation packages for top executives in the banking industry of the United States, it does not have any data on European banks. Thomson One Banker provides salary and bonus for the current CEOs of the European banks, but it does not give any information of the previous CEOs. Considering the average tenure of a CEO is around 3 to 4 years, Thomson One Banker would not provide sufficient data that meets our prior standard. Moreover, Thomson One Banker rarely covers dates prior to the year 2004. To conduct our research with a larger data set, we had to collect the compensation data manually from the annual reports. I downloaded all of the companies' filings of European banks that are available in the Filings section of Thomson One Banker, from which I put together all the annual reports. I was then able to identify annual reports for 366 banks in 25 European countries. However, none of the banks in the following countries, Czech Republic, Finland, Greece, Hungary, Luxembourg, Portugal, Russia, Slovenia, Slovakia, Turkey, disclosed details of the executive's compensation in their annual reports, which leaves annual reports from 292 banks in 15 countries. The process of extracting information from the remaining annual reports is onerous and time-consuming and frequently not in English resulting in the cumbersome use of Google Translation to locate key words such as executive and director to locate the Director's report[13] section in the annual reports. Unfortunately many banks in continental European do not disclose information of CEO compensation in their annual reports. I was

[13] In some of the annually reports, the exact figure of compensation is not in the Director's report, but in the Note appended at the end of the annual report.

able to collect 63 banks with 516 bank-years observations of salary and 481 bank-years observations of bonus. The data range and banks used in the study are set out in the Table 2.1.

In the earlier literature, the measure of compensation was salary and bonus. Recently, long-term payments such as restricted stock and stock options are also included in the compensation package for research. This is because the portion of cash and short-term incentive payment of total compensation in America has been declining through the years. In recent years, salary and bonus only comprised around 20% of the total compensation (Figure 2.1).

Figure 2.1 Salary plus bonus in percentage of total compensation in S&P500 companies in the United States, 1992-2010

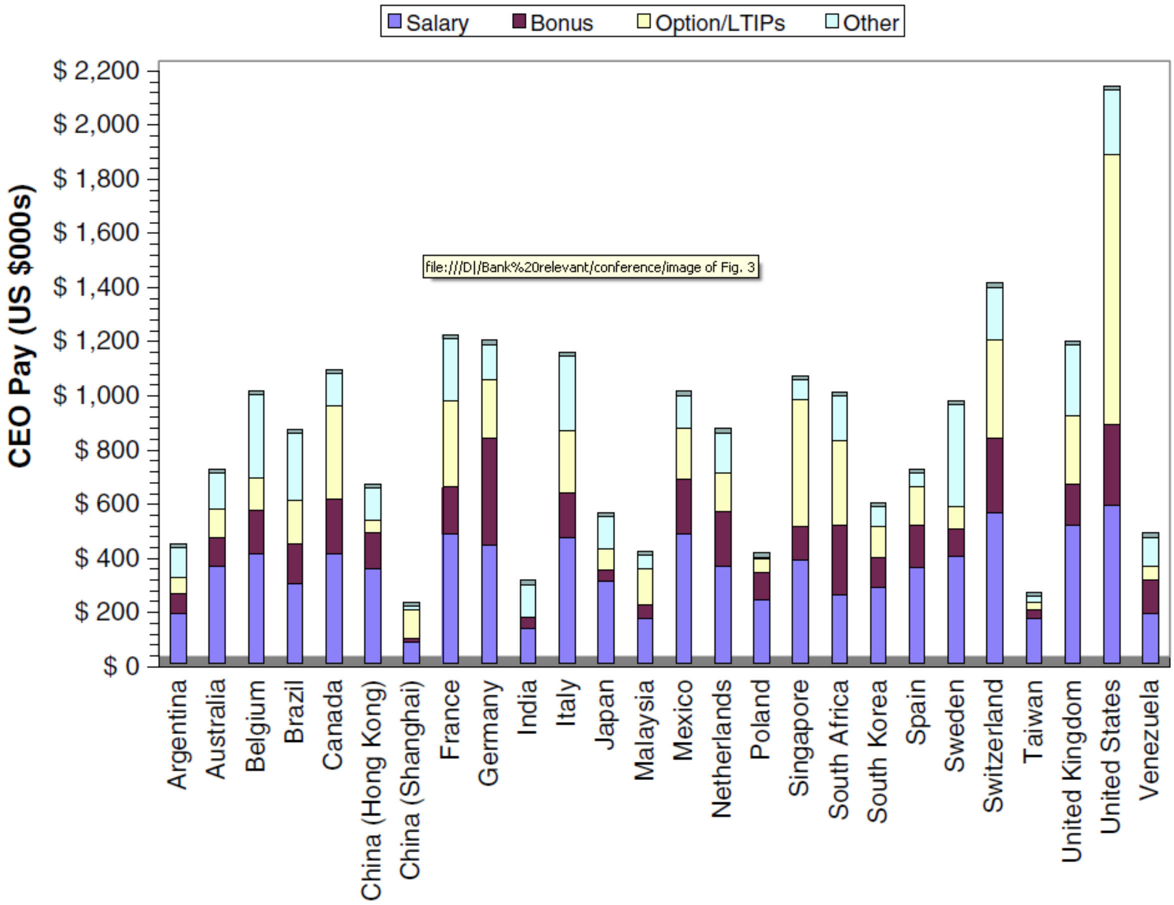


Note: Data are from Wharton Research Data Service (WRDS), Compustat, Execucomp. Total compensation for the individual year, comprised of the following: Salary, Bonus, Other Annual, Total Value of Restricted Stock Granted, Total Value of Stock Options Granted (using Black-Scholes), Long-Term Incentive Payouts, and All Other Total. Values are mean values in percentages.

Long-term incentive payment (LTIP) is usually in the form of share-based or equity-based payment. Their objective is to motivate the executive directors to contribute towards the creation of long-term shareholder value. I made strong attempts to collect data of the executive long-term incentive payments scheme. However there are reasons that data for long-term incentive payments are not used in this study. Firstly there is hardly any data on executives' long term payment for European bank CEOs on databases such as Bank Scope or Thompson One Banker. Only about half of the sample banks reveal information on long-term incentive payment in their annual reports. For the rest we do not know whether they do not reveal their long-term incentive payment or they simply do not have such a payment scheme. In other words we cannot decide whether I should put zero or NA for the long-term incentive payment for this sample banks. Secondly, to calculate the value of options granted requires more detailed information of the option such as spot price, strike price and time to maturity. The limited information on the annual reports simply does not allow us to do that. This would further reduce our sample size. Moreover while most of the literature use US banks for their research, we focus on European banks, and the long-term payment scheme is very different across countries and banks. In the UK, a number of share-based payment schemes have operated in some of the banks. For example, employee share option scheme (ESOS), employee share ownership plan (ESOP), save as you earn scheme (SAYE), performance share plan (PSP), approved profit sharing scheme (APSS), and deferred share scheme (DSS). Share option grants are often subject to a performance condition which is reviewed by the Remuneration Committee annually, and they are usually vested three to five years after being granted. Sometimes options are exercisable only if they are over a period of years from the date of grant, or the performance of the bank has exceeded a certain target.

However the main reason we ignore the long-term incentive payment in our study is that the structure of the European CEO Remuneration differs significantly from that of US executives. Not only that the executive remuneration is lower in the European countries, but European CEOs receive a much smaller proportion of their total remuneration for long-term incentive payments such as options. Hall and Murphy (2003) states that the median option grant for US CEOs was approximately 16 times that for UK CEOs. The option grant comprised 42% of total remuneration among US CEOs, which it is only10% in the UK. According to Towers Perrin's Worldwide Remuneration Survey 2006, the proportion of salary plus bonus in percentage of total remuneration is 37.5% in the US, while it is 55.9% in the UK. Arguably one would expect even higher proportion of fixed salary and bonus in other European countries. In European countries, such as Poland, Spain, Sweden etc., as in Figure 1.2, the percentage of Option and Long-term incentive payment (LTIP) in total compensation is significantly less than that in the United States. For these reasons, our study only focuses on salary and bonuses of the CEO compensations.

Figure 2.2 CEO Pay Mix: International Comparison



Note: Level and mix of CEO pay by country. The figure shows the estimated compensation level and mix for local employees of firms in 26 countries in 2005 with at least US $500 million in worldwide sales. The amounts are expressed in USD converted at the exchange rates of April 1, 2005. Salary represents the base salary, including regular payments (vacation allowance, 13th month salary) and non-performance-related bonus; bonus is target performance-based cash awards, options/LTIPs include the expected value of option grants at the grant date and annualized targets from LTIPs. Other compensation includes both compulsory and voluntary company contributions.

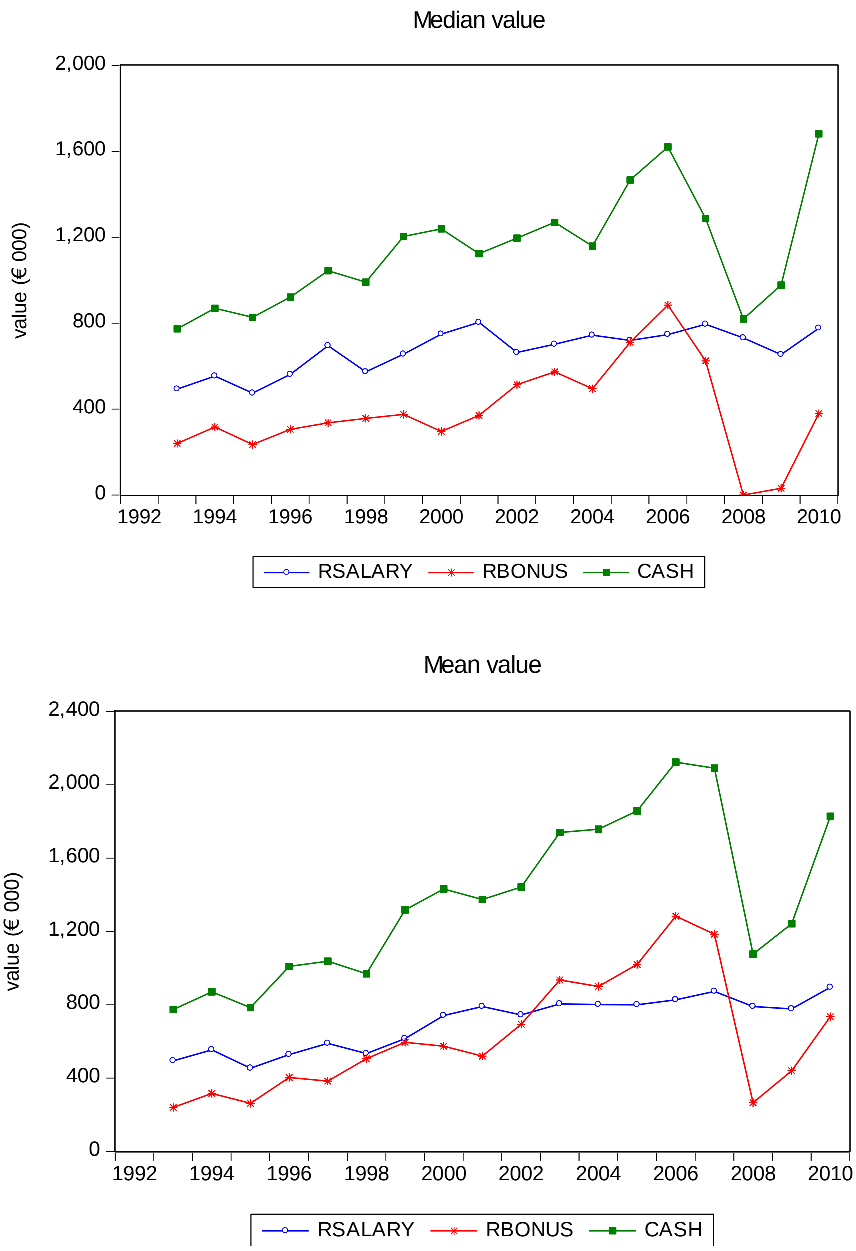
Source: Tower Perrin's 2006 Worldwide Total Remuneration report, from Goergen (2011).

Bonuses are usually paid when certain targets or benchmarks were met in the past year. Bonuses can be deferred for a vesting period with the purpose of retaining the CEO, and the deferred bonus can also be paid as restricted stock. This "bonus" is categorized as equity-based compensation. In our study, bonus is paid in cash in respect of the accounting year, which is an annual short-term incentive payment.

Due to the difference in corporate governance structures among countries, some countries such as Austria, Belgium, Denmark, Germany, Italy, Netherlands, and Poland, their banks may not have an officer titled as CEO. In this case the managing director, president of the executive committee or chairman of the management board, is considered as their CEO. I also collected the number of the CEO shareholdings, CEO age and the starting date of the CEO position, from which I calculate the CEO tenure.

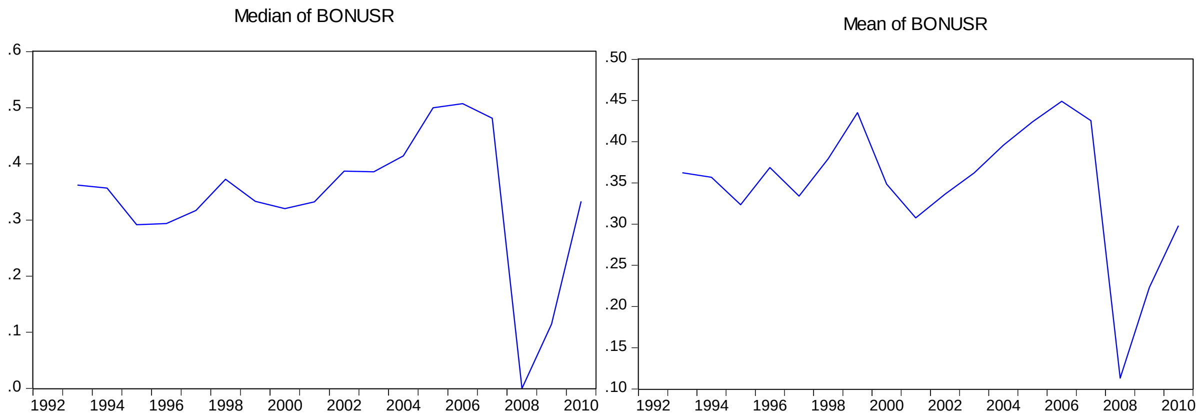
Figure 2.3 shows how the value of compensation evolved in the last two decades. Although the fixed salary fluctuates, it increases moderately with an average rate of 5.1% per annum (average 8.24% before financial crisis in 2007). The bonus increases in a greater magnitude compared to the salary. The mean of real bonus exceeded real salary from 2002. The mean of real bonus peaked in the year 2007 at € 1.28 million, which is more than 5 times compared to the year 1993. We use the ratio of bonus to total cash compensation (salary plus bonus) to measure the CEO’s short term incentives. Figure 2.4 shows that the bonus in proportion of the CEO compensation increased moderately before 2007. The figure of bonus plummets for the year 2007 and 2008 because of the financial crisis. The median value of bonus dropped to zero in 2008. Bonus recovered soon after the crisis, reaching € 7.35 million, which is similar to the level in 2003. During the financial crisis, many banks offered zero-bonuses to theirs CEOs. Not surprisingly, we see a median value or zero bonus in 2008. Also in the distribution chart of compensation in Figure 2.5, we have a high frequency of zero bonus bar. We observe that the mean value of compensation is higher than their median value, and the distribution of compensation has a positive skew. It suggests that some CEOs received a much larger compensation package than other CEOs. Table 2.2 provides summary statistics for the full sample, pre-crisis period, crisis year, and post crisis period. The inflation adjusted salary grows steadily through the crisis year. On the other hand, real bonus and also the bonus to cash compensation ratio dropped dramatically during the crisis year. Although bonuses increased after the crisis year, it still hasn't recovered to the pre-crisis level.

Figure 2.3 Median and Mean of the real value of salary, bonus and total cash compensation



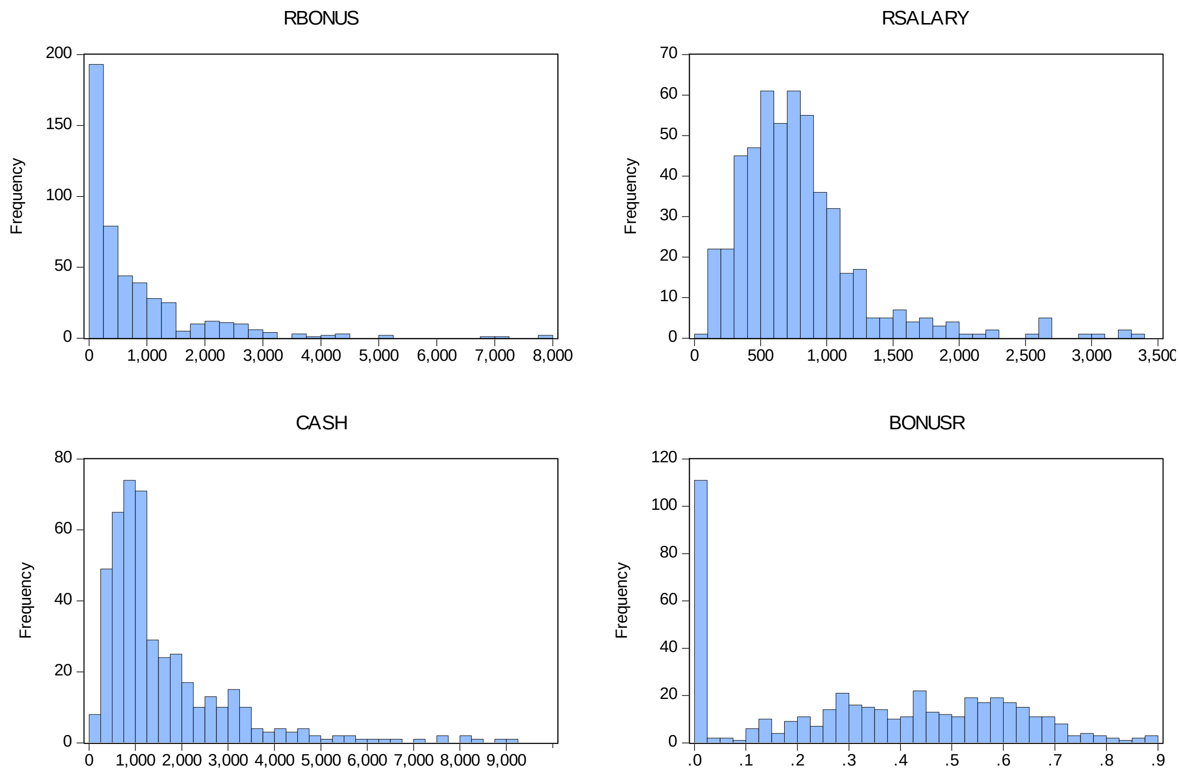
There is a sharp decrease in bonus in2008 due to financial crisis.

Figure 2.4 Mean and Median of short-term incentives



Short-term CEO incentives BONUSR is calculated as the ratio of bonus to total cash compensation. There is a notable dip in 2008 due to financial crisis.

Figure 2.5 Distribution of real value of salary, bonus, total cash compensation and short-term CEO incentives of the whole sample



Note: Short-term CEO incentives BONUSR is calculated as the ratio of bonus to total cash compensation

We use three variables to measure the CEO's characteristics - CEO's tenure, age and ownership. This data is also manually collected from the bank's annual reports. Ownership is calculated as the number of CEO's shareholding in percentage of the total number shares. CEO tenure is the number of years in which the top executive has served the bank as chief executive officer. A CEO with longer tenure is likely to obtain a higher remuneration package to compensate him for his company-specific human capital. Moreover, his long experience may also make him more competitive on the managerial labour market. Furthermore, a more entrenched CEO with a longer tenure may have more influence on their remuneration. This will be the case especially if he also serves on the compensation and remuneration committees. Table 2.3 shows the CEO's average age is about 54 years old with a standard deviation of 6.5 year, while the mean of their tenure is around 3 years with a standard deviation of 3.2 years. Both age and tenure are proxy to human capital. We hypothesised that there is a positive relationship between compensation and human capital.

2.3.2 Bank performance and other bank accounting measures

All bank-accounting data is from Thomson One Banker and Data Stream. ROE (Return on Equity), ROA (Return on Asset) and EPS (Earning per Share) are common measures of performance in the literature. However, EPS can vary across banks simply because of differences in the number of shares outstanding, which could be linked to the growth rate and other factors. ROE is more closely measures return to shareholders. In this study we use ROE as bench mark for bank performance. Table 2.5 shows the mean of ROE for each year. We observe a notable fall of ROE in the year 2002 and 2008. The mean of ROE after crisis is significant lower than the pre-crisis level. One of the most important influences on compensation in the literature is firm (bank) size. Firm size has been shown to explain most of the cross-sectional variation in total managerial compensation (Murphy 2000). Larger firms pay their executives more than small firms because they require CEOs with high managerial talent which also entails more responsibilities. Firm size is often measured by book value of assets, level of sales or even number of employees being managed. Here we use the logarithm of the book value of the real assets to measure firm size. Leverage is measure as the total debt as percentage of assets. MB is the market-to-book ratio – a ratio of the market value of the bank to the book value of the bank, which is a proxy for growth opportunities. NPLOAN is the ratio of non-performing loan to loan.

Figure 2.6 Mean and Median of short-term incentives

2.3.3 Risk Measures

Four different risk measures are used in this study. Total risk δ_j is measured by the standard deviation of the daily stock return of the year. Another risk measure Beta is downloaded from Data Stream. Beta is a measure of market risk which shows the relationship between the volatility of the stock and the volatility of the market[14]. This coefficient is based on between 23 and 35 consecutive month end price percent changes and their relativity to a local market index. Beta is calculated using a 5 year period. The share price is then regressed against the respective DataStream total market index using log changes of the closing price on the first day of each month[15]. The other two measures of risks, systematic risk and idiosyncratic risk are obtained from the two-factor market model. This method has been widely used in the banking literature (Flannery and James 1984, Kane and Unal 1988, Saunders, Strock et al. 1990, Chen, Steiner et al. 2006, Belkhir and Chazi 2008, Pathan 2009). For each year for each bank, the model estimate:

$$R_j = \alpha + \beta_{mj}(R_m) + \beta_{Ij}(I) + u_j \qquad (2.5)$$

where R_j is the daily stock return of bank j, α is the intercept term, R_m is the daily return on the weighted market index for each country, I is the daily yield in the interest rate, and u_j is the error term. The Table 2.6 table gives the market index that is used in the estimation for each country.

The coefficient is estimated by ordinary least square (OLS). β_m provides a risk measure, as a proxy for systematic risk (market risk). The other risk measure, idiosyncratic risk (firm risk) δ_{uj} is generated by calculating the standard deviation of the residual u_j. Daily stock

[14] Data Definition Guide
http://extranet.datastream.com/News_Events/product_data%20news/caccounts/Worldscope%20Data%20Definition%20Guide%20(Issue%2014.2).pdf

[15] http://extranet.datastream.com/Codes/Economics/69Chan/69Beta.htm

return R_j and stock market index R_m data is also from the DataStream. The estimated interest rate risk is highly volatile and may give inconsistent result, so I didn't use interest rate risk in the study. I downloaded the Beta from Data Stream as an attempt at robustness. The results using the estimate Beta and the download do not given any significant difference. Also the estimate for idiosyncratic risk and systematic risk agree with the literature. The following Table 2.7 presents the sample descriptive statistics for all the risk measures.

Total risk δ_j, measured by the standard deviation of daily stock returns for a given year, has a mean (median) of 0.0207 (0.0179) with a standard deviation of 0.013, whereas idiosyncratic risk δ_{uj} has a mean (median) of 0.0165 (0.014) with a standard deviation of 0.0112. The average systematic β_m risk is 0.8215 with a median of 0.8632, while the average beta is 1.0852 with a median of 1.09. Our risk measures are comparable to Pathan's (2009) risk measures over the 1997-2004 period, Belkhir's (2008) over the 1993-2006 period, and Chen's (2006) over the 1992-2000 period. Pathan reports a mean of total risk of 0.026(median: 0.0202), a mean of idiosyncratic risk of 0.0198 (median: 0.0185) and a mean of systematic risk of 0.52 (median: 0.47); Belkhir reports a mean of total risk of 0.0221 (median: 0.0208), a mean of idiosyncratic risk of 0.0213 (median: 0.02) and a mean of systematic risk of 0.5523 (median: 0.4232); while Chen reports a mean of total risk of 0.0184 (median: 0.017), a mean of idiosyncratic risk of 0.0171 (median: 0.0157) and a mean of systematic risk of 0.9491 (median: 0.9072). The above comparison shows the total risk and idiosyncratic risk in European banks are similar to those of the US banks, and it suggests that the market risk in the US has decreased and now European banks bear a higher market risk than the US banks.

2.4 Model and methodology

2.4.1 Empirical models and estimation methods

The following base model is formulated to test the interacting relationship between bank performance, bank risk, and CEO compensation.

Risk Equation:

$$\begin{aligned} Risk_{it} = {} & \beta_1 + \beta_2 \ln(Compensation)_{it} + \beta_3 SIZE_{it} + \beta_4 LEVERAGE_{it} + \beta_5 MB_{it} \\ & + \beta_6 Performance_{it} + \beta_7 NPLOAN_{it} + \beta_8 OWNERSHIP_{it} + \varepsilon_{it} \end{aligned} \quad (2.6)$$

Performance Equation:

$$\begin{aligned} Performance_{it} = {} & \theta_1 + \theta_2 Risk_{it} + \theta_3 Compensation_{it} + \theta_4 SIZE_{it} \\ & + \theta_5 LEVERAGE_{it} + \theta_6 MB_{it} + \varepsilon_{it} \end{aligned} \quad (2.7)$$

Compensation Equation:

$$\begin{aligned} Compensaton_{it} = {} & \delta_1 + \delta_2 MB_{it} + \delta_3 SIZE_{it} + \delta_4 LEVERAGE_{it} + \delta_5 RISK_{it} \\ & + \delta_6 Performance_{it} + \delta_7 TENURE_{it} + \delta_8 AGE_{it} + \varepsilon_{it} \end{aligned} \quad (2.8)$$

where subscripts i denotes individual bank (i=1, 2, …, 63), t time period and ln is the natural logarithmic. β, δ, and θ are the parameters to be estimated . ε is the idiosyncratic error term. The primary estimation method is ordinary least squares (OLS) single equation with panel fixed-effect (FE) for both bank (cross-section) and year (period). We test these three equations with all the for risk measures: total risk, systematic risk (market risk), idiosyncratic risk (firm risk), and beta.

2.4.2 System Estimation

Not only do we have simultaneity, but endogeneity may also exist amongst the independent variables. Although we have four equations, there might be other variables that are endogenous excluded from the model. In a full general equilibrium model, it is possible some of the independent variables will be endogenous. Those variables are correlated with the error term, and omitting those leads to biased inconsistent results. I don't develop the general equilibrium model here because I have a simultaneous structural model. As well as the single equation approach, we also use the system estimation approach where we estimate simultaneously the complete set of parameters of the equations in the system.

It is argued that 2SLS is a single equation estimator that does not take account of the covariance between residuals. It is not in general fully efficient. It is an appropriate technique when the right-hand side variables are correlated with the error terms, and there is both heteroskedasticity, and contemporaneous correlation in the residuals. 3SLS is a system method that estimates all of the coefficients of the model, then forms weights and re-estimates the model using the estimated weighting matrix.

Because 3SLS uses the 2SLS residuals, the first two stages of 3SLS are the same as in 2SLS. Consider a case of single equation 2SLS estimation when some of the variables in X are endogenous. The system may be written in compact form as,

$$y = X\beta + \varepsilon \qquad (2.9)$$

Under the standard assumption, the residual variance matrix from this system is given by,

$$V = E(\varepsilon\varepsilon') = \sigma^2 (I_M \otimes I_T) \qquad (2.10)$$

The errors may be heteroskedastic across the equation, and they may be heteroskedastic and contemporanesouly correlated. These cases can be characterize by defining the matrix of contemporaneous correlations, Σ, where the (i, j)th element of Σ is given by $\sigma_{ij} = E(\varepsilon_{it}\varepsilon_{jt})$ for all t. If the error are contemporaneous uncorrelated then $\sigma_{ij} = 0$ for $i \neq j$. More generally, if the errors are heteroskedastic and contemporaneously correlated, $V = \Sigma \otimes I_T$.

Write the j-th equation of the system as,

$$Y\Gamma_j + X\mathrm{B}_j + \varepsilon_j = 0 \tag{2.11}$$

Or, alternatively:

$$y_j = Y_j\gamma_j + X_j\beta_j + \varepsilon_j = Z_j\delta_j + \varepsilon_j \tag{2.12}$$

where $\Gamma_j^{'} = (-1, \gamma_j^{'}, 0)$, $\mathrm{B}_j^{'} = (\beta_j^{'}, 0)$, $Z_j^{'} = (Y_j^{'}, X_j^{'})$ and $\delta_j^{'} = (\gamma_j^{'}, \beta_j^{'})$. Y is the matrix of endogenous variables and X is the matrix of exogenous variables; Y_j is the matrix of endogenous variables not including y_j.

In the first stage, regress the right-hand side endogenous variables Y_j on all exogenous variables X and get the fitted values:

$$\hat{Y}_j = X(X^{'}X)^{-1}X^{'}Y_j \tag{2.13}$$

In the second stage, regress y_j on $\hat{Y}_j$ and X_j to get:

$$\delta_{2SLS} = (\hat{Z}_j^{'}\hat{Z}_j)^{-1}\hat{Z}y \tag{2.14}$$

where $\hat{Z}_j = (\hat{Y}_j, X_j)$.

3SLS uses these 2SLS residuals to obtain a consistent estimate of Σ. In the third stage, apply feasible generalized least squares (FGLS) to the equations in the system in a manner analogous to the Seemingly Unrelated Regression (SUR). SUR is appropriate when all the right-hand side regressors X are assumed to be exogenous, and the errors are heteroskedastic and contemporaneously correlated so that the error variance matrix is given by $V = \Sigma \otimes I_T$. Zellner's SUR estimator takes the form:

$$b_{SUR} = (X^{'}(\hat{\Sigma} \otimes I_T)^{-1} X)^{-1} X^{'}(\hat{\Sigma} \otimes I_t)^{-1} y \qquad (2.15)$$

while 3SLS takes the form:

$$\delta_{3SLS} = (Z(\hat{\Sigma}^{-1} \otimes X(X^{'}X)^{-1}X^{'})Z)^{-1} Z(\hat{\Sigma}^{-1} \otimes X(X^{'}X)^{-1}X^{'})y \qquad (2.16)$$

where $\hat{\Sigma}$ has typical element:

$$s_{ij} = ((y_i - Z_i\hat{\gamma}_{2SLS})^{'}(y_j - Z_j\hat{\gamma}_{2SLS}))/\max(T_i, T_j)$$

2.5 Empirical results

The OLS estimates results of the base model in section 2.4.1 are presented in Appendix I at the end of this chapter. The result of the risk equation is in Table A.1. It shows a strong negative relationship between risk and compensation across all the four risk measures. This is contrary to the popular view that incentives induce risk taking. We separate the total cash compensation into two parts – salary and bonus, and estimate the same equation again. It is worth mentioning again that we use BONUSR here, the ratio of bonus to total cash compensation as a proxy for short-term incentive compensation. Since bonus can be zero, we do not take natural logarithm of this variable. The result from Table A.1.1 suggests that the negative relationship between compensation and risk comes from the aggregation with bonus. There is no statistical significant relationship between salary and risk. The result of the performance equation is in Table A.2. We observe a negative relationship between ROE and risks here. The result of compensation equation is in Table A.3. We again separate the salary and bonus in this equation as we did for the risk equation. Result is Table A.3.1 also shows a negative relationship between risk and bonus. Risk and salary is not statistically related.

These results suggest that we should separate salary and bonus when modelling compensation. As we did so, we also find a positive relationship between size and salary, but the relationship between size and bonus is not significant. Moreover, results show that ROE and bonus is positively related, however no significant relationship is found between ROE and salary. We use a Wald test to examine each independent variable and remove the insignificant ones from each equation. We also recognised there might be dynamic issues, so we include a lagged dependent variable (LDV) in each equation. The literature on wage stickiness[16], suggest rigidity in nominal wages. We expect a positive coefficient on lagged salary, because people tend to use last year's salary as a benchmark for this year's salary.

[16] Keynes, J.M., 2006. General theory of employment, interest and money. Atlantic Publishers & Dist.

Bonus on the other hand doesn't have this relationship. ROE tends to follow the business cycle, and the business cycle is highly auto-correlated, so we expect dynamics in ROE. Risk on the other hand is related to ROE by portfolio theory. If return is auto-correlated, risk is also auto-correlated. We find that the LDVs are significant, except for the bonus equation, which is what we expected because the wage stickiness only applies for fixed salary but not for bonus. Base on the results of these experiments, we cleaned up the previous results and redesign the following four equations as our base model.

Risk Equation:

$$\begin{aligned} RISK_{it} &= \delta_1 + \delta_2 RISK_{it-1} + \delta_3 SBONUSR_{it} + \delta_4 SIZE_{it} + \delta_5 MB_{it} \\ &\quad + \delta_6 NPLOAN_{it} + \varepsilon_{it} \end{aligned} \tag{2.17}$$

Bonus Equation

$$BONUSR_{it} = \beta_1 + \beta_2 \Delta ROE_{it} + \beta_3 \Delta \ln(PRICE)_{it} + \beta_4 RISK_{it} + \varepsilon_{it} \text{ [17]} \tag{2.18}$$

Salary equation:

$$\begin{aligned} \ln SALARY_{it} &= \alpha_1 + \alpha_2 \ln SALARY_{it-1} + \alpha_3 MB_{it} + \alpha_4 SIZE_{it} + \alpha_5 ROE_{it} \\ &\quad + \alpha_6 TENURE_{it} + \varepsilon_{it} \end{aligned} \tag{2.19}$$

Performance Equation:

$$ROE_{it} = \phi_1 + \phi_2 ROE_{it-1} + \phi_3 BONUSR_{it} + \phi_4 MB_{it} + \phi_5 RISK_{it} + \varepsilon_{it} \tag{2.20}$$

[17] PRICE is the share price. $\Delta \ln(PRICE)$ measures the growth in share price. Bonus has zero value and it cannot be expressed in log form.

We recognised that the least squares dummy variable regression (LSDV) is inconsistent for a dynamic panel data model with individual effects, whether the effects are fixed or random. The bias of the LSDV estimator in a dynamic model is generally known as dynamic panel bias or Nickell (1981)'s bias. In both the fixed and random effects setting, the difficulty is that the lagged dependent variable is correlated with the disturbance, even if it is assumed that ε_{it} is not itself auto-correlated. We can think of the fixed effects model as an ordinary regression with a lagged variable. Consider a regression with a stochastic regress that is dependent across observation. In a dynamic regression model, the estimator based on T observation is not unbiased, but it is consistent in T. The finite sample bias is of order 1/T. We would obtain large sample results by allowing T to grow large, but in a panel dynamic model setting, T is assumed to be small, and large-sample results are obtained with respect to n growing large, not T. The fixed effect estimator can be view as an average of n estimators. The average of n inconsistent estimators will still be inconsistent. One of the solutions is to use alternative estimators such as IV (Anderson and Hsiao 1982) or GMM (Arellano and Bond 1991).

Taking consideration of the endogeneity amongst risk, compensation and ROE, we use simultaneous equations estimation, which take into account the interdependencies amongst the equation in the system. Simultaneous equation models include 3 stage least square (3SLS), full-information maximum likelihood (FIML), and generalized method of moments (GMM). The GMM estimator brings efficiency gains in the presence of heteroscedasticity. If the disturbances are homoscedastic, then it is asymptotically the same as 3SLS. Although GMM is generally more efficient than 3SLS, 3SLS is estimator has better finite sample properties than GMM[18].

[18] Wooldridge, J. M. (2010). Econometric analysis of cross section and panel data. MIT press.

In this study we use a 3SLS estimator. Although most researchers apply a single equation technique to investigate compensation, risk, and performance, there are still many literatures in both corporations and banks that use the 3SLS estimator in this area of research. Barnhart and Rosenstein (1997) used a 3SLS estimator to model the board composition, managerial ownership, and firm performance. Campbell et al (2007) find that CEOs are compensated for exposure to environmental risk, which considered as endogenous in their study. They also find that this premium is reduced when the CEO has greater opportunities to improve the firm's environmental performance. Callan and Thomas (2008) hypothesise that financial performance and social performance are determined simultaneously. They show that corporate social responsibility is among the determinants of CEO pay, which indicates that pay-for-performance does not sufficiently explain compensation. Chien and Wen (2013) used a two-equation simultaneous equation system, in which both firm's risks and compensation structures are endogenous. They show that contracts with large versus small bonus-option components induce risk-taking and in addition, perceptions of firms' risk do substantially impact the design of compensation contracts. In the banking literature, Pathan (2009) used 3SLS approach to model board structure, CEO power and bank risk taking. Yang (2010) used 3SLS system to explore the causal relationship between compensation structure and risk-taking in banks, where both risk and incentive measures are contemporaneously determined. Livne et al. (2013) examines the relation between the investment horizon of banks and their CEO compensation, and its consequences for risk and performance. They use 3SLS simultaneous equations to control for the endogeneity in the relation between firm risk, compensation, and investment patterns, Yang and Peng (2014) investigates the dynamic relationship between bank management structure payment contract and bank return volatility. In their model, vega, delta and bank risk are all treated as endogenous variables and are jointly determined.

Our 3SLS results are presented in Table B.2. In the risk equation, we find that risk is auto-correlated. Because risk is related to ROE by portfolio theory, if return is auto-correlated, risk is also auto-correlated. Both size and non-performing loans are insignificant in the risk equation. If size is positively related to risk, it could imply that larger banks appear to be more sensitive to general market movements and bear higher risk. On the other hand, it can also be argued that small (and medium-sized) enterprises tend to take on more risk and face more uncertainty. Lafrance (2012) finds a higher volatility of the rates of return for smaller firms, especially, the smallest. However we do not find this evidence in our European bank samples. Market to book ratio is the proxy for investment opportunities and it is negatively related to risk. We also find a strong negative relationship between risk and bonus.

We also confirmed a strong negative relationship between risk and bonus in the bonus equation. Both the change in ROE and change in stock price are positively related to bonus. This suggests that bonus is rewarded for better performance. Our results confirm a positive pay to performance relationship. We tried to include the lagged of bonus in the bonus equation. However it is not significant, which is what we expected. ‘Wage stickiness’ doesn’t apply to bonus itself, but to fixed salary or overall wage.

Fixed salary shows strong auto-correlation in the salary equation, which gives evidence to the ‘wage stickiness’ theory by Keynes (2006), who argued that nominal wages display downward rigidity, in the sense that workers are reluctant to accept cuts in nominal wages. Market to book ratio and salary are positively related. Since Market to book ratio signalling growth rates, it suggests banks with higher growth opportunities offer higher salaries. There is a positive relationship between size and salary. Many literatures have confirmed this relationship (Kostiuk 1990, Cordeiro 2003 and Anderson 2003). Large banks tend to offer higher compensation packages. There is no significant relationship between ROE and salary. It suggests that bonuses would be rewarded or penalised on performance, but fix salary is not affected by performance. Tenure is not significant in the salary equation. It suggests that being loyal to the same bank doesn't contribute to CEOs' higher salary.

Lastly in the ROE equation, we find the ROE is also auto-correlated. This is because ROE tends to follow the business cycle, which is also auto-correlated. We find a positive relationship between market to book ratio and ROE. A high market to book ratio commonly has a correspondingly high ROE, since investors are inclined to pay higher multiples of book value for a stock that is showing them a good return. Companies with high growth rates are likely to have high market to book ratios. Chandra and James (2000) also document the same finding – "the growth opportunity variable (market-to-book ratio) is the most significant factor in bank performance." Risk is negatively related to ROE. This finding is in accordance with Low (2009), which indicates that less profitable firms have higher equity volatility. It could also mean that higher risk results in higher cost of capital and therefore lower return. It may suggest that excessive risk taking has negative impact to performance. Bonus carries a positive sign in the ROE equation. It shows higher bonus can incentivize CEOs to make more profits.

Our results confirm a positive pay-performance relationship. This conforms to the finding in the majority of the US banking literature (Crawford et al. 1995, Madura et al. 1997 and Gregoriou and Rouah 2003). We find that the positive relationship comes from bonus but not the fixed salary. However, contrary to the more popular view that risk and bonus is positively related, we find that the relationship between risk and bonus is negative. In both the bonus and risk equation, their negative relationship remains strong at 1% significance level. We have investigated whether the negative relationship between our risk measures and cash compensation changes at high levels of cash compensation by adding a quadratic term of cash compensation. However the quadratic relation is not significant. Although whether managerial incentives matters; whether incentives generated by executive compensation programs are correlated with excessive risk-taking by banks is still under debate (see discussion in Bhagat and Bolton 2014), we raise the question whether the relationship between bonus and risk is causally correlated or determined by exogenous factors, whether this relationship persists throughout the period. We discuss this in the next section.

2.6 Dynamic properties and steady-state solution

In this section we look at the dynamic properties of the simultaneous equation. It is important to examine whether our solution is stable. For example our result suggests that a positive shock in size increases risk. However a higher risk implies a lower ROE, which reduces bonus; bonus has a negative effect on risk, so it further increases risk. At this stage we cannot be certain if our system is stable and therefore converges on a determinate solution. We have a structural simultaneous model. This model is a dynamic model. Any movement of an exogenous variable cannot say with definitiveness that a solution exists. An unstable solution cannot make a determinate statement of equilibrium.

In Appendix II we evaluate the dynamic properties of the system. We remove the salary equation from the system because salary doesn't feed into the loop of the system. The simultaneity only exists amongst risk, bonus, and ROE. We show that the system can be reduced to a second-order difference equation. We find that the solution is stable. This suggests moving from one equilibrium to another is a stable process. This process is not monotonic but cyclical because we find complex characteristic roots.

We also solve for the steady-state solution of the system. Details are provided in Appendix II. The steady-state solution is as follows,

$$\begin{aligned} RISK = &-0.262838 - 0.006693 DLNPRICE + 0.001872 SIZE - 0.006774 MB \\ &+ 0.136715 NPLOAN \end{aligned} \quad (2.21)$$

$$\begin{aligned} BONUSR = &\ 0.431203 + 0.111810 DLNPRICE - 0.008986 SIZE + 0.032518 MB \\ &- 0.656329 NPLOAN \end{aligned} \quad (2.22)$$

$$\begin{aligned} ROE = &\ 0.240319 + 0.070946 DLNPRICE - 0.013062 SIZE + 0.086685 MB \\ &- 0.954088 NPLOAN \end{aligned} \quad (2.23)$$

We checked this solution by simulation. The simulation procedure is described at the end of Appendix II. Simulation results and hand-solving results are identical. We put down the steady-state solution above in a Jacobian matrix in Table B.2.

Our results show that size has a positive effect on risk and a negative effect on bonus ratio and ROE. Larger banks tend to take higher risks. They may offer higher salaries and long-term incentive schemec and other forms of compensation so that the short term bonus pay as a ratio of total compensation is lower. Larger banks also have lower ROE. We find a negative effect of MB to Risk and positive effects of MB to bonus ratio and ROE. ROE is positively associated with the market value so that the effect of MB to ROE is also positive. There have been debates whether MB is a proxy for risk. We find that MB and risk are negatively related. Benston and Evan (2006) and Hagendorff and Vallascas (2011) also report a negative relationship between risk and MB. Banks with higher level Non-performing loan bear higher risk and have lower bonus ratio and ROE as expected. Finally higher the growth in share prices, lower the risk level, and higher the bonus ratios and ROE.

We have shown a positive relationship between change in ROE and the bonus ratio, which confirms a positive pay-performance relationship. Regarding the risk and incentive payment, it is established in the literature that equity based compensation (long-term incentive plan such as option) is positively related to risk. Most literature using data from firms/banks in the USA, where long-term incentive scheme is a major part of the CEO’s compensation. Bonus is considered to be a part of cash compensation, and it is not separately specified in the risk equation. So far there is no literature addressing the exclusively the relationship between short-term incentive bonus and risk. A study by Belkhir and Chazi (2008) show that cash compensation has negative effect on risk. In European banks where equity-based compensation is less dominant in the compensation package, and short-term bonus is an essential part of compensation, we believed that bonus also has a positive relationship with risk. However we find a strong negative relationship between risk and bonus ratio. We postulate that any potential positive relation between risk and bonus may cause by two separate events. We now reconsider the following two equations in the system.

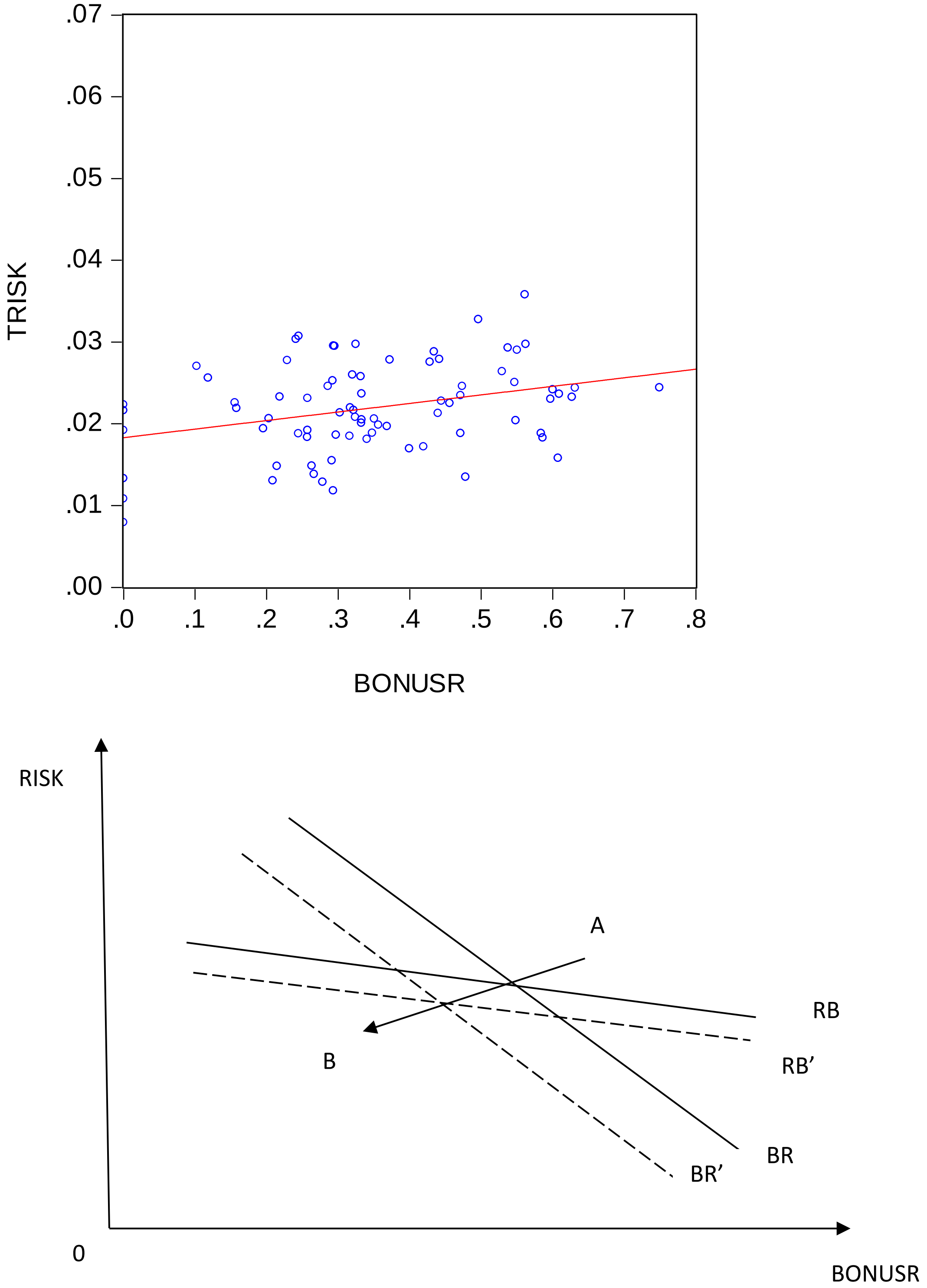
$$RISK_t = \alpha_1 + \alpha_2 RISK_{t-1} + \alpha_3 BONUSR_t + \alpha_4 SIZE_t + \alpha_5 MB_t + \alpha_6 NPLOAN_t \quad (2.24)$$

$$BONUSR_t = \beta_1 + \beta_2 ROE_t - \beta_3 ROE_{t-1} + \beta_4 DLNPRICE_t + \beta_5 RISK_t \quad (2.25)$$

In the steady-state $RISK_t$=$RISK_{t-1}$ and ROE_t=ROE_{t-1}, If we plot equation (2.24) and (2.25) together in a chart with RISK being the vertical axis and BONUSR being the horizontal axis. The slope of equation (2.24) is $\alpha_3/1-\alpha_2$, and the slope of equation (2.25) is $1/\beta_4$. According our estimated results, the slopes are -0.059 and -0.208 respectively. The slope of equation (2.24) is flatter than the slope of equation (2.25).

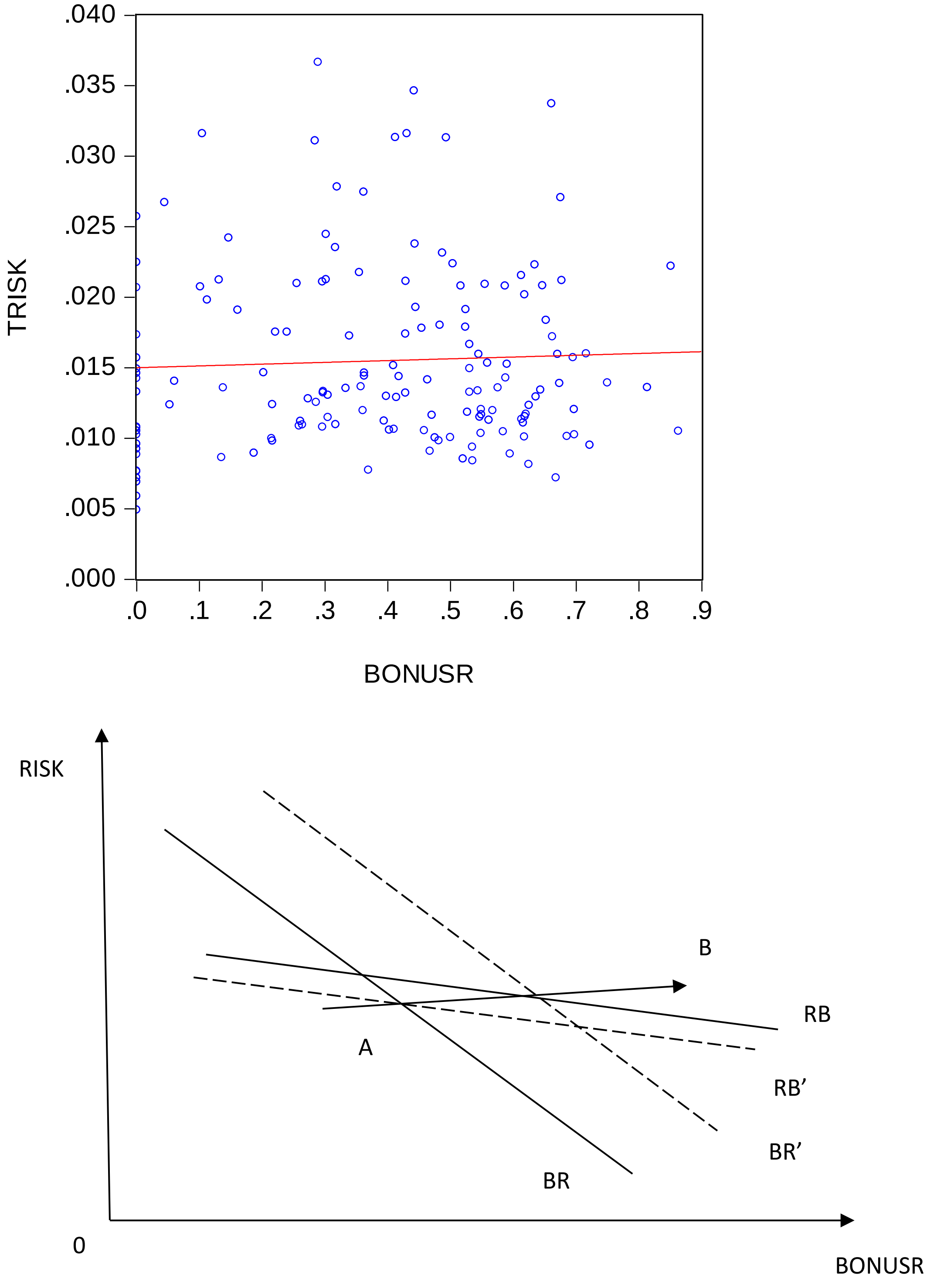
We take three arbitrary periods, 1994 to 2001, 2002 to 2005 and 2006 to 2010, and then we plot the scatter plot between risk and bonus for these three periods in Figure 2.7 to Figure 2.8. From the scatter plot, we see that in the first period the slope is positive. In the second period the slope is rather flat. In the last period, the slope became negative. In order to understand the movement of risk and bonus, we produce a figure under each scatter plot. Equation (2.24) is represented by line RB and Equation (2.25) is represented by line BR in Figure 2.7 to Figure 2.9. In Figure 2.7, A to B represents the movement of risk and bonus from 1994 to 2001. This is the overall effect of a downward shift of both the risk and bonus equation. The overall effect is calculated in Table B.3.

Figure 2.7



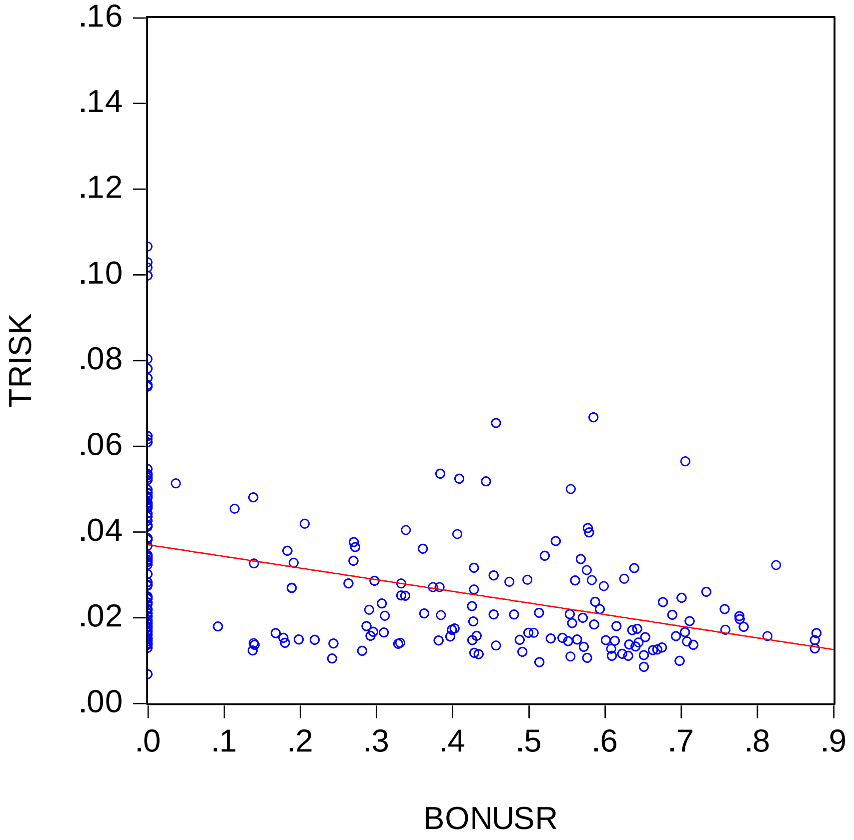
Scatter plot of TRISK and BONUSR for the period 1994 to 2001. RB represents the risk equation. BR represents the bonus equation. Movement from A to B represents the overall effect from Table 2.13.

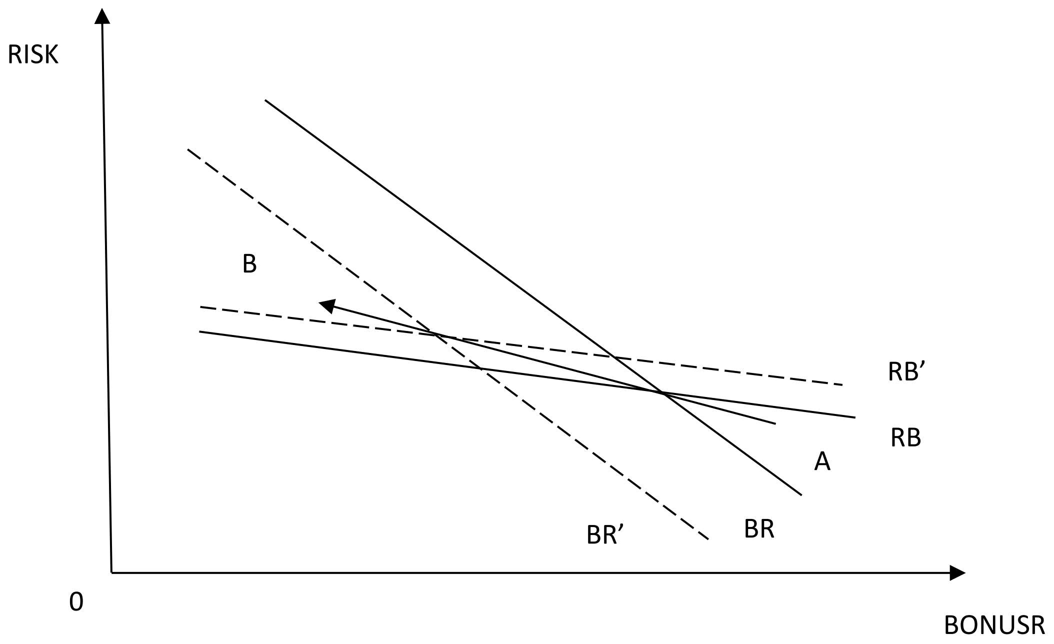
Figure 2.8



Scatter plot of TRISK and BONUSR for the period 2002 to 2005. RB represents the risk equation. BR represents the bonus equation. Movement from A to B represents the overall effect from Table 2.13.

Figure 2.9





Scatter plot of TRISK and BONUSR for the period 2006 to 2010. RB represents the risk equation. BR represents the bonus equation. Movement from A to B represents the overall effect from Table 2.13.

Figure 2.7 to Figure 2.9 show different associations between risk and bonus in three different periods. The First period is from 1994 to 2001. We use a longer period because we have an imbalanced panel data, and there are less data points in the early period of the sample. Data shows that there is a positive relationship between risk and bonus. The next period is from 2002 to 2005. Although we can still observe a positive relationship between risk and bonus, the relationship is not very strong as the slope of the curve is flat. The last period is from 2006 to 2010 which includes the crisis period. In contrast to the previous two periods, the figure shows a strong negative relationship between risk and bonus.

More often, the positive relationship between the incentive payment and risk taking is recognised in the literature. An early literature by Saunders et al. (1990) shows that stockholder controlled banks exhibit significantly higher risk taking behaviour than managerially controlled banks during the 1979-1982 period of relative deregulation. Houston and James (1995) examine 134 commercial banks from 1980 to 1990, and show a positive and significant relation between the importance of equity-based incentives and the value of the bank's charter. Chen et al. (2006) investigate the relationship between option-based executive compensation and market measures of risk for a sample of commercial banks during the period of 1992 to 2000. They show that following deregulation, banks have increasingly employed stock option-based compensation. As a result, the structure of executive compensation induces risk-taking, and the stock of option-based wealth also induces risk-taking. Bhagat and Bolton (2014) study the executive compensation structure in 14 of the largest U.S. financial institutions during 2000 to 2008. They focus on the CEO's purchases and sales of their bank's stock, their salary and bonus, and the capital losses these CEOs incur due to the dramatic share price declines in 2008. Their results are supportive of the findings of Bebchuk, Cohen and Spamann (2010), that is, managerial incentives matter —

incentives generated by executive compensation programs are correlated with excessive risk-taking by banks.

However, some researchers do not support the view that incentive payment and risk taking is strictly positively related. Mullins (1992) argues that Saunders et al. (1990) findings of the positive link between risk and incentives are largely attributable to their failure to adequately control for bank size. Fahlenbrach and Stulz (2011) find some evidence that banks with CEOs whose incentives were better aligned with the interests of shareholders performed worse with no evidence that they performed better. Using 98 sample banks for the period 2006 to 2008, they find that banks with higher option compensation and a larger fraction of compensation in cash bonuses for their CEOs did not perform worse during the crisis. They argue that bank CEOs and senior executives could not, nor did not, foresee the extreme high risk nature of some of the bank's investment and trading strategies. The poor performance of these banks during the crisis is attributable to an extremely negative realization of the high risk nature of their investment and trading strategy.

Our result shows the bonus and risk relationship is positive in the pre-crisis period, but negative after crisis. However, it is not uncommon to have contrary results for pre-crisis and post-crisis periods. Efling et al. (2015) exploits a large payroll data set to extract incentive pay measures for 67 banks in Austria, Germany, and Switzerland in the period 2004–2011. They show that the Bonus Share, defined as the average bonus relative to the total salary, decreased substantially in the crisis period 2008–2011 relative to the pre-crisis period 2004–2007. This substantial reduction occurred despite the fact that the overall trading income in our bank sample did not decrease in the crisis period. They document a robust positive correlation of pay incentives with the bank's trading income and its volatility, and this positive correlation is particularly pronounced in the pre-crisis period. In their study, instrumented incentive pay shows a negative and weakly significant effect on the Sharpe

Ratio (ratio of trading returns and their standard deviation) of trading returns for the pre-crisis period, which becomes positive and significant for the later crisis period. From the perspective of NPV maximization, the optimal incentive pay for a bank's trading operation should maximize the Sharpe ratio of trading income. This requires the marginal effect of the incentive pay on the Sharpe Ratio to be zero. Therefore, bonus payments seem too high before and too low during the crisis. Our evidence supports Efling et al. (2015)'s finding. As we have discussed, European banks has a strong culture of 'too big to fail'. Bank shareholders should find it optimal to approve larger bonuses to the CEOs because they benefit selectively from the upside of increased risk. We show a positive relationship between bonus and risk in the pre-crisis periods. However, the excess risk taking behaviour might have contributed to the financial crisis. This is supported by Bhagat and Bolton (2014).

The popular view is that incentives generated by executive compensation programs led to excessive risk-taking. However, in the post-crisis period, we observe a strong and negative relationship between risk and bonus. We argue that short-term incentive pay (bonus) and risk are not casually related, rather, they are determined by exogenous factors. We evaluate the overall exogenous effect for bonus and risk. The results are set out in Table 2.13. In the first pre-crisis period, the overall exogenous effect for both risk and bonus are negative (-0.00408 and -0.04389). Therefore in Figure 2.7, both the risk and bonus curve shift downwards. As a result, it is showing a positive relationship between risk and bonus. In the second pre-crisis period, Table 2.13 shows that the exogenous effect for risk is negative (-0.00135), but it is positive for bonus (0.079211). The risk curve shifts downwards and the bonus curve shifts upwards in Figure 2.8, resulting a positive relationship between risk and bonus. In the last period, the overall exogenous effect for risk is negative (-0.04366) while it is positive for bonus (0.007154). Therefore the risk curve shifts upwards and the bonus curve shifts downwards in Figure 2.9. As a result, the relationship between risk and bonus is negative.

The structure equations we have don't support the popular thinking that bonus and risk taking is positively related. We find that the actual causal relationship between risk and bonus are actually negative for the whole sample. When we decompose the shocks to explaining the general movement of bonus and risk in three different periods, we find that the relationship between risk and bonus can be both positive and negative. However as a result of exogenous factors jointly determine bonus and risk, bonus and risk are not causally related. Future empirical works need to fully investigate what other exogenous factors could have also driven the relationship between risk and bonus.

2.7 Conclusion

Conflicts of interest between the shareholders and managers have been recognized in the Agency Theory since the early 80s. The public's perception of CEO compensation is generally negative because executive compensations are constantly on the rise, even during dismal economic conditions and often despite the poor performance of the firm they manage. Compensation of CEOs in the banking industry has been a major controversy since the tremendous growth in executive compensation during the last decades. How well the compensation package is playing the role of aligning the interests between CEOs and shareholders still attract public and academic attentions. On the other hand the use of incentive pay in banking is also believed to have motivated excessive risk taking and acted as a contributory factor to the recent financial crisis.

This chapter considers the relationship between bank CEO compensation, bank performance and bank risk. Our empirical evidence is based on 63 banks across 15 European countries for the period 1992 to 2010. Data for CEO compensation are collected from annual reports. We specified three single equations with fixed effect, and included dynamics to investigate this relationship. We account of endogeneity and estimated them as three simultaneous equations in a system using 3SLS. We also explore the dynamic properties in the system and solved for steady-state solution.

Our evidence confirms a significant positive relationship between CEO compensation and performance. This relationship is mainly attributed to bonus and performance. The relationship between salary and performance is not as strong. CEO characteristic such as tenure is positively related to salary but not bonus. Long-term incentive payment (equity based compensation) may induce higher risk taking according to previous studies. We find that higher short-term incentives (bonus paid in cash) actually reduces risk taking. This negative relationship between bonus and risk remain strong with four different measures of risk.

The popular view is that there should be a positive relationship between bonus and risk taking. The negative relationship we have from the structural model is surprising. It suggests that bonus might not be a tool to induce risk taking. However when we separate the sample, we find that there is a positive relationship between risk and bonus in the two pre-crisis periods, this relationship became positive in the post crisis period. We argue that because the European banking industry has a strong culture of TBTF, CEOs might take on excessive risk which contributed to the crisis. At the same time shareholders should find it optimal to approve larger bonuses because they benefit selectively from the upside of increased risk. However, we argue that the relationship between risk and bonus are not casual, and we could explain the positive relationship from the shocks to the individual equations and the interaction of the equations. We conclude that any observed positive relationship between short-term incentive payments and risk is caused by other exogenous factors and are not causally linked. Our result suggests that short-term incentive may not be a tool to induce risk taking.

Our results are empirically generated using the bench marks which have been used in the previous literatures. Without a theoretical model, it's hard to interpret structural parameters. We are not driven by the deductive approach common in economic modelling, starting from a theoretical model, and then identifying and estimating the model. Rather, we reverse the process by looking at the literature, and then estimate the empirical regularities from the literature. By doing so we find a surprising result which cannot be explained by the theoretical model. In that sense therefore, one could question the validity of the theoretical models. However we have looked at identification of structural parameters and conducted appropriate tests, the negative relationship between risk and bonus is robust. It may well be the model is mis-specified and that the negative result is misconstrued, or alternatively the model is correct but we haven't found a good enough theory to interpret it, or it could be a bit of both. Although the positive relationship can be explained, the result from the structural model is inelegant. This area clearly requires more work both on the theory as well as the empirics.

Appendix I Tables

Table 2.1 Sample banks

NAME	COUNTRY	SAMPLE PERIOD
Erste Group Bank AG	Austria	2003-2010
Dexia	Belgium	2001-2010
Danske Bank A/S	Denmark	2005-2010
BNP Paribas	France	1998-2010
Credit Agricole S.A.	France	2003-2010
Credit Industriel & Commecial	France	2005-2010
Natixis	France	2002-2010
Societe Generale	France	2000-2010
Aareal Bank AG	Germany	2004-2010
Commerzbank AG	Germany	2004-2010
Deutsche Bank AG	Germany	2003-2010
Deutsche Postbank AG	Germany	2003-2010
IKB Deutsche Industriebank AG	Germany	2004-2010
LBB(Landesbank Berlin) Holding AG	Germany	2005-2010
Kaupthing Bank	Iceland	2005-2008
Anglo Irish Bank Corp LTD	Ireland	2001-2008
Allied Irish Bank Plc	Ireland	1999-2010
Bank of Ireland	Ireland	2000-2010
Banca Carige	Italy	2000-2007
Banca Finnat	Italy	2003-2010
Gruppo Monte dei Paschi di Siena	Italy	2005-2008
Banca Popolare DI Milano	Italy	2000-2009
BANCA POPOLARE DELL ETRURIA & DEL LAZIO	Italy	2002-2010
Banca Popolare DI Sondrio	Italy	2001-2010
BANCO DI DESIO & DELLA BRIANZA SPA	Italy	2000-2007
Credito Bergamasco	Italy	2000-2008
Credito Emiliano	Italy	2003-2010
Intesa Sanpolo	Italy	2004-2010
Mediobanca Spa	Italy	2002-2010
ABN Amro Holding NV	Netherlands	2000-2006
Van Lanschot NV	Netherlands	2001-2010
DnB Nor ASA	Norway	2002-2010
SpareBank 1 Nord Norge	Norway	1992-2010
Sparebank 1 SR Bank	Norway	2004-2010
Sparebanken Ost	Norway	2003-2007
BRE Bank	Poland	2004-2010
Fortis Bank Polska	Poland	2004-2010
Kredyt Bank	Poland	2003-2010

Banco Bilbao Vizcaya Argentaria SA	Spain	2002-2010
Banco Santander SA	Spain	2002-2010
Banco Popular Espanol	Spain	2005-2010
Nordea Bank AB	Sweden	2000-2010
Skandinaviska Enskilda Banken AB	Sweden	1998-2010
Svenska Handelsbanken AB	Sweden	2002-2010
Swedbank AB	Sweden	2000-2010
BANK SARASIN & CO LTD	Switzerland	2008-2010
Banque Cantonale Vaudoise	Switzerland	2008-2010
Banque Cantonale De Geneve	Switzerland	2008-2010
Credit Suisse Group	Switzerland	2007-2010
EFG International	Switzerland	2007-2010
Julius Baer Group	Switzerland	2007-2010
Liechtensteinische Landesbank	Switzerland	2006-2010
UBS AG	Switzerland	2008-2010
Abbey National Plc	UK	1998-2008
Barclays Plc	UK	1995-2010
Bank of Scotland	UK	1997-2001
Bradford & Bingley Plc	UK	2000-2010
HBOS Plc	UK	2001-2008
HSBC Holding Plc	UK	1993-2010
Lloyds Banking Group Plc	UK	1995-2010
Northern Rock	UK	1997-2009
Royal Bank of Scotland Group Plc	UK	1995-2010
Standard Chartered	UK	1993-2010

Table 2.2 Summary statistics of CEO compensation

Full Sample (1992 – 2010)

	CASH	BONUS	SALARY	BONUSR
Mean	1607.814	781.8013	788.7830	0.338796
Median	1095.005	367.7222	713.3206	0.348042
Maximum	9120.641	7990.975	3346.891	0.878230
Minimum	122.3800	0.000000	95.29592	0.000000
Std. Dev.	1447.614	1107.281	490.1945	0.249823
Observations	457	481	516	457

Pre-crisis (1992 – 2007)

	CASH	SALARY	BONUS	BONUSR
Mean	1722.386	775.7019	904.1928	0.392961
Median	1196.493	710.5182	489.9329	0.414201
Std. Dev.	1491.159	451.0776	1163.922	0.226899

Crisis (2008)

	CASH	SALARY	BONUS	BONUSR
Mean	1075.964	789.8372	265.4896	0.113171
Median	819.8263	731.706	0	0
Std. Dev.	1191.783	488.929	789.9969	0.207509

Post-crisis (2009 – 2010)

	CASH	SALARY	BONUS	BONUSR
Mean	1462.034	835.2845	552.7164	0.251237
Median	1049.953	724.0702	121.5445	0.189627
Std. Dev.	1323.241	613.632	855.8255	0.265241

Table 2.3 Summary statistics of CEO characteristics

	TENURE	AGE	OWNERSHIP
Mean	3.075117	53.67877	0.000944
Median	2.000000	54.00000	4.63E-05
Maximum	18.00000	71.00000	0.055053
Minimum	0.000000	35.00000	0.000000
Std. Dev.	3.207196	6.433469	0.006048
Skewness	1.551450	-0.279428	8.504287
Kurtosis	5.732393	2.951164	74.46290
Observations	426	358	315

Table 2.4 Summary bank-accounting data[19]

	MB	SIZE	LEVERAGE	ROE	NPLOAN
Mean	1.712163	11.51214	0.388573	0.106241	0.021144
Median	1.628935	11.81491	0.368318	0.122800	0.013708
Maximum	6.948480	14.68670	0.969926	1.188400	0.720582
Minimum	0.102995	5.878818	0.000000	-3.777200	0.000000
Std. Dev.	0.872800	1.832702	0.187451	0.198081	0.044155
Skewness	1.214792	-0.541946	1.102186	-9.844044	11.94856
Kurtosis	7.095526	2.756692	4.758139	167.1232	173.7027
Observations	506	536	526	1043	445

MB - market to book ratio. Size = ln(real asset). Leverage = debt/asset. Nploan=non-performing loan/loan

[19] Initial we have other controls such as capital asset ratio, liquidity ratio. In all of these are insignificant except for equity to asset ratio in salary is only marginally significant at 10%.

Table 2.5 Mean and standard deviation of ROE each year

YEAR	Mean	Std. Dev.	Obs.
1992	-0.041418	0.626572	39
1993	0.095516	0.099747	44
1994	0.113229	0.098124	45
1995	0.125076	0.083008	49
1996	0.129647	0.092515	51
1997	0.124375	0.104220	53
1998	0.146119	0.072001	54
1999	0.148107	0.133274	54
2000	0.157812	0.180977	59
2001	0.113270	0.086542	60
2002	0.055658	0.190843	59
2003	0.096908	0.208002	61
2004	0.138156	0.082469	61
2005	0.168200	0.068716	61
2006	0.177431	0.062012	61
2007	0.167944	0.088024	62
2008	-0.009687	0.322520	60
2009	0.036062	0.131253	55
2010	0.023229	0.248991	55
All	0.106241	0.198081	1043

Table 2.6 Market Index

Austria	ATX
Belgium	BEL20
Denmark	OMX Copenhagen 20
France	CAC 40
Germany	DAX
Iceland	OMX
Italy	FTSE MIB
Netherland	AEX
Norway	OBX
Poland	MWIG 40
Spain	IBEX 35
Sweden	OMX Stockholm 30
Switzerland	SMI
UK	FTSE 100

Table 2.7 Summary statistics of four risk measures

	Total Risk δ_j	Idiosyncratic Risk δ_{uj}	Systematic Risk β_m	Beta
Mean	0.020737	0.016495	0.821499	1.085233
Median	0.017901	0.014062	0.863192	1.090000
Maximum	0.152582	0.130527	2.745963	5.070000
Minimum	0.001462	0.001553	-1.401413	-1.610000
Std. Dev.	0.012858	0.011188	0.529770	0.575959
Skewness	3.234562	3.688273	0.156839	0.694769
Kurtosis	21.84018	25.55723	3.073419	7.832071
Observations	1019	864	864	508

Table A.1 Risk Equations

Variable	TRISK		FRISK		SRISK		BETA	
	Estimate	**P-value**	**Estimate**	**P-value**	**Estimate**	**P-value**	**Estimate**	**P-value**
Intercept	0.001455	0.9669	0.01882	0.5756	-2.54523	0.0333	2.436509	0.0971
LNCASH	-0.00574	0.0011	-0.00661	0.0001	-0.12847	0.0256	-0.19033	0.0100
SIZE	0.005271	0.0542	0.004011	0.1278	0.358594	0.0002	0.011394	0.9199
LEVERAGE	0.015106	0.0227	0.013167	0.0367	0.501999	0.0244	0.010467	0.9696
MB	-0.00525	0.0000	-0.00476	0.0000	-0.06778	0.0778	-0.06535	0.1640
ROE	-0.01581	0.0568	-0.02176	0.0054	0.167631	0.5399	-0.61999	0.0728
NPLOAN	0.258626	0.0000	0.200382	0.0008	5.39017	0.0103	10.02749	0.0002
OWNERSHIP	-2.34801	0.0541	-0.91313	0.4169	-45.8691	0.2490	-12.1122	0.8103
R-squared	0.828489		0.773784		0.825194		0.796481	
Obs	246		223		223		224	

OLS estimation using annual over the period 1994 to 2010. Dependent variables are Total risk, Firm risk, Systematic risk and Beta. MB - market to book ratio. Size = ln(real asset). Leverage = debt/asset. Nploan=non-performing loan/loan. Ownership is the percentage of shareholding. Lncash is the log of total compensation.

Table A.1.1 Risk Equations separating salary and bonus

Salary:

Variable	TRISK		FRISK		SRISK		BETA	
	Estimate	**P-value**	**Estimate**	**P-value**	**Estimate**	**P-value**	**Estimate**	**P-value**
Intercept	-0.03324	0.3589	-0.01453	0.6791	-2.56009	0.0329	2.025258	0.1743
LNSALARY	0.001103	0.6953	-0.00021	0.9392	-0.0974	0.2901	-0.09212	0.4322
SIZE	0.004252	0.1272	0.00302	0.2709	0.337744	0.0004	-0.02003	0.8603
LEVERAGE	0.013475	0.0435	0.011156	0.0833	0.544625	0.0131	0.048278	0.8596
MB	-0.00535	0.0000	-0.00497	0.0000	-0.06071	0.1062	-0.06639	0.1498
ROE	-0.02114	0.0027	-0.02326	0.0005	-0.05254	0.8146	-0.55957	0.0513
NPLOAN	0.250333	0.0001	0.197433	0.0009	5.730511	0.0045	10.36386	0.0001
OWNERSHIP	-2.22474	0.0740	-0.91778	0.4314	-47.8444	0.2275	-21.5777	0.6709
R-squared	0.816483		0.747233		0.83687		0.795566	
Obs	263		240		240		259	

OLS estimation using annual over the period 1994 to 2010. Dependent variables are Total risk, Firm risk, Systematic risk and Beta. MB - market to book ratio. Size = ln(real asset). Leverage = debt/asset. Nploan=non-performing loan/loan. Ownership is the percentage of shareholding. Lnsalary is the log of fixed pay.

Bonus:

Variable	TRISK		FRISK		SRISK		BETA	
	Estimate	**P-value**	**Estimate**	**P-value**	**Estimate**	**P-value**	**Estimate**	**P-value**
Intercept	-0.01884	0.5646	-0.0034	0.9141	-3.02485	0.0090	1.554238	0.2746
BONUSR	-0.0168	0.0000	-0.01735	0.0000	-0.2808	0.0194	-0.2695	0.0748
SIZE	0.003953	0.1353	0.002386	0.3491	0.329658	0.0005	-0.0202	0.8597
LEVERAGE	0.014313	0.0252	0.011155	0.0661	0.459486	0.0376	-0.03869	0.8886
MB	-0.00502	0.0000	-0.0045	0.0000	-0.06299	0.1003	-0.0619	0.1916
ROE	-0.01405	0.0809	-0.02032	0.0075	0.175091	0.5218	-0.66005	0.0587
NPLOAN	0.280828	0.0000	0.221313	0.0001	5.783607	0.0058	10.40618	0.0001
OWNERSHIP	-2.33209	0.0486	-0.89606	0.4119	-45.5574	0.2515	-12.3848	0.8079
R-squared	0.838601		0.786841		0.825694		0.792609	
Obs	246		223		223		242	

OLS estimation using annual over the period 1994 to 2010. Dependent variables are Total risk, Firm risk, Systematic risk and Beta. MB - market to book ratio. Size = ln(real asset). Leverage = debt/asset. Nploan=non-performing loan/loan. Ownership is the percentage of shareholding. Bonusr=bonus/total compensation.

Table A.2 Performance equation

	Dependent variable : ROE							
	Estimate	P-value	Estimate	P-value	Estimate	P-value	Estimate	P-value
Intercept	0.314467	0.3282	0.225151	0.5265	0.161645	0.6578	0.320102	0.3302
LNCASH	0.037169	0.0336	0.032812	0.0699	0.049778	0.0059	0.048973	0.0051
SIZE	-0.03627	0.1930	-0.02567	0.4019	-0.03345	0.2929	-0.04228	0.1324
LEVERAGE	-0.06119	0.3806	-0.04846	0.5052	-0.08948	0.2240	-0.08144	0.2589
MB	0.033345	0.0127	0.027396	0.0523	0.039989	0.0046	0.036405	0.0072
TRISK	-2.4065	0.0010						
FIRSK			-3.33252	0.0001				
SRISK					-0.0303	0.2012		
BETA							-0.06135	0.0014
R-squared	0.500983		0.504277		0.481524		0.498109	
Obs	416		389		389		407	

OLS estimation using annual over the period 1994 to 2010. Dependent variables is ROE. Four risk measures is applied - Total risk, Firm risk, Systematic risk and Beta. MB - market to book ratio. Size = ln(real asset). Leverage = debt/asset. Nploan=non-performing loan/loan. Lncash is the log of total compensation.

Table A.2.1 Performance equation separating salary and bonus

Salary:

	Dependent variable : ROE							
	Estimate	**P-value**	**Estimate**	**P-value**	**Estimate**	**P-value**	**Estimate**	**P-value**
Intercept	0.06542	0.8336	0.009348	0.9786	-0.07613	0.8325	0.115179	0.7216
LNSALARY	0.072338	0.0049	0.073469	0.0062	0.085539	0.0019	0.095248	0.0008
SIZE	-0.03322	0.2076	-0.02855	0.3359	-0.03189	0.3040	-0.05095	0.0616
LEVERAGE	-0.05251	0.4387	-0.04895	0.4873	-0.0847	0.2401	-0.06904	0.3425
MB	0.033801	0.0074	0.027943	0.0373	0.041837	0.0019	0.041382	0.0012
TRISK	-2.83589	0.0000						
FIRSK			-3.71663	0.0000				
SRISK					-0.03006	0.1834		
BETA							-0.05673	0.0018
R-squared	0.501848		0.505651		0.477183		0.495206	
Obs	470		443		443		456	

OLS estimation using annual over the period 1994 to 2010. Dependent variables is ROE. Four risk measures is applied - Total risk, Firm risk, Systematic risk and Beta. MB - market to book ratio. Size = ln(real asset). Leverage = debt/asset. Nploan=non-performing loan/loan. Lnsalary is the log of fixed pay.

Bonus:

	Dependent variable : ROE							
	Estimate	**P-value**	**Estimate**	**P-value**	**Estimate**	**P-value**	**Estimate**	**P-value**
Intercept	0.435757	0.1716	0.333268	0.3433	0.32298	0.3731	0.483774	0.1368
BONUSR	0.050743	0.1986	0.041409	0.3100	0.085381	0.0352	0.084593	0.0265
SIZE	-0.02585	0.3448	-0.01642	0.5863	-0.02013	0.5212	-0.02952	0.2867
LEVERAGE	-0.05135	0.4624	-0.03767	0.6042	-0.0749	0.3103	-0.06826	0.3452
MB	0.034057	0.0113	0.028157	0.0469	0.041629	0.0032	0.037077	0.0065
TRISK	-2.51644	0.0007						
FIRSK			-3.49569	0.0000				
SRISK					-0.03174	0.1857		
BETA							-0.0628	0.0012
R-squared	0.496719		0.500686		0.476289		0.493596	
Obs	416		389		389		407	

OLS estimation using annual over the period 1994 to 2010. Dependent variables is ROE. Four risk measures is applied - Total risk, Firm risk, Systematic risk and Beta. MB - market to book ratio. Size = ln(real asset). Leverage = debt/asset. Nploan=non-performing loan/loan. Bonusr=bonus/total compensation.

Table A.3 Compensation Equations

	Dependent variable : LNCASH							
	Estimate	**P-value**	**Estimate**	**P-value**	**Estimate**	**P-value**	**Estimate**	**P-value**
Intercept	4.78437	0.0001	4.960439	0.0003	4.879549	0.0006	4.993571	0.0001
MB	-0.0481	0.3048	-0.05176	0.3029	-0.01391	0.7808	-0.02337	0.6193
SIZE	0.197959	0.0354	0.16693	0.1102	0.177228	0.1052	0.170124	0.0732
LEVERAGE	0.783579	0.0017	0.903693	0.0005	0.771623	0.0033	0.682785	0.0065
ROE	0.483523	0.0068	0.404839	0.0277	0.558968	0.0022	0.59798	0.0008
TENURE	0.018704	0.0717	0.01191	0.2743	0.019519	0.0746	0.023394	0.0245
AGE	-0.00223	0.6836	0.003316	0.5833	0.000667	0.9142	-0.00286	0.6051
TRISK	-6.94546	0.0119						
FIRSK			-11.2678	0.0003				
SRISK					-0.14769	0.1008		
BETA							-0.02814	0.6712
R-squared	0.840601		0.83667		0.828736		0.836066	
Obs	297		274		274		296	

OLS estimation using annual over the period 1994 to 2010. Dependent variables is log of total compensation. Four risk measures is applied - Total risk, Firm risk, Systematic risk and Beta. MB - market to book ratio. Size = ln(real asset). Leverage = debt/asset. Nploan=non-performing loan/loan.

Table A.3.1 Compensation equation separating salary and bonus

Salary:

	Dependent variable : LNSALARY							
	Estimate	**P-value**	**Estimate**	**P-value**	**Estimate**	**P-value**	**Estimate**	**P-value**
Intercept	4.361352	0.0000	4.039238	0.0000	4.00422	0.0000	4.323741	0.0000
MB	0.012039	0.6623	0.025162	0.3929	0.026496	0.3518	0.013063	0.6299
SIZE	0.174724	0.0018	0.183603	0.0030	0.189722	0.0025	0.176161	0.0016
LEVERAGE	0.551985	0.0002	0.637661	0.0000	0.636717	0.0000	0.552619	0.0002
ROE	0.365965	0.0004	0.346007	0.0010	0.347218	0.0006	0.37207	0.0002
TENURE	0.019845	0.0012	0.015078	0.0175	0.015447	0.0130	0.019912	0.0010
AGE	-0.0027	0.3912	0.0014	0.6842	0.001066	0.7570	-0.00272	0.3877
TRISK	0.243262	0.8773						
FIRSK			-0.73425	0.6828				
SRISK					-0.03401	0.4981		
BETA							0.019202	0.6127
R-squared	0.861469		0.864576		0.864744		0.861434	
Obs	321		298		298		320	

OLS estimation using annual over the period 1994 to 2010. Dependent variables is log of fixed pay. Four risk measures is applied - Total risk, Firm risk, Systematic risk and Beta. MB - market to book ratio. Size = ln(real asset). Leverage = debt/asset. Nploan=non-performing loan/loan.

Bonus:

	Dependent variable : BONUSR							
	Estimate	**P-value**	**Estimate**	**P-value**	**Estimate**	**P-value**	**Estimate**	**P-value**
Intercept	0.123386	0.8285	0.450767	0.4704	0.39165	0.5518	4.78437	0.0001
MB	-0.0278	0.2001	-0.03652	0.1150	-0.01173	0.6184	-0.0481	0.3048
SIZE	0.02002	0.6441	-0.00775	0.8716	-9.83E-05	0.9985	0.197959	0.0354
LEVERAGE	0.168546	0.1405	0.185617	0.1185	0.09953	0.4175	0.783579	0.0017
ROE	0.129617	0.1151	0.097047	0.2499	0.197406	0.0214	0.483523	0.0068
TENURE	-0.00162	0.7360	-0.0027	0.5898	0.002302	0.6542	0.018704	0.0717
AGE	0.001939	0.4431	0.002875	0.3022	0.001109	0.7039	-0.00223	0.6836
TRISK	-5.66709	0.0000						
FIRSK			-7.42787	0.0000				
SRISK					-0.1006	0.0181		
BETA							-6.94546	0.0119
R-squared	0.737644				0.71034		0.840601	
Obs	297		274		274		297	

OLS estimation using annual over the period 1994 to 2010. Dependent variables is bonus/total compensation. Four risk measures is applied - Total risk, Firm risk, Systematic risk and Beta. MB - market to book ratio. Size = ln(real asset). Leverage = debt/asset. Nploan=non-performing loan/loan.

Table B.1 3SLS estimation

	Coefficient	Std. Error	t-Statistic	P-value
Dependent Variable: TRISK				
C	0.0210	0.0061	3.4399	0.0006
TRISK(-1)	0.4302	0.0577	7.4532	0.0000
BONUSR	-0.0341	0.0041	-8.2445	0.0000
SIZE	0.0008	0.0005	1.5643	0.1181
MB	-0.0028	0.0009	-2.9396	0.0034
NPLOAN	0.0555	0.0421	1.3196	0.1873
Dependent Variable: BONUSR				
C	0.4839	0.0323	14.9603	0.0000
D(ROE)	0.4909	0.1168	4.2023	0.0000
D(LOG(PRICE))	0.0797	0.0295	2.6993	0.0071
TRISK	-4.8007	1.2635	-3.7996	0.0002
Dependent Variable: LNSALARY				
C	1.1521	0.2497	4.6146	0.0000
LNSALARY(-1)	0.7372	0.0438	16.8369	0.0000
MB	0.0447	0.0173	2.5795	0.0100
SIZE	0.0414	0.0125	3.3120	0.0010
ROE	0.0825	0.1021	0.8082	0.4191
TENURE	0.0128	0.0187	0.6819	0.4955
Dependent Variable: ROE				
C	0.0390	0.0293	1.3324	0.1830
ROE(-1)	0.4636	0.0789	5.8766	0.0000
BONUSR	0.1632	0.0389	4.1925	0.0000
MB	0.0211	0.0101	2.0860	0.0372
TRISK	-2.9601	0.5765	-5.1351	0.0000

3 Stage Least Squares using annual over the period 1994 to 2010. Dependent variables are total risk, bonus/total compensation, log of fixed pay, and ROE. D(ROE) is the first difference of ROE. D(lnprice) is the first difference of the log of stock price. MB - market to book ratio. Size = ln(real asset). Nploan=non-performing loan/loan. Using lagged dependent variables as instruments is a standard approach. Two lags of dependent variable are used in all equations as instruments. In addition, we use D(ROE) D(LOG(PRICE)) for Risk equation, SIZE MB NPLOAN for bonus equation, NPLOAN D(ROE) D(LOG(PRICE)) for salary equation and SIZE NPLOAN D(ROE) D(LOG(PRICE)) for ROE equation. Sargan’s instrument validity test is not rejected, showing the instruments are valid.

Table B.2 Steady-state solutions

	SIZE	MB	NPLOAN	DLNPRICE
RISK	0.001872	-0.006774	0.136715	-0.006693
BONUSR	-0.008986	0.032518	-0.656329	0.111810
ROE	-0.0130.62	0.086685	-0.954088	0.070946

This is a Jacobian matrix which summarised the steady-state solution for the endogenous variable risk, bonusr and ROE. See Appendix II for calculations.

Table B.3 Exogenous effect for risk and bonus

	1994	2002	2006	2010
Mean				
SIZE	11.604	11.392	11.386	11.722
MB	1.195	1.727	2.019	1.016
NPLOAN	0.026	0.014	0.015	0.033
DLOGPRICE	-0.106	-0.207	0.251	-0.032
DROE	0.016	-0.057	0.03	-0.013
Difference				
SIZE		-0.212	-0.006	0.336
MB		0.532	0.292	-1.003
NPLOAN		-0.012	0.001	0.018
DLOGPRICE		-0.101	0.458	-0.283
DROE		-0.073	0.087	-0.043
Marginal effect				
SIZE		-0.00017	-4.8E-06	0.000269
MB		-0.00149	-0.00082	0.002808
NPLOAN		-0.00067	5.55E-05	0.000999
DLOGPRICE		-0.00805	0.036503	-0.02256
DROE		-0.03584	0.042708	-0.02111
Overall effect				
TRISK		-0.00408	-0.00135	0.007154
BONUSR		-0.04389	0.079211	-0.04366

The first section of the table takes the mean of each variable in the corresponding year. The second section takes the difference of mean from the first section. The third section of uses the coefficient of the variables from 3SLS estimation in Table B.2, multiply by the differenced of mean in the second section. In the last section, the overall effect of Trisk is the sum of the Marginal effect of SIZE, MB and NPLOAN, and the marginal effect of BONUSR is the sum of the marginal effect of DLOGPRICE and DROE.

Appendix II Dynamic Properties and Steady-state Solution of the System

Salary doesn't feed into the loop of the system, so we only concern the simultaneity amongst risk, bonus, and ROE, which leaves us the following three equations.

$$RISK_t = \alpha_1 + \alpha_2 RISK_{t-1} + \alpha_3 BONUSR_t + \alpha_4 SIZE_t + \alpha_5 MB_t + \alpha_6 NPLOAN_t \quad (1)$$

$$BONUSR_t = \beta_1 + \beta_2 ROE_t - \beta_2 ROE_{t-1} + \beta_3 DLNPRICE_t + \beta_4 RISK_t \quad (2)$$

$$ROE_t = \theta_1 + \theta_2 ROE_{t-1} + \theta_3 BONUSR_t + \theta_4 MB_t + \theta_5 RISK_t \quad (3)$$

Substitute for BONUSR in (1),

$$\begin{aligned} RISK_t &= \alpha_1 + \alpha_2 RISK_{t-1} + (\alpha_3\beta_1 + \alpha_3\beta_2 ROE_t - \alpha_3\beta_2 ROE_{t-1} \\ &+ \alpha_3\beta_3 DLNPRICE_t + \alpha_3\beta_4 RISK_t) + \alpha_4 SIZE + \alpha_5 MB_t + \alpha_6 NPLOAN_t \end{aligned} \quad (4)$$

Let $A = 1 - \alpha_3\beta_4$

$$\begin{aligned} RISK_t &= \frac{\alpha_1 + \alpha_3\beta_1}{A} + \frac{\alpha_2}{A} RISK_{t-1} + \frac{\alpha_3\beta_2}{A} ROE_t - \frac{\alpha_3\beta_2}{A} ROE_{t-1} \\ &+ \frac{\alpha_3\beta_3}{A} DLNPRICE_t + \frac{\alpha_4}{A} SIZE + \frac{\alpha_5}{A} MB_t + \frac{\alpha_6}{A} NPLOAN_t \end{aligned} \quad (5)$$

Substitute for BONUSR in (2),

$$\begin{aligned} ROE_t &= \theta_1 + \theta_2 ROE_{t-1} + \theta_3\beta_1 + \theta_3\beta_2 ROE_t - \theta_3\beta_2 ROE_{t-1} \\ &+ \theta_3\beta_3 DLNPRICE_t + \theta_3\beta_4 RISK_t + \theta_4 MB_t + \theta_5 RISK_t \end{aligned}$$

$$\begin{aligned} ROE_t &= \theta_1 + \theta_3\beta_1 + \theta_3\beta_2 ROE_t + (\theta_2 - \theta_3\beta_2) ROE_{t-1} \\ &+ \theta_3\beta_3 DLNPRICE_t + (\theta_3\beta_4 + \theta_5) RISK_t + \theta_4 MB_t \end{aligned} \quad (6)$$

Let $B = -(\theta_3\beta_4 + \theta_5)$

$$\begin{aligned} RISK_t &= \frac{\theta_1 + \theta_3\beta_1}{B} + \frac{(\theta_3\beta_2 - 1)}{B} ROE_t + \frac{(\theta_2 - \theta_3\beta_2)}{B} ROE_{t-1} \\ &+ \frac{\theta_3\beta_3}{B} DLNPRICE_t + \frac{\theta_4}{B} MB_t \end{aligned} \quad (7)$$

Use (7) to substitute for RISK in (5)

$$\frac{\theta_1+\theta_3\beta_1}{B}+\frac{(\theta_3\beta_2-1)}{B}ROE_t+\frac{(\theta_2-\theta_3\beta_2)}{B}ROE_{t-1}+\frac{\theta_3\beta_3}{B}DLNPRICE_t+\frac{\theta_4}{B}MB_t$$
$$=\frac{\alpha_1+\alpha_3\beta_1}{A}+[\frac{\alpha_2}{A}\frac{\theta_1+\theta_3\beta_1}{B}+\frac{\alpha_2}{A}\frac{(\theta_3\beta_2-1)}{B}ROE_{t-1}+\frac{\alpha_2}{A}\frac{(\theta_2-\theta_3\beta_2)}{B}ROE_{t-2}+$$
$$\frac{\alpha_2}{A}\frac{\theta_3\beta_3}{B}DLNPRICE_{t-1}+\frac{\alpha_2}{A}\frac{\theta_4}{B}MB_{t-1}]+\frac{\alpha_3\beta_2}{A}ROE_t-\frac{\alpha_3\beta_2}{A}ROE_{t-1}$$
$$+\frac{\alpha_3\beta_3}{A}DLNPRICE_t+\frac{\alpha_4}{A}SIZE+\frac{\alpha_5}{A}MB_t+\frac{\alpha_6}{A}NPLOAN_t$$

Let $C=\left(\frac{(\theta_3\beta_2-1)}{B}-\frac{\alpha_3\beta_2}{A}\right)^{-1}$

$$\begin{aligned}ROE_t &= (\frac{\alpha_1+\alpha_3\beta_1}{A}-\frac{\theta_1+\theta_3\beta_1}{B}+\frac{\alpha_2}{A}\frac{\theta_1+\theta_3\beta_1}{B})C\\
&+(\frac{\alpha_2}{A}\frac{(\theta_3\beta_2-1)}{B}-\frac{(\theta_2-\theta_3\beta_2)}{B}+\frac{\alpha_3\beta_2}{A})C\ ROE_{t-1}\\
&+\frac{\alpha_2}{A}\frac{(\theta_2-\theta_3\beta_2)}{B}C\ ROE_{t-2}\\
&+(\frac{\alpha_3\beta_3}{A}-\frac{\theta_3\beta_3}{B})C\ DLNPRICE_t+\frac{\alpha_2}{A}\frac{\theta_3\beta_3}{B}DLNPRICE_{t-1}\\
&+(\frac{\alpha_5}{A}-\frac{\theta_4}{B})C\ MB_t+\frac{\alpha_2}{A}\frac{\theta_4}{B}MB_{t-1}\\
&+\frac{\alpha_4}{A}C\ SIZE+\frac{\alpha_6}{A}C\ NPLOAN_t\end{aligned} \quad (8)$$

Let m be the constant and exogenous variable terms,

$$d_1=-(\frac{\alpha_2}{A}\frac{(\theta_3\beta_2-1)}{B}-\frac{(\theta_2-\theta_3\beta_2)}{B}+\frac{\alpha_3\beta_2}{A})C$$

and $d_2=\frac{\alpha_2}{A}\frac{(\theta_2-\theta_3\beta_2)}{B}C$

$$ROE_t+d_1ROE_{t-1}+d_2ROE_{t-2}=m$$

This is a second order difference equation.

The two characteristic roots are,

$$\lambda_1,\lambda_2=\frac{-d_1\pm\sqrt{d_1^2-4d_2}}{2}$$

Using the estimated coefficients from the base model, we find that

d_1=-0.925 and d_2=0.233. We have complex roots because $d_1^2 - 4d_2 < 0$. $|d_1| < 1 + d_2$ and $d_2 < 1$ suggest the solution is stable.

Steady State solution:

$$RISK = RISK_t = RISK_{t-1}$$

$$ROE = ROE_t = ROE_{t-1}$$

Let $D = 1 - \alpha_2 - \alpha_3\beta_4$

(4) becomes

$$RISK = \frac{\alpha_1 + \alpha_3\beta_1}{D} + \frac{\alpha_3\beta_3}{D} DLNPRICE + \frac{\alpha_4}{D} SIZE + \frac{\alpha_5}{D} MB + \frac{\alpha_6}{D} NPLOAN \qquad (9)$$

$$RISK = -0.262838 - 0.006693 DLNPRICE + 0.001872 SIZE - 0.006774 MB + 0.136715 NPLOAN$$

Substitute (9) in (2)

$$BONUSR = \beta_1 + \beta_3 DLNPRICE + \beta_4 \left(\frac{\alpha_1 + \alpha_3\beta_1}{D} + \frac{\alpha_3\beta_3}{D} DLNPRICE + \frac{\alpha_4}{D} SIZE + \frac{\alpha_5}{D} MB + \frac{\alpha_6}{D} NPLOAN\right)$$

$$= \left(\beta_1 + \frac{\beta_4(\alpha_1 + \alpha_3\beta_1)}{D}\right) + \left(\beta_3 + \frac{\beta_4\alpha_3\beta_3}{D}\right) DLNPRICE + \frac{\beta_4\alpha_4}{D} SIZE + \frac{\beta_4\alpha_5}{D} MB + \frac{\beta_4\alpha_6}{D} NPLOAN \qquad (10)$$

$$BONUSR = 0.431203 + 0.111810 DLNPRICE - 0.008986 SIZE + 0.032518 MB - 0.656329 NPLOAN$$

Substitute (9) in (6)

$$ROE = \theta_1 + \theta_3\beta_1 + \theta_2 ROE + \theta_3\beta_3 DLNPRICE + (\theta_3\beta_4 + \theta_5)\left(\frac{\alpha_1 + \alpha_3\beta_1}{D} + \frac{\alpha_3\beta_3}{D} DLNPRICE + \frac{\alpha_4}{D} SIZE + \frac{\alpha_5}{D} MB + \frac{\alpha_6}{D} NPLOAN\right) + \theta_4 MB$$

Let $E = (1 - \theta_2)^{-1}$ and $F = (\theta_3\beta_4 + \theta_5)$

$$
\begin{aligned}
ROE &= E(\theta_1 + \theta_3\beta_1) + E\theta_3\beta_3 DLNPRICE \\
&+ EF\left(\frac{\alpha_1 + \alpha_3\beta_1}{D} + \frac{\alpha_3\beta_3}{D} DLNPRICE + \frac{\alpha_4}{D} SIZE + \frac{\alpha_5}{D} MB + \frac{\alpha_6}{D} NPLOAN\right) + E\theta_4 MB \\
&= E\left(\theta_1 + \theta_3\beta_1 + \frac{\alpha_1 + \alpha_3\beta_1}{D}\right) + E\left(\theta_3\beta_3 + \frac{F\alpha_3\beta_3}{D}\right) DLNPRICE + \frac{EF\alpha_4}{D} SIZE \\
&+ E\left(\frac{F\alpha_5}{D} + \theta_4\right) MB + \frac{EF\alpha_6}{D} NPLOAN
\end{aligned} \tag{11}
$$

$$ROE = 0.240319 + 0.070946 DLNPRICE - 0.013062 SIZE + 0.086685 MB - 0.954088 NPLOAN$$

We also use an alternative method, using computer to simulate the solution. To get the marginal effect of size on risk, bonusr and ROE, we give all the variables zero as starting value but size equal to one. The system repetitively calculates the value of risk, bonusr and ROE from equation (1) to (3) until they converge. This is the first repetition. We use the value of risk, bonusr and ROE we got from the first repetition as the starting value, and put it back to the system. Iterate until risk, bonusr and ROE converges. This is the second repetition. Use the new set of value from the second repetition as starting value for the third repetition. We carry on this procedure until the value of risk, bonusr and ROE doesn’t change any more for each repetition. The converged values of risk, bonusr and ROE are the marginal effect of size. The results are exactly the same as the results above solved by hand. To get the marginal effects of mb nploan and dlnprice, we set their staring value as one and everything else to zero in the first repetition, and follow the same procedure above. Again the solution we got from simulation confirms our hand-solving solution.

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Chapter 3 Forecasting Horizon and Forward Market Efficiency

3.1 Introduction of research background and motivation

One of the fundamental concepts in finance is market efficiency. Malkiel and Fama (1970) summarise this idea in their classic survey as: "a market in which prices always 'fully reflect' available information is called 'efficient'." They also distinguished three different forms of market efficiency, with respect to different available information sets: the weak-form, the semi-strong form and the strong form. Geweke and Feige (1979) further distinguish two categories between single-market efficiency and multi-market efficiency within the semi-strong form of market efficiency. The efficient markets hypothesis (EMH) states that if the foreign exchange market is competitive, frictionless (i.e. no taxes, transaction costs or other costs), with all information available and used rationally by the risk – neutral economic agents, then there will be no speculations because the expected returns will be zero (Hansen and Hodrick 1980). In other words, in an aggregate sense, if the participants in the foreign exchange rates market are risk neutral and have rational expectation (RE), forward exchange rate should be an unbiased predictor of the corresponding future spot exchange rate because it contains all of the relevant information about the expected future exchange rate.

However one the implications of efficiency market hypothesis, that forward rate being an unbiased predictor of future spot rate is empirically far from conclusive. Many empirical literature find a forward rate bias, where the forward rate does not provide an unbiased forecast of the future spot exchange rate. In theory, the relationship between spot and forward exchange rates is governed by the uncovered interest rate parity (UIP) condition, which suggests that the forward premium must be perfectly positively related to future spot exchange rate changes. In practice, we usually observe a negative relationship empirically. Fama (1984) reports the evidence of the relationship between spot and forward exchange rates is generally discrediting towards the expectations theory of unbiased forward rates. In particular, he finds that the difference between the current forward and spot rates is an upward-biased estimate of the subsequent change in the spot rate. His result suggests that the bias in the forward rate is such that when the forward rate exceeds the spot rate, then the spot rate tends to decline on the average, whereas the expectations theory predicts that the spot rate will increase on the average in this situation (Tauchen 2001).

The forward premium puzzle is closely related to the presence of forward rates bias, and the failure of the uncovered interest rate parity (UIP) to hold. The theoretical implication of UIP, that the forward premium must be perfectly positively related to future exchange rate changes is not empirically supported as we observe a negative relationship. The puzzle is that the forward premium tends to points at the opposite direction of the ex post movement of the spot exchange rate. It subsequently suggests that domestic currency is likely to appreciate when its nominal interest rate is higher which again contrary to what the theory predicts. To illustrate this contradiction, we start from the following relationship:

$$S_{t+1} = \alpha + \beta F_t + u_{t+1} \quad (3.1)$$

Let s_t be the current spot exchange rate, and S_t be the natural logarithm of the spot rate (defined as the domestic currency per unit of foreign currency), so that $S_t = \ln s_t$. f_t is the forward exchange rate, and F_t denotes the natural logarithm of the forward exchange rate, so $F_t = \ln f_t$. u_{t+1} is the residual term. If forward rate is an unbiased predictor of the corresponding future spot exchange rate, one would expect α=0 and β=1 provided the agents are risk neutral and do not make systematic errors in their forecast. However in reality, regression estimates do not find a zero α and a unity β. Moreover, the estimated regression error term often exhibits serial correlation, violating the rational expectations hypothesis.

More formally, researchers test the following equation, by subtracting S_t from the previous equation:

$$\Delta S_{t+1} = \alpha + \beta(F_t - S_t) + u_{t+1} \qquad (3.2)$$

$\Delta S_{t+1} = S_{t+1} - S_t = \ln s_{t+1} - \ln s_t \cong \frac{s_{t+1} - s_t}{s_t}$ is the future rate of depreciation, the depreciation of spot exchange rate from period t to t+1. $(F_t - S_t)$ is the forward premium. This equation if often referred as the Fama equation[20]. The puzzle is that not only α appears different from zero, β also appears different from unit, and β is typically negative. McCallum (1994) also emphasized another stylised fact that the R^2 in this equation is typically very low and the forward premium itself is positively correlated. The forward premium is linked to the interest rate by the interest rate parity. If the covered interest rate parity (CIP) holds, then:

$$\frac{1+i_t^H}{1+i_t^F} = \frac{f_t}{s_t} \qquad (3.3)$$

where i_H is the nominal interest rate in the home country and i_F is the nominal interest rate in the foreign country. Let $R_t^H = \ln(1+i_t^H)$, $R_F = \ln(1+i_t^F)$, $F_t = \ln(f_t)$ and $S_t = \ln(s_t)$, from the equation above we have:

$$R_t^H - R_t^F = F_t - S_t \qquad (3.4)$$

Then equation (3.2) becomes:

[20] See Fama (1984)

$$\Delta S_{t+1} = \alpha + \beta(R_t^H - R_t^F) + u_{t+1} \qquad (3.5)$$

A negative β suggests that if there is a positive change in $R_t^H - R_t^F$, there will be a negative response of ΔS_{t+1}. In other words when R_t^H the domestic interest rate becomes higher, we would expect a decrease in S_{t+1}, that the domestic currency will appreciate.

If covered interest rate parity is assumed to be held, testing equation (3.1) is equivalent of testing equation (3.2). A large volume of empirical work has tested the efficient market hypothesis as β=1. Results often showed that the least-squares estimates of β is significantly smaller than 1. Actually, in many cases, β is less than zero. The evidence is strongly against the efficient market hypothesis which theoretically predicts that β=1. Moreover, many researches often produce a negative slope coefficient of the equation, which suggests that domestic currency will appreciate when the domestic interest rate is higher. This suggests a simple and profitable trading scheme (Roll and Yan 2000): a trader can borrow in the low interest rate country and use the proceeds to buy bonds in the high interest rate country. On the contrary, an implication of many economic models is that the domestic currency is expected to depreciate when domestic nominal interest rates exceed foreign interest rate (Lucas Jr 1982, Bansal, Gallant et al. 1995, Bekaert 1996, Bansal and Dahlquist 2000). Also Equation (3.5) is the uncovered interest rate (UIP) test equation. If UIP holds the slope coefficient β is expected to be unity. The finding of a negative β not only represents an alluring opportunity, it also rejects UIP. This puzzling phenomenon is known as the Forward Premium Puzzle.

Since the Forward Premium Puzzle arose in the 80s, numerous researches in this area have done in the past decades. Economists have used different sample countries and periods to test the Forward Premium Puzzle. Researchers have tried various ways to explain the Forward Premium Puzzle, by either modifying the model or incorporating new econometric techniques. The explanation of the Forward Premium Puzzle is still far from conclusive.

In this study we also collect 3 sets of exchange rates with US dollar, sterling and Euro as numeraire to see if they get consistent results. One of the main differences between these currencies is their liquidity. For example the US dollar and Euro are more liquid than Sterling. However the primary reason of using all three currencies is for robustness. If there is no significant difference between currencies, it suggests that our result is robust. If the results are different, this could mean that the arbitrage opportunities haven't been completely exploited. If cross rate exists, then there might be an opportunity of triangular arbitrage between these three currencies. When the market is efficient, if one dollar is exchanged to Sterling, then to Euro, then back to dollar, this should generate exactly one dollar subject to transition cost. Even with zero transaction cost, there is no triangular arbitrage opportunity under the assumption of market efficiency. The other arbitrage opportunity in the foreign exchange market is similar to the carry trade strategy, where an investor borrows money in a low-interest-rate currency, converts the funds into a high-interest rate currency and lends the resulting amount in the target currency at the higher interest rate. In the foreign exchange market, investors can sell currencies which the forward exchange rate is higher than the spot exchange rate, and buy currencies which the forward exchange rate is lower than the spot exchange rate. However the theory of market efficiency implies that these strategies should yield no predictable profits. For these reasons, it is important for us the carry out this study with three different currencies and see whether they yield significantly different results.

Time horizon is an important element in the studies related to market efficiency. Investors in equity markets intervene according to different decision-making time horizons: e.g., intra-day or daily traders, individual non-professional portfolio managers, long-term institutional investors such as pension funds. When returns are unpredictable, there is a single risk premium, but when stock returns are predictable, risk premia are horizon-dependent. Prat (2013) points out that since the years 2000, academic work using survey data revealing experts' stock return expectations straightforwardly confirms the existence of a time-varying term structure for equity risk premia. Thus, studies by Welch (2000) and Prat (2001) show that, despite common trends, substantial discrepancies characterize risk premia depending on the time horizon. These studies strongly confirm that risk premium is both time-varying and horizon-dependent. The existence of time-varying return premia implies that the movements of the yield curve over time are driven not only by changes in the expectations about future one-period interest rates but also by changes in the return premia. It was also argued that in the traditional liquidity preference theory that return premia (and forward premia) exists because lenders prefer the liquidity provided by short-term bonds. Hence, extra rewards have to be made to induce them to purchase long-term bonds. Under the liquidity preference theory, changes in the return premia over time should be related to changes in the liquidity preference of investors in the bond markets.

It is a general consensus that risk premium is not constant but time variant, and risk premium increase over time. Harvey (1989) shows that US equity risk premia are higher at business cycle troughs than they are at peaks. Subsequent results of Li (2001) confirm these findings. Cochrane and Piazessi (2005) find that the term premium is countercyclical in the US. De Paolia (2008) shows that in order to generate countercyclical varying premia, one requires either hump shaped consumption dynamics or highly persistent shocks and slow-moving habits. It is also recognised in the literature on the existence of time varying premiums in forward rates [Hsieh (1982), Hansen and Hodrick (1983), and Hodrick and Srivastava (1984)]. Fama (1984) argues that the currency forward rates are in general biased predictors for spot exchange rates, because they not only reflect expected spot rates but additionally comprise time-varying risk premium.

We aim to revisit the issue of spot-forward market efficiency at different time (forecast) horizons. Most existing literatures focus on a single forecast period while testing this hypothesis. In the real world, different agents require forward contracts spanning different durations (i.e., maturity): forward contract for a day, a week, a month, etc. At any point in time, forward rates on offer for different durations are in effect the predictions of future spot exchange rates. In this context, it is natural to think that the longer the duration of forward contract (e.g., a year versus a week) the longer is the forecast horizon of the movement of the future spot rate. Analogously, the longer the forecast horizon the higher the likelihood of committing larger forecast errors. This provides us with an interesting testable hypothesis.

We hypothesize that the rejection of the unbiasedness of the forward market is positively associated with the horizon of the forward contract. In other words, there should be more rejections of the market efficiency hypothesis as the length of the forward contract gets longer. This is due to the forecast errors associated with the long horizon forecast. It is much easier to forecast what the spot exchange rate will be tomorrow and set the corresponding forward rate accordingly compared to a month or a year hence. It is also important to note that it is extremely difficult to forecast risk premium and factor determining risk premium for longer forecast horizons. We use 9 different time horizons, namely, one day, one week, one month, two months, three months, six months, nine months, one year and two years. We expect rejection of unbiasedness hypothesis to increase as the contract horizon gets longer. Our result shows that forward rate bias is not much of a bias when forecast (forward contract) horizon is short. Only two of the 32 countries reject the hypothesis for one day contract and 7 countries reject the weekly forward contract in the Sterling exchange rate sample. Consistent with our hypothesis, the number of rejections increases in the longer forecast horizon. It suggests that the forward rate unbiasedness holds in the short horizon but not in the longer horizon. Forward rate started to lose its predictive power when the time to maturity is longer than a month.

We select a mixture of developed and developing countries, which includes some large economies e.g. China, India and Russia, some strong trading economies e.g. Taiwan, Turkey and Philippines, countries with or without capital controls, and countries with different levels of liquidity. It is generally assumed that the emerging markets are less efficient than the developed market. Many researches have confirmed a weak-form market efficiency in emerging economies (Dickenson 1994, Vieito 2013). It is not unlikely that the market participants are not well informed and behaving irrationally compared to well organised markets. The causes of the lack of financial development, especially in capital markets, are due to certain market imperfection such as transaction costs, lack of timely information cost of acquiring new information, and possibly greater uncertainty about the future (Mobarek 2008). The effect of liquidity to market efficiency is mixed. Chordia (2008) is the first study that focuses specifically and examines empirically the effects of liquidity on market efficiency. He presents two hypotheses on how liquidity can be related to short-horizon market efficiency. First, if market makers cannot absorb the impact of price pressure from imbalances in buy and sell orders, temporary price deviations arise inducing return predictability and creating arbitrage profit potential. Higher liquidity facilitates arbitrage trading which leads to lower return predictability and higher market efficiency. In this situation, liquidity is positively related with market efficiency. Second, if market makers fail to utilize the information in order flows and eliminate return predictability, other market participants have incentives to gather new information about order flows and trade on such information. While the consequent increased adverse selection faced by market makers lowers liquidity, the market is more efficient as more information is incorporated in the prices (Barberis et al., 1998). In this case, liquidity is negatively associated with market efficiency. Chordia (2008) also points out that if market makers could fully absorb the price pressure from imbalances in buying and selling orders and utilizing all information in the order flows, then there should be no relationship between liquidity and market efficiency. An empirical study by Oh et al. (2007) suggests that the markets with a larger liquidity such as European and North American foreign exchange markets have higher market efficiencies than those with a smaller liquidity such as the African and Asian markets, except Japan. We select countries with a mixture of different characteristics. The idea is to examine the forward market efficiency across a range of economies to arrive at robust results. We are interested if the hypothesis holds across all countries in short horizons or if there are clusters of countries showing different results.

When comparing emerging economies with developed economies, we find that the predicting bias is worse in emerging economies. We argue it is because emerging economies are less liquid and have higher risk premium. Our evidence support Oh and Kim et al. (2007) who suggest that the markets with a larger liquidity such as

European and North American foreign exchange markets have a higher market efficiency than those with a smaller liquidity, such as the African and Asian markets - except Japan.

We use unit root test to test the stationarity of both the spot exchange rate and the forward rate. It is established in the early literatures that exchange rate can be viewed as following a non-stationary time series process or process with a unit root (Baillie and McMahon, 1990). However there are some contrary evidences. For example Zhou (2008) rejects the null hypothesis of nonstationarity for most of the Asian-Pacific real exchange rates, but not for the Japanese Yen based rates. We find that exchanges rates in most countries are stationary, although there are a few exceptions. We contribute to the existing literature by detailing the changes of the predicting parameters over different time horizons. To test for efficient market hypothesis using nonstationary data, we use cointegrating regression methods FMOLS and DOLS.

We also investigate the forward premium puzzle by testing the Fama equation. We are interested to find out whether forward premium puzzle worsen in longer time horizons. We test the Fama equation for each horizon for all 31 countries. β has increasing or decreasing trend for only a few countries, but for the majority of the countries, β doesn't have a trend as time horizon becomes longer. Our evidence doesn't support the finding of To (2007). They find that the longer the maturity of the forward contracts, the less negative the β coefficient is. Our finding suggests that forward premium doesn't disappear even in longer time horizons.

The remainder of this chapter is organized as follows. Section 3.2 provides a brief review of some of the key literature addressing the forward premium puzzle. Section 3.3 introduces the econometric methodologies applied in this chapter. Data description and the basic analysis of the raw data is in Section 3.4. Details of the models and empirical results are provided in Section 3.5. Section 3.6 concludes the chapter.

3.2 Literature Review

Serious effort has been made to explain the forward premium puzzle. One of the main approaches to resolve the puzzle is by introducing risk-averse behaviour into the standard rational expectations model. Nobel Prize winner Eugene Fama (1984) first attribute the forward rate bias to time-varying risk premium. Assume that investors in the foreign exchange market are risk averse, thus the forward rate not only incorporates their expectations of future spot rates but also a risk premium hedging against the risky asset, a more volatile asset with higher expected rate of return. From the principle of no-arbitrage, one can argue that currency forwards are in general biased predictors for spot exchange rates because they not only reflect expected spot rates but also a time-varying risk premium that compensate for both currency risk and interest rate risk.

Fama decomposed the forward premium into the expected rate of depreciation q_t and the expected excess return p_t,

$$F_t - S_t = (F_t - E_t S_{t+1}) + (E_t S_{t+1} - S_t) = p_t + q_t \qquad (3.6)$$

where $S_t = \ln s_t$ and $F_t = \ln f_t$, the natural log of the spot and forward exchange rate at time t. The excess return is p_t , which also interpreted as the risk premium. q_t is the expected depreciation. Let $\overline{\beta}$ represent the estimate of β in equation (3.1). If the estimator is consistent, the population regression coefficients β is

$$\beta = \text{plim}(\overline{\beta}) = \frac{\text{cov}(q, p+q)}{\text{var}(p+q)} = \frac{\text{cov}(q, p) + \text{var}(q)}{\text{var}(p+q)} \qquad (3.7)$$

Clearly if we assume a constant risk premium p, cov(q,p)=0 and var(p+q)=var(q), hence β=1 according to equation (3.7). Since $\text{var}(p+q) > 0$, to generate a negative value of β requires cov(q,p) + var(q) < 0. Given that var(q) > 0, we need

$\mathrm{cov}(q,p)<0$, and $|\mathrm{cov}(q,p)|>|\mathrm{var}(q)|$ i.e. $\mathrm{var}(p)>\mathrm{var}(q)$. Fama concludes a negative regression coefficient β needs a negative covariance between p and q, and a greater variance of p than q. In other words implied risk premium must be negatively related with its expected rate of depreciation and have greater variance. Although theoretically possible, in reality such models have difficulty reproducing this inequality under reasonable levels of risk aversion (Engel 1996), thus led to a general scepticism of the time-varying risk-premium explanation.

Researchers adopt several alternatives to rational expectations models including irrational expectations, learning, speculative bubbles, expected utility and peso problems to explain the forward premium puzzle. Frankel and Froot (1987) find that exchange rate expectations are not static. They reject rational expectations and suggest that investigating heterogeneous investor expectations would be a useful avenue. Froot and Frankel (1989) assert that the bias is entirely due to expectational errors and that none is due to time-varying risk. They also reject the claim that the risk premium is more variable than expected depreciation. Landon and Smith (2003) provides evidence that the rejection of forward exchange rate unbiasedness can be attribute to both non-rational expectation and a time-varying risk premium.

Rational learning happens when there is a potential permanent shift in the economy, due to a change in monetary or fiscal policy. Agents did not immediately believe that the change would persist, but instead learned the shift rationally. The expected future exchange rate is the weighted expected exchange rates under the two regimes, where the weights are the probabilities of each regime. The exchange rate will be biased until the learning process is finished. Lewis (1989) investigates the effects of learning about the increase in U.S. money demand in the early 1980s. The process of learning implies that β should converge to one at later times after the shift happened. However Lewis (1989) also acknowledges that the bias continued beyond the initial shift she considered. The problem of explaining the puzzle using learning is that regime changes do not occur frequently enough to account for the persistence of the puzzle over many periods of time. Chakraborty and Evans (2008) show that replacing rational expectation with perpetual learning (discounted least-squares) generates a negative bias that becomes strongest when the fundamentals are strongly persistent (close to a random walk). If traders do not have perfectly rational expectations, their forecast errors may be correlated with the previous period's information and this would bring a bias in the forward-premium regression results. They argued that learning theory approach should be considered in future empirical work on the forward premium puzzle. Chakraborty (2009) argued that the negative β is a reflection of the learning dynamics, and is not intrinsically an indication of market inefficiency.

Evans and Lewis (1995) seek to explain risk premium variability by the peso problem. Asset prices are determined by expectations about the paths of future economic variables. Hence, the asset price behaviour is directly affected by the anticipated discrete changes in the distribution of these variables. The 'peso problem' focuses on how asset prices behave when the market has expectations about infrequent discrete shifts in economic determinants. With these expectations, the discrete changes can induce behaviour in asset prices that apparently contradicts conventional rational expectation assumptions. The fundamental shifts typically occur infrequently, even in relatively large samples. In a way, the 'peso problem' can be seen as a small-sample inference problem arising from these expected events. The 'peso problem' was first noted in the Mexican peso market. The original source of the term is unknown, although some economists have attributed it to Milton Friedman.

The empirical phenomenon was originally mentioned by Rogoff (1980). Based on evidence from the Mexican peso futures market from Jun 1974 to Jun 1976, Rogoff used the relationship between futures contracts and spot contract to test market efficiency under rational expectations and risk neutrality. He found that the implications of market efficiency were rejected, but that the behaviour of future contracts could be explained by the market's persistent belief that the Mexican peso might be devalued. Consistent with his explanation, the peso was devalued in August 1976.

Evans and Lewis (1995) describes that dollars appears to have periods of persistent appreciation and then depreciation, and traders in the market is likely to anticipate shifts between these regimes. This expectation in turn affects the behaviour of forward rates relative to observed spot rates. If exchange rates switch infrequently between different regimes, rational expectations of switches that are not realised over significant periods of time will result in systematic differences between the expected and realised exchange rate through a 'peso problem'. They purposed that 'peso problem' can affect inferences about the risk premium in at least two ways: one is that it can make the foreign exchange risk premium appear to contain a permanent disturbance when it does not; and secondly it can bias downward the Fama (1984) coefficient and contribute to a higher measured risk premium. If foreign- exchange markets think there is some chance the exchange rate will fall, then until it actually does, the forward exchange rate will remain below the spot value of the exchange rate, since the forward rate embodies the market's expectation. However it is also argued that the peso problem alone cannot explain the puzzle (Lewis 1994). The puzzle still exists after adjusting the coefficients and variances based on the simulated distribution.

McCallum (1994) argued that UIP relation is both more enlightening and more important from the perspective of economic analysis than the question of foreign exchange market unbiasedness. He developed an explanation for the failure of unbiasedness to hold that is consistent with UIP. His model takes account the effect of the central banks, and his policy response hypothesis is that the monetary authorities manage interest rate differentials so as to smooth their movements, while also resist rapid changes in exchange rates. For example when the home currency is tending to appreciate, central banks can “lean against the wind”, becoming more expansionary leading to a relative decrease in the interest rate. He finds his policy response hypothesis is attractive conceptually and is capable of explaining the negative β while maintaining the UIP relationship. Meredith and Ma (2002) extends McCallum (1994) to show how a correlation between the forward premium and shocks from risk premium or expectations can arise from the response of monetary policy to output and inflation, which are in turn affected by the exchange rate. Using five-year simulated data, they find that UIP is restored over longer horizons.

Other existing theories in financial economics have also been used to explain the puzzle. Term structure has brought to attention. Earlier papers that investigate the link between exchange rate and interest rates with term structure factor models include Bakshi and Chen (1997) and Bansal (1997). A Pioneering paper is Backus, Foresi et al. (2001), which adapts modern affine term structure theory to a multi-economy setting. They replicated the puzzle by imposing further conditions on affine models: either there is a common-idiosyncratic factor structure and interest rates take on negative values with positive probabilities, or global factors and state variables have symmetric effects on state prices in different countries. A recent paper by Sarno, Schneider et al. (2012) developed an expression for the risk premium and employ it in a prediction model resembling the Fama (1984) regression, where the time-varying risk premium is estimated from a multi-currency term structure model. They find their model is capable of producing unbiased predictions for excess return, and hence suggest that accounting for risk premium can be sufficient to resolve the forward bias puzzle without additionally requiring departures from rational expectations. Fukuta and Saito (2002) find that introducing liquidity effects is able to contribute to solving the puzzle. Suppose there is positive monetary shock, the current nominal interest rates decrease due to liquidity effects, whereas quantity theory of money tells us inflation rate will rise. As a consequence, CIP suggests that the current forward rates appreciate because of a lower interest rate, at the same time according to the purchasing power parity (PPP), the future spot rates depreciate due to higher inflation rate. Thus liquidity effects are able to weaken the one-to-one linkage between current forward rates and future spot rates, thereby offering a potential explanation for the action of current forward rates against the movement of future spot rates. They claim that the unbiased prediction of the forward discount rate is recovered to some extent to a theoretical manner once the liquidity effects in taken into consideration. Coudert and Mignon (2013) find that the "forward bias" is somewhat alleviated by introducing default risk (proxied by the sovereign credit default swap spread) in the Fama regression.

Researchers also adopt different econometric methodologies, statistical measures of the accuracy of the exchange rate forecast, and measures of the risk premium to either find evidence of forward rate as an unbiased predictor of spot rate, or to explain the forward premium anomaly. Tauchen (2001) examine the small sample properties of Fama's estimator, he concluded that large deviation in β should not be surprising, while moderate deviations below unity are unlikely and negative values for β are more unlikely. Given β turns out to be negative in many actual empirical work, he believes the evidence against the hypothesis of unbiased forward rates is effectively much stronger. McMillan (2009) use logistic smooth-transition model (LSTR) to examine the forward premium behaviour of 16 countries. He finds that only in four cases does the model support an unbiased predictor interpretation. For the remaining countries, results generally support the view that the larger the forward premium the better predictor of the future spot rates. Some suggest that the forward premium puzzle may be primarily a statistical artefact rather than a true economic puzzle. Maynard and Phillips (2001) use both semiparametric and parametric estimation methods to evaluate the traditional regression approaches used to test the forward rate unbiasedness hypothesis, including regression in levels, in returns and in error-correction format. They find evidence of non-stationary, long-memory, fractionally integrated behaviour in the forward premium. They suggest that the principal failure of unbiasedness may be due to the difference in persistence between the two series. Baillie and Bollerslev (2000) also find that the forward premium has very persistent autocorrelation or long memory. They suggest the forward premium anomaly may be viewed mainly a statistical artefact from having small sample sizes and persistent autocorrelation in the forward premium. Kellard and Sarantis (2008) agreed that long memory in the forward premium contribute to the forward premium anomaly. They further pointed out that the fractionally integrated behaviour of the forward premium can be jointly explained by similar behaviour in the true risk premium (TRP) and the conditional variance of the spot rate. However, Maynard (2006) is against the view that forward premium anomaly is a statistical artefact, but rather a real economic puzzle. In order to provide inference robust to the presence of persistent conditioning variables, they use sign, covariance and conditional tests, where the process of driving the forward premium is modelled as a near-unit roots, long-memory or structural break process. They find that a substantial puzzle remained even after their influence is accounted for, and forward premium puzzle cannot be explained as a purely statistical phenomenon. Pippenger (2011) argued that the standard test equation that produces the puzzle is due to two missing variables that covered interest parity implies should be included. He further claimed that those two missing variables explain the downward bias in the forward-bias puzzle and that the solution to the forward-bias puzzle is straightforward. However Baillie (2011) argue that the model that Pippenger (2011) presents has nothing to do with the issues surrounding Uncovered Interest Parity (UIP). Furthermore, his model suffers from extreme misspecification and multicollinearity issues which render its OLS estimates to be suspicious from any testing perspective. Della Corte, Sarno et al. (2009) evaluate the economic value of exchange rate predictability of economic fundamentals. In their research, forward premium is modelled in a framework which allows for time-varying volatility. They use Bayesian estimation methods and construct combined forecasts based on Bayesian model averaging (BMA). Their results provide robust evidence against the random walk (no predictability) benchmark, and therefore reinforce the notion that exchange rates are predictable. They argued that the random walk hypothesis as applied to exchange rates might have been overstated; while at the same time justify the widespread use of forward bias and volatility timing strategies in the practice of currency management. Al-Zoubi (2011) decomposes the spot and forward rates into permanent nonlinear trend components and transitory stationary component. They conclude that the forward rate is poor in tracking spot rate movements over short horizons. However the permanent component of the forward rate is an unbiased predictor of the permanent component of the future spot rate.

The foregoing review makes it amply clear that there has been heightened interest in explaining the forward premium puzzle. However, to our knowledge, existing literature in the topic has not engaged the time horizon pattern of the forward premium bias. In this chapter we investigate how exchange rates the forward premium puzzle behave in different time horizons.

3.3 Data Description

We collect daily data (5 day week) on spot exchange rates and forward exchange rates including both developed and emerging countries for 31 economies from WM/Reuters, DataStream. The sample period covers from January 1990 to March 2013.

There are two different quotation of an exchange rate for a currency pair in the foreign exchange market Direct (Price) Quotation and Indirect (Quantity) quotation. Direct Quotation uses a country's domestic currency as the price currency. Exchange rate is measured as domestic currency per unit of the foreign currency, so that an increase in exchange rate implies depreciation of the domestic currency. Direct Quotation is used by most countries in the foreign exchange market, and US dollar is often the domestic currency. Indirect Quotation on the other hand, uses a country's domestic countries as the unit currency, where the foreign currency is in the numerator and the domestic currency is in the denominator. It is not difficult to see that Indirect Quotation = 1 / Direct Quotation. Using Indirect Quotation, exchange rate increases when domestic currency appreciates. Indirect Quotation is used in British newspapers and is also common in Australia, New Zealand and the Eurozone. In research papers however, Direct Quotation is commonly used with US dollar being the numéraire currency.

We use Direct Quotation in our study. In contrast with the existing literature where only US dollar is used as the base currency for exchange rates, in this chapter we examine three sets of exchange rate data using Sterling, Euro and US Dollar, each as numéraire currency. We mainly report the results based on Sterling as the base currency; however the results from the other two numéraire currencies are discussed as robustness check. The spot rate is denoted as S_t, foreign currency per unit of home currency at time t. F_t, the forward rate is the exchange rate at time t, where only forward rate of one maturity date (1 month or 3 months forward rate in particular) is used in their researches, we also obtain results base on forward rates with different time to maturities. In order to carry out our research, our forward rates covers nine different time horizons: tomorrow next (one day), one week, one month, two months, three months, six months, nine months, one year and two years.

Our data set contains 31 economies, 11 of which are classified as developed economies and the remaining 20 are emerging economies, according to the International Monetary Fund (IMF)'s World Economic Outlook Report[21]. We consider the 17 countries in the Euro Zone as one developed Economy. The European legacy currencies (preceding currencies of the Euro Zone) are not incorporated in the study. The 11 developed economies are: Australia, Canada, Switzerland, Hong Kong, Israel, Japan, Norway, New Zealand, Singapore, United State, and Euro Zone countries. The 20 emerging economies are: United Arab Emirates, Brazil, Chile, China, Colombia, Czech Republic, Hungary, Indonesia, India, Morocco, Mexico, Malaysia, Philippines, Pakistan, Poland, Russia, Thailand, Turkey, Taiwan and South Africa. Currency names and short codes are provided in Table 3.1.

The sample of spot rates starts from beginning of January 1990 to end of March 2013, which gives us 6066 observations. We cannot find data of exchange rate prior to 1990 for many emerging countries. Reason being that many emerging economies did not open for foreign investors until the early 90s. For example China industry shifted heavily to encourage and support foreign trade and investment after Chairman Deng Xiaoping's open market reform and his visit to one of the Special Economic

[21] http://www.imf.org/external/pubs/ft/weo/2012/01/pdf/text.pdf

Zones (SEZ) Shenzhen in 1992. In fact the majority of the sport rate data from WM/Reuters starts from December 1989. Most of the forward rates data start from 1997, which provides 4240 observation (or 4026 observations if it starts from the end of October). Some of the forward rates data from the emerging economies only start from 2004, which give us 2351 observations. The full descriptive statistics of daily spot and forward exchange rates are presented in Table 3.2. We report statistics for each of the 31 economies for Sterling exchange rates only. We also report the panel statistic of full sample, emerging economies and develop economies for Sterling, US and EURO exchange rates.

Some of the forward rates, in particular the tomorrow next and the 2 years forward rates are not available for certain economies. Missing data is shown as NA in Table 3.2. For Sterling Forward rates, we don't have BRL[22], CLP, CNY, COP, MXN, PKR, and TWD for the tomorrow next, also we don't have AUD, CAD, IDR, INR, MYR, PHP, PKR, RUR and THB for the 2 years forward rate. HUF, PKR is missing for the 1 year forward rate, and finally PKR is missing for the 9 months forward rate. For US Forward rates, 7 tomorrow next forward rates are missing for the same currency. IDR, INR, MYR, PHP and PKR are missing for the 2 years forward rate, and PKR is missing for the 1 year and 9 months forward rate. For Euro forward rates, again the same 7 tomorrow next forward rates are missing, we don't have IDR, INR, MYR, PHP, PKR and THB for 2 years forward rates, also no 9 month forward rates for PKR. To sum up, out of the 31 economies, we have 24 tomorrow next, 30 nine months, 29 one year, and 23 two years Sterling forward rates; we have 24 tomorrow next, 30 nine months, 30 one year, and 25 two years for the US forward rates; we have 24 tomorrow next, 30 months and 25 two years for the Euro forward rates.

[22] See Table 3.1 for Countries and Currency short codes

Currencies that not been mention here has the full 31 economies coverage. It is important to make clear the available number of economies, because later we will test our test equations for each forward rate individually, and see how many currencies / economies out of the 31 (or whatever is available) passes the test.

Table 3.2 provides descriptive statistics of all Sterling exchanges rates for each country. The mean of forward rates increase as the time to maturity becomes longer for developed economies (except AUD). It suggests that the currencies in the developed economies have been expected to appreciate against Sterling. We do not compare the overall mean value of the tomorrow next and 2 year forward rate because of the missing data. On the other hand, Table 3.2 also shows that the mean of forward rates for most of the emerging economies decrease as the time horizon becomes longer. It suggests that most of the currencies in the emerging economies have been expected to depreciate against Sterling, though some of the currencies remain strong, for example, United Arab Emirates Dirham, Chinese Yuan, Malaysian Ringgit and Taiwan New Dollar as in Table 3.2.

Table 3.3 shows that daily exchange rate changes are more volatile for many emerging economies as we observe higher standard deviations of exchange rate changes in many emerging economies than developed economies. Also there is a greater dispersion in the exchange rate volatility of emerging economies.

Table 3.4 presents the summary statistics for the Sterling spot rate changes ΔS_t, and forward premium F_t-S_t. The mean of spot rate changes and forward premium are close to zero, however the result of t test show that both of them are significantly different from zero. The standard deviation of spot rate changes is much greater than the standard deviation of forward premium[23]. This is shown in Figure 3.1, where we plot the one month spot rate changes and forward premium in the same chart for all the 31 economies. The blue line is spot rate changes and the red line is the forward premium. The amplitude of forward premium in the graph is very small relative to spot rate changes, which looks like a straight line. The straighter the red line, the greater variance of spot rate changes than forward premium. Our statistics is comparable with Wang and Wang (2009). They use monthly spot exchange rates and 30-day forward exchange rates of the US dollar vis-a`-vis the Australian dollar, the British pound, the Canadian dollar, the euro, the Japanese yen, and the Swiss franc in their study. They find that the variance of spot return is in the range of 100–200 times of the variance of the forward premium.

Both the standard deviations of spot return and forward premium increase in longer time horizon. However the increase of variance in forward premium is greater than the increase if spot rate changes. As a result, in Table 3.4, the ratio of variance between spot rate changes and forward premium become less in longer time horizons. If we compare Figure 3.2 (one-year horizon) with Figure 3.1 (one-month horizon), we observe that the red lines are more straight in Figure 3.1; the forward premium is virtually static compare to the volatile spot return in the short horizon. However the red lines show more variation in longer time horizon as it is shown in Figure 3.2. This pattern is also shown in Figure 3.3, where US to Sterling spot rate changes and forward premium are plot in the same graph for all the 9 time horizons. Clearly the red line becomes more variant as the time horizon increase, which again implies that the variance of forward premium increase faster than the variance spot rate changes when the time horizon becomes longer.

[23] The only exception is Turkish Lira (see Figure 3.4). We see an unusual slump of forward premium in the year 2001.

3.4 Methodology

In this section we introduce some of the econometric methodologies and statistical procedures that applied in this Chapter.

We mainly focus on the following two equations. The simple market efficiency hypothesis equation

$$S_{t+n} = \alpha + \beta F_{t,n} + u_{t+n} \tag{3.8}$$

and the Fama equation

$$\Delta S_{t+n} = \alpha + \beta(F_{t,n} - S_{t,n}) + u_{t+n} \tag{3.9}$$

We will test these two equation using daily spot and forward exchange rates with three currencies as numeraire, namely US dollar, sterling, and Euro. Both equations are tested over 9 different horizons, one day, one week, one month, two month, three month, six month, nine month, one year and two year for 31 economies. We consider the hypothesis of α=1, β=1, and the joint test of α=1 and β=1. We calculate the number of rejections of these hypotheses out of the 31 economies, and see if the number of rejection increases as the time horizon goes forward. We will also investigate how α and β change in longer time horizons.

We use cointegrating regression methods FMOLS and DOLS which are described as follows.

It is well known that (Ordinary Least Squares) OLS regression involving non-stationary series will produce misleading results. This problem dates back to Yule (1926) "Why Do We Sometimes Get Nonsense Correlations between Time-series?" It is known as spurious regression after Granger and Newbold (1974), where they showed that if integrated time-series data are used in regression model, a significant relationship are likely to be found even when the series are independent of each other.

They also illustrate that the regression residuals tends to be autocorrelated, as characterised by a high R^2 value and a very low value of Durbin Watson (DW) statistics. Phillips (1986) provided an analytical explanation for the behaviour of the OLS coefficient estimator. He developed an asymptotic theory which showed that in a spurious regression, R^2 and OLS parameter estimator converge to functionals of Brownian motions; the t-ratios and F-statistic diverge in distribution in larger sample; and the DW statistic converges in probability to zero. He proved that the consequences of spurious regression cannot be eliminated by increasing sample size.

The fact that many macro time-series contains a unit root has spurred the development of the theory of non-stationary time-series analysis. Engle and Granger (1987) pointed out that a liner combination of two or more non-stationary time-series may be stationary. In this case non-stationary time-series are said to be cointegrated. In fact, if two or more series are individually integrated but some linear combination of them has a lower order of integration, then the series are cointegrated. The vector of coefficients which form such linear combination is defined as the cointegrating vector. The stationary linear combination is called the cointegrating equation and may be interpreted as a long-run equilibrium relationship among the variables.

There are a number of methods to test the cointegrating relationship in time-series. Engle and Granger (1987)and Phillips and Ouliaris (1990) are residual based tests, which are simply unit root tests applied to the residuals obtained from OLS estimation. The null hypothesis of nonstationarity against the alternative of stationarity in this unit root test corresponds to a test of the null of no cointegration against the alternative of cointegration. Engle and Granger (1987) is a two-step, bi-variate single equation approach; it uses a parametric, augmented Dickey Fuller (ADF) approach, while the Phillps-Ouliaris test uses the nonparametric Phillips and Perron

(1988) methodology. There is also the Johansen test which is a vector autoregression (VAR) based cointegration test developed in Johansen (1991), Johansen (1995). Compared to Engle-Granger test, this test allows more than one cointegrating relationship.

If cointegration holds, the variables share a common stochastic drift, the linear combination of them is stationary, and the OLS estimator is said to be super-consistent. Also if cointegration exists, non-stationary regression methods may be used to estimate the cointegrating equation. The static OLS estimation of the cointegrating vector is consistent and converging at a faster rate than is standard. However Hamilton (1994) pointed out one important short coming of OLS is that the estimates have an asymptotic distribution that is generally non-Gaussian, exhibit asymptotic bias, asymmetry, and are a function of non-scalar nuisance parameters. OLS is generally not recommended if one wishes to conduct inference on the cointegrating vector. Conventional testing procedures are not valid unless modified substantially.

3.5 Empirical Results

3.5.1 Forward rate unbiasedness

Before testing the market efficiency hypothesis, we carried out unit root test for the spot rate and each of the forward rates. Many studies have found that the spot and forward exchange rates for the major industrialized countries follow a unit root process.

Since we are dealing with non-stationary data, we use cointegrating regression method to estimate. Phillips and Hansen (1990) propose an estimator which employs a semi-parametric correction to eliminate the problems caused by the long run correlation between the cointegrating equation and stochastic regressors innovations. The resulting Fully Modified OLS (FMOLS) estimator is asymptotically unbiased and has fully efficient mixture normal asymptotics allowing for standard Wald tests using asymptotic Chi-square statistical inference. Contrary to the nonparametric approach provided by Phillips and Hansen, the DOLS method proposed by Saikkonen (1991) is based on parametric regressions. We report the result for both FMOLS and DOLS. We also test for cointegration after estimating the cointegrating regression. This can be achieved by testing the unit root of the residual obtained from the cointegrating regression. If the residual series is stationary, then cointegration exists.

We aim to see how the estimate changes with a longer time to maturity of the forward exchange rate. We start with the traditional approach to test the simple foreign market efficiency hypothesis based on the following regression.

$$S_{t+n} = \alpha + \beta F_{t,n} + u_{t+n} \qquad (3.10)$$

where S_{t+n} is the logarithm of the spot rate at time t+n, ; $F_{t,n}$ is the logarithm of the forward rate at time t with n periods to maturity; α and β are coefficients; and u_{t+n} is an error term. We have 9 forward exchange rates for each economy with different time to maturity: tomorrow next (one day), one week, one month, two months, three months, six months, nine months, one year and two years. Specifically the value of n is 1, 5, 20, 40, 60, 120, 180, 240 and 480 (days) for each period in our sample. Under the foreign exchange market efficiency hypothesis, the forward exchange rate can predict future spot rates accurately, or the forward rate is the unbiased estimate of spot rates. This suggests that $S_{t+n} = F_{t,n}$; the null hypothesis of the simple test equation is $\alpha = 0$ and $\beta = 1$. Assuming u_{t+n} is white noise, if we cannot reject this null, our evidences support the efficient market hypothesis and vice versa. For each of forward rates, we test for the market efficiency hypothesis, $\alpha = 0$, $\beta = 1$ separately and test $\alpha = 0$ and $\beta = 1$ jointly.

It is well known that the problem of Spurious Regression may arise when we model the long run relationship of non-stationary variables without taking consideration of their dynamics. Even series are unrelated, and there was no cointegrating relationship, the unit root in the error process led to a low Durbin Watson, a high R^2, and a high significance of the coefficients. Engle and Granger (1987) point out, if a set of variables are cointegrated, then there exists a valid error correction representation of the data, and vice versa. If y and x are both I(1) and have a long run relationship, there must be some force which pulls the equilibrium error back to zero. We have found out that the spot and forward exchange rates are mostly I(1) in our sample. We perform ADF test of stationarity on the estimated residual series u_t. If u_t is stationary, the variables in the test equation are cointegrated (forms a valid cointegration vector).

The results of the unit root test for the natural logarithm of spot rate and forward rates for each economy are shown in Table 3.5. Overall the Augmented Dickey – Fuller (ADF) test results for each economy show that exchange rate is a non-stationary unit root process. For most of the spot and forward exchange rates in our Sterling exchange rate sample, we cannot reject the unit root I(1) hypothesis. However there are some noticeable exceptions. For the spot rates, Brazilian Real (BRL), Colombian Peso (COP), Czech Koruna (CZK), Indian Rupee (INR), Norwegian Krone (NOK), Polish Zloty (PLZ), and Russian Rubble (RUR) are stationary[24]. For the forward rates, Indonesian Rupiah (IDR), Norwegian Krone (NOK), Pakistan Rupee (PKR) and Russian Rubble (RUR) appear to be a stationary process[25].

We estimate Equation (3.10) by both FMOLS and DOLS, and using Sterling, Euro and USD as numeraire currencies. Results are reported from Table 3.6.1 to Table 3.6.6 respectively. Before we look at the results, we test for cointegration. We obtain the residual series u_t from both the FMOLS and DOLS estimation, then we use ADF test to test whether the u_t has a unit root. If u_t has a unit root then there is no cointegration relationship. On the other hand if u_t is stationary then cointegration exists. The ADF test statistics are also reported in Table 3.6.1 to Table 3.6.6. By comparing the test statistics with MacKinnon (1996)'s critical values, we find the null hypothesis of u_t has a unit root is rejected for all equations; only except some in the 2-year forward rate, such as AED, CHF, JPY, TWD and USD. For other forward rates

[24] However when ADF test are performed in levels (not in logarithm), only CZK and PZK spot rates are found to be trend stationary.
[25] Graphs of the stationary forward rates are shown in Figure 3.5

with time to maturity less than 2 years, ADF test results suggest that cointegrating relationship exists between spot rate and forward rates.

We test for α=0, β=1 and α=0 and β=1 jointly for each of the 31 economy[26], and we calculate the total number economies (currencies) that has been rejected by the test statistics in Table 3.7. For example in panel A using sterling as the base currency, the number of rejections for testing α=0 was only one when we use the tomorrow next (2 days) forward rate. It rises to 3 rejections for 1 week (5 days) forward rate, then 9 rejections for 1 month, 15 for 2 months and 17 for 3 months. The number of rejections for testing β=1 is exactly the same as testing α=0 for the above forward rates time horizons by coincident[27]. The rejection number for α=0 reaches its peak at 21 when using 9 month forward rate. The maximum number of rejection for β=1 is 22; it appears from 6 months forward rates and onwards. We then move along and test α=0 and β=1 jointly. The Wald statistics reported in the table above. The total number of rejections of the joint test was only when using tomorrow next forward rate, then it rises up to 7 using 1 week forward rate. The figure almost doubled to 13 when 1 month forward rate is used, and it almost doubled again at 24 when the forward rate time to maturity increases to 2 months. The number of rejections gradually rises up to 27 with 9 months forward rate. The rejections for the 2 years forward rates seem to reduce down to 22 from 27, but notice that we only have 22 economies for the 2 year forward rate; in fact the joint tests are rejected in all economies for the 2 year forward rate. Table 3.7 summarises the number of restrictions of the same unbiased test equation, also use USD and EURO as numéraire currency, using both FMOLS and DOLS estimators. All the regression results are set out in Table 3.6.1 to 3.6.6. The

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[26] We have 31 economies for the 1 week for 6 months forward rate. We only have 24 economies for overnight forward rate, 30 economies for 9 months, 29 economies for 1 year and 22 economies for 2 years.

[27] We say it is coincident because this relationship doesn't hold when using EURO and USD samples, and rejecting a=0 does not necessarily imply rejecting β =1.

results using different numéraire currency are not exactly the same, suggesting that the arbitrage opportunities haven't completed been exploited. However, no matter which currency as numéraire and which estimator of the two we are using, we observe a common theme, where the number of rejections of efficient market hypothesis increases in longer forward exchange rate time to maturity horizon. The number of rejections increased rapidly when time horizon is longer than one month. Since this is a clear feature and the results are similar, we only focus on the results from sterling as numéraire currency using FMOLS estimator.

When comparing the results between the developed and emerging economies, we find that although the number of rejections increases in longer time horizon for both economies, more developed economies pass the test than emerging economies in longer time horizon. Our sample consists of 11 developed economies and 20 developing economies. As we can see in Table 3.7 panel A using sterling as an example, when time to maturity is 1 month, total number of rejections for the joint test is 13, and these rejections all come from the emerging economies, however all the 11 developed economies in our sample pass the test. When time to maturity increase to 2 months, we have 24 rejections, of which 20 are from the emerging economies, and 4 are from the developed economies; all the developing economies expect China have failed the test. When time to maturity 6 months, Chinese Yuan also fail the test; total number of rejection is 27, the remaining 3 currencies that passed the test are all from the developed economies. They are Swiss Franc, Euro and Singaporean Dollar.

We horizontally compare the estimates with different forward rates, and try to understand how the estimated results change as time to maturity of the forward rates increase. It is much straight forward to see the changes of the parameters in a graph. We use the results we obtained in Table 3.6.1 and make a plot of the coefficient of α each economy in Figure 3.6. The values of α are on the vertical axis. The time to maturity is on the horizontal axis. Since we have 9 different time horizons, we will get 9 points in each graph representing 9 different values of α for each economy. These points are then connected with a line. We are interested to see how α changes around the value of zero, because we are testing whether α=0, therefore we also add a horizon line, which represent the value of zero in Figure 3.6. With the values of β in Table 3.7, using the same method, we produce the line plot for β in Figure 3.7. For the same purpose, since the hypothesis is β=1, we add a horizontal line in Figure 3.7, which represent the value of one. We also add confidence intervals in the figure. It is not surprised to see the confidence interval get larger as the horizon goes forward because we get more rejections. Also the figures of α and β are mirror images. Because for equation 3.10 to hold under the condition α=0 and β =1, when β gets larger than one, α must go in a compensating opposite direction below zero. In other words when β gets larger, α must get smaller.

In Table 3.6.1, we can see that α was very closed to zero and becomes significantly different from zero in longer time horizons. Most of the αs are positive and they get larger as the time to maturity increases. In Figure 3.6, we see that most of the graphs have a positive slope with positive values of α. We also observe some negative values of α, such as those in AUD, CAD, CHF, CNY, MAD, MYR, NZD and SGD. Regardless of the sign and slope of α, we observe a general pattern of these graphs in Figure 3.6, the value of α gradually deviate from the zero line when time to maturity becomes longer. From Figure 3.7, we also observe that β was closed to one but as the time horizon increases, it gradually deviate from unity. Most of the βs get smaller. We can observe this pattern in the mean equation at the end of Table 3.6.1, where we take the mean of the estimates across all 31 economies. The mean value of β becomes smaller in longer time horizons. This can be observed clearly from Figure 3.7. Most of the β coefficient curves follow a monotonic decreasing pattern starting from the unity line. Four currencies in the developing country, PHP, THB TWD and TRL had a period of increase in the value of β, although they maintain the overall decreasing trend because β continued to decrease after that one period of increase. The period of increase is from 6 month to 9 month for the three Asian countries, while for TRL it is from 9 month to 1 year. Only a few countries appeared to have an increasing trend. Their value of β deviates from one in a positive direction. They are AUD, CHF, and CNY, although their values of β decrease in the longer horizon. For AUD β decreases from the 9 month horizon, while for CHF and CHY, β decreases from the one year horizon. Three currencies do not have a strict increasing or decreasing pattern. They are CAD, NZD, SGD and MYR. Their value of β can become larger and smaller than one when the time horizon becomes longer. Overall, the statistics in Table 3.6.1 show that the deviation of β from unity increases as the time span of the forward rates increase. This can also be observed in Figure 3.7, for most of the economies, the value of β was one in the short horizon and it gradually deviates from one in the longer time horizon. Figure 3.6 and 3.7 give us the same message that the forward rate unbiasedness holds in the short horizon, but not in the long horizon. Forward rate gradually loses its predicting power for future spot rate as time horizon becomes longer.

We find that β is less than unity for most of our sample. This is consistent with the finding from Froot and Thaler (1990) who review many of these regression tests, and conclude that the estimate β coefficient is reliably less that one. Because simple efficiency test rests upon two hypotheses, there are two explanations for the empirical rejection of the $\beta=1$ hypothesis. First, $\beta<1$ could be explained by a time-varying currency risk premium such that higher interest rates imply greater risk when investing in assets. Alternatively, if we maintain that the currency risk is diversifiable or that investors are risk neutral, b<1 could be evidence of expectational errors and against rational expectations. Therefore the deviation of β from 1 can be interpreted as the combination of exceptional error and time-varying currency risk premium.

In addition, when comparing the emerging economies with the developed economies, we find the both α and β drift further out from zero and one for emerging economies. For example Figure 3.6 shows that in most of the developed countries, the value of α is less than 0.5, although for HKD and JPY it gets over 2 in the two years horizon. For developing countries, for the two year horizon, the value of α exceeds two for most of the currencies. For IDR it even gets to 10. The same goes for the value of β. In general, β from the developed countries deviates from the unity line further away than the developing countries. This suggests that prediction bias is worse in emerging economies. Because premium comes out of risk aversion, and risk aversion increases over time, we argue forward rate is less an accurate predictor of the future spot rate because of the inability to measure the increasing risk premium in the longer time horizon. The prediction bias is worse in emerging economies, because it is less liquid in the emerging economies and hence higher the risk premium. It supports the view that emerging markets are less efficient than the developed market (Dickenson 1994, Vieito 2013).

3.5.2 Forward Premium Puzzle

We test the equation which is extensively used to document forward premium puzzle. This equation can be derived by subtracting S_t from both sides of equation (3.6).

$$\Delta S_{t+n} = \alpha + \beta(F_{t,n} - S_{t,n}) + u_{t+n} \qquad (3.11)$$

This equation is also known as the Fama regression, where S_{t+n} is the logarithm of the spot rate at time t+n, ; $F_{t,n}$ is the logarithm of the forward rate at time t with n periods to maturity; α and β are coefficients; and u_{t+n} is a white noise. ΔS_{t+n} is the spot return and $(F_{t,n} - S_t)$ is the forward premium. Under the efficient market hypothesis, assuming uncovered interest rate parity holds, we would again expect a zero constant α, and a slop coefficient β of unity. Forward premium puzzle refers to the fact that empirical evidence doesn't support the efficient market hypothesis, that forward rate is an unbiased predictor of the future spot rate. Moreover, we often observe negative slope-coefficient β in the Fama regression.

Many studies have confirmed that the spot and forward exchange rates for the major industrialized countries follow a unit root process, implying a stationary spot return and forward premium. However, although the short-memory stationarity of the forward premium was taken for granted, the current evidence from unit root and cointegration tests appears to lead to conflicting conclusions. As discussed in (Maynard and Phillips 2001), Fama (1984) failed to reject unit roots in several forward series. Using KPSS test, he is also able to reject stationarity in both of his data set. However, this conclusion appears to contrast sharply with evidence from similar tests conducted by Tauchen (2001), Horvath and Watson (1995) and Engel

(1996). Our ADF test for spot return and forward premium are presented in Table 3.9 and Table 3.10.

Table 3.8 shows that the hypothesis of a unit root in spot returns in all horizons are rejected in all the three specifications of the ADF test; with trend and constant, and with constant only. Our results confirm that spot return is a stationary process. However the results of ADF test for forward premium varies. Table 3.9 shows in the short horizons, one month and under in particular, forward premium are stationary. In horizons longer than three months, forward premium of many currencies have a unit root. In the developed economies, 6 out of 11 in our sample follows an I(1) process in longer horizons. They are AUD, CHF, XEU, JPY NOK and USD. In the emerging economies on the other hand, 7 out of 20 are found to have a unit root. They are AED, CLP, CNY, MAD, MXN, MYR, PKR and ZAR.

Because the stationary of forward premium varies across countries and time horizons, we use OLS, FMOLS and DOLS estimators in the Fama equation depending on the situation. The reason is that when spot return and forward premium are both stationary, it is unnecessary to apply cointegrating estimation. In this case, we use the OLS estimator. However, when the spot return is stationary and the forward premium has a unit root, if we continue to use the OLS estimator, the resulting regression will be a spurious regression. In this case we must apply cointegrating estimation, namely, FMOLS or DOLS. The ADF unit root test result for forward premium is presented in Table 3.9. Using the result in Table 3.9, for each time horizon and each currency, we use OLS estimator when the forward premium is stationary, and FMOLS and DOLS estimator when the forward premium has a unit root. The estimated results of the Fama equations for sterling exchange rate are shown in Table 3.10.1 and Table 3.10.2. Estimated results for Euro and USD are not reported due to the length of the table, and also because it yields similar results and patterns.

The presence of forward premium still prevails with the sterling exchange. We can see in Table 3.10.1, the R squares of the Fama equation is very low, many coefficient of β are negative. These are two of the most distinct feature in forward premium puzzle. A negative β implies that domestic currency will appreciate when the domestic interest rate is higher which is contradicting to the UIP theory. We observe a negative β even in the shortest time horizon – one day. 7 out of the 11 developed countries' β is negative even on the one day horizon. Out of the 13 developing countries, which has data on one day forward rate, 6 of them has a negative beta on the one day horizon. Only 4 currencies have positive β across all time horizons. They are CZK, HUF, MYR and TWD, which are all from the developing countries. We cannot say that the evidence of forward premium puzzle is less in the developing countries, because only 4 out of 21 developing countries can produce a positive β, and we have less developed countries than developing countries in the sample. However, even those 4 countries can produce a positive β, their estimating equation still has a very low R squares, which indicates the presence of the forward premium puzzle.

We produce the same plot of coefficient of α and β as we did when testing forward rate unbiasedness. In Figure 3.9, quite often we see the line plot of β go under the zero line, showing negative values of β. Compare Figure 3.9 with Figure 3.7, in Figure 3.7 β starts from one in the short horizon, and it gradually deviates from one in the long horizon, implying forward rate gradually loses its predicting power in the longer horizon. However we do not observe this pattern in Figure 3.9. The behaviour of β in Figure 3.7 is rather radical compared to Figure 3.7. The value of β doesn't start from the unity line. As the time horizon becomes longer, β fluctuates, while in Figure 3.7, β often monotonically decreases. Another evidence for the premium puzzle is that often the confidence interval of β becomes more precise in the longer time horizons. We can see that in Figure 3.9 the distance between β+, β and β- becoming smaller as the time horizon increases. This is opposite to what we observe in Figure 3.7 for the efficiency market testing equation, where the distance β+, β and β- become larger in the longer time horizons. Also α and β are no longer mirroring each other in Figure 3.8 and Figure 3.9.

Does the severity forward premium puzzle change in longer time horizon? According to To (2007) there are two possible explanations. Time-varying risk premium explanation suggests that the longer the time horizon of holding a financial asset, the higher the risk associated due to more expected changes in the market. A one year forward rate carries more uncertainty and risks than a one-month forward rate, therefore we would expect a higher risk premium in the one year forward rate. Thus the puzzle should be more severe or the β coefficient should be more negative using forward rates of longer maturity. Conversely, systematic forecast error explanation implies that bias of the forward rate is reduced over time. Over a learning period after a shift in the regime, market participants will rationally update their information, adjusting the spot rate in accordance to the new underlying permanent distribution. Assuming investors in the markets are rational, we would expect peso problem to result in the eventual realization of market expectations. A longer maturity forward rate allows these processes to materialize, reducing the bias. This explanation suggests that β coefficient should be less negative using forward rates of longer maturity.

We cannot see evidence for either side of the argument in our result. The only currency out of the 31 countries that has a clear increasing trend in β is HUF, but for the most part, the value of β fluctuates. We cannot say whether the phenomenon of forward premium puzzle improves or worsens when time horizon gets longer, because the changing path of β is erratic and unpredictable. Our finding does not support To (2007) where they find that the longer the maturity of the forward contracts, the less negative the β coefficient is.

Table 3.13 summarises the number of rejections in different time horizons using Sterling, USD and the Euro exchange rate sample. Numbers in each row of the table represents the number of restrictions of Fama equation for the hypothesis $\alpha=0$, $\beta=1$, and the joint test $\alpha=0$ and $\beta=1$ respectively, We still see a gradual increase of rejections for the test $\alpha=0$, however if we look at the number of rejections for the joint test $\alpha=0$ and $\beta=1$, the majority of the currencies are rejected even in the short horizon – one week. The phenomenon of premium puzzle still presents in both short and long horizons.

Our main findings are, market is efficient in the short horizon, typically within a one month period, but inefficient in the long horizon; forward premium puzzle presents in the short horizon and it persists in the long horizon. We also find that emerging markets are less efficient than the developed market. This motivates us for our future research. We are interested to find out what differences between the developed and developing countries are the key factors influencing their level of market efficiency. It could be the level of capital control, the reliance on trade, or the level of liquidity. We could use different measures of capital control, or liquidity to see how sensitive the market efficiency is to the change of these measures, and see how the sensitivity changes in longer time horizons. The focus of this chapter however is to find out the commonality in these countries. We are also interested to look at the dynamics of the forward premium in different time horizons. On the basis of our result, we conject that the forward premium for short forecast horizons are likely to be stationary, whereas, for longer forecast horizons, they are likely to be nonstationary, making it much harder to forecast.

3.6 Conclusion

In this chapter we examine two important anomalies in international finance and economics; the forward rate biasedness and forward premium puzzle. The forward rate biasedness is the rejection of the joint hypothesis a zero intercept and a unity slope coefficient in the regression of the natural logarithm of spot exchange rate on forward exchange rate. Thus it rejects the implication from the efficient market hypothesis, that the forward rate is an unbiased predictor of the corresponding expected future spot rate under the assumptions of risk neutrality and rational expectations. The forward premium puzzle refers to the regression of the spot rate return on the forward premium, which should also yield a slope coefficient of unity, however, the slope coefficient has been typically reported a negative figure throughout literature. Its implication is counterintuitive – high interest rate currencies are expected to depreciate. This is contrary to what uncovered interest rate parity predicts.

Prior literatures often use currencies in developed economies to USD exchange rate as their sample. We contribute to the literature by using a much large sample from both developed and emerging economy at a daily frequency from 1990 to 2013. Our sample consists of 11 currencies from the developed economy and 21 currencies from the emerging economy. This sample covers currencies not only to USD, but also GBP (Sterling) and Euro exchange rates. The main contribution of this chapter is we suggest a new way to examine the anomalies by looking at the time horizon pattern of the forward rate bias. Previous literatures only use a single time horizon, usually one month or three months in particular to carry out their research. In this study, we obtained forward rates cover 9 time horizons: 1 day, 1week, 1 month, 2 months, 3 months, 6 months, 9 months, 1 year and 2 years. We use ADF Unit Root test, along with FMOLS and DOLS estimators to test and model the cointegrating relationship between forward and spot exchange rates.

Comparing developed economies with emerging economies, we find the exchange rates changes are more volatile in the emerging economies, and also there is greater dispersion in the exchange rate volatility of emerging economies. The variance of the spot return is much greater than the variance of the forward premium. The variances of the spot return and forward premium increase in longer time horizons. The ratio of the spot return to forward premium variance decreases when the time horizon becomes longer, implying the variance of forward premium increase at a larger scale compare to the variance of the spot return.

We compare the results from 3 different currencies as numeraire, namely US dollar, Sterling and Euro. We see slightly different results. This could be a rejection of market efficiency, or it could be some arbitrage opportunities haven't completed been exploited due to different transaction cost.

We find that forward rate unbiasedness holds in the short horizon but not in the longer horizon. Forward rate started to lose its predictive power when the time to maturity is longer than a month. When comparing emerging economies with developed economies, we find that the predicting bias is worse in emerging economies, because emerging economies are less liquid and have higher risk premium. Forward premium puzzle prevails in both short horizons and long horizons, and it does not seem to disappear over long horizon.

It is recognized in the literature that risk premium is not constant but time variant, and risk premium increase over time. We find the forward rate's prediction worsen in longer horizons. This could be the inability to measure the increasing risk premium as time goes forward. Diminishing prediction accuracy of forward rate is a common feature in our selection of countries; whether it's a liquid or less liquid market, strict capital controlled or open free market, large or small economies, developed or developing economies, they all have the same pattern. In a way the exchange rate resembles the liquidity of the term structure, the longer the time horizon the greater the risk premium, which makes the forward rate even more difficult to predict the future spot rate.

As a practical matter, knowing whether the market is efficient is very important for policy makers of any country. If a foreign exchange market is inefficient, the ability of government authorities to influence the movement of exchange rates is restricted as the exchange rates are not predictable. The government cannot make informed decisions on exchange rates, and take actions to intervene the market, such as borrowing foreign currency or changing the interest rate. An efficient foreign exchange market on other hand is typically favourable for mercantilist countries that are reliant on trade, because it is essential for policy makers to predict the exchange rate movement and to facilitate international trade and the inflow of foreign investments.

The information of market efficiency is also important for participants in the foreign exchange market such as investors and multinational firms. When the market if efficient, they can make profit and protect their investment because the exchange rates behave in a predictable manner. However if the market is inefficient, investors cannot devise various trading rules or techniques to make abnormal profits from transactions in the foreign exchange market, and they cannot gain from any hedging policies to avoid the effects of exchange rate risks. Our results suggest that the market is efficient in the short run but not in the long run. Forward rates started to lose its predictive power when the time to maturity is longer than a month. This gives an important message to policy makers and investors. Horizons of the forward rate and timing of transactions should be considered as important factors in decision making. Decisions should be made based on the prediction of exchange rate movement within a one month period. Predictions made for longer horizons are not reliable.

Appendix

Table 3.1 Country and currency short codes

Currency Code	Name of Currency	Country
AED	United Arab Emirates Dirham	United Arab Emirates
AUD	Australian Dollar	Australia
BRL	Brazilian Real	Brazil
CAD	Canadian Dollar	Canada
CHF	Swiss Franc	Switzerland
CLP	Chilean Peso	Chile
CNY	Chinese Yuan	China
COP	Colombian Peso	Colombia
CZK	Czech Koruna	Czech Republic
XEU	Euro	Euro Zone
GBP	British Pound	United Kingdom
HKD	Hong Kong Dollar	Hong Kong
HUF	Hungarian Forint	Hungary
IDR	Indonesian Rupiah	Indonesia
ILS	Israelite Shekel	Israel
INR	Indian Rupee	India
JPY	Japanese Yan	Japan
MAD	Moroccan Dirham	Morocco
MXN	Mexican Peso	Mexico
MYR	Malaysian Ringgit	Malaysia
NOK	Norwegian Krone	Norway
NZD	New Zealand Dollar	New Zealand
PHP	Philippine Peso	Philippines
PKR	Pakistan Rupee	Pakistan
PLZ	Polish Zloty	Poland
RUR	Russian Rubble	Russia
SGD	Singaporean Dollar	Singapore
THB	Thai Baht	Thailand
TRL	Turkish Lira	Turkey
TWD	Taiwan New Dollar	Taiwan
USD	US Dollar	United States
ZAR	South African Rand	South Africa

Table 3.2 Descriptive statistics of daily spot and forward Sterling exchange rates

	SP	TN	1W	1M	2M	3M	6M	9M	1Y	2Y
AUD										
Mean	2.2559	2.2874	2.2879	2.2824	2.2841	2.2857	2.2905	2.3043	2.3009	NA
Std dev	0.3582	0.4220	0.4214	0.4105	0.4087	0.4069	0.4017	0.4052	0.3921	NA
N	6066	4026	4026	4240	4240	4240	4240	4026	4240	0
CAD										
Mean	2.0881	2.0831	2.0827	2.0893	2.0874	2.0856	2.0802	2.0689	2.0710	NA
Std dev	0.2672	0.3156	0.3152	0.3082	0.3069	0.3056	0.3018	0.3046	0.2950	NA
N	6066	4026	4026	4240	4240	4240	4240	4026	4240	0
CHF										
Mean	2.1560	2.1130	2.1116	2.1203	2.1149	2.1096	2.0938	2.0676	2.0638	1.8318
Std dev	0.3486	0.3784	0.3776	0.3704	0.3677	0.3652	0.3578	0.3566	0.3446	0.3270
N	6066	4026	4026	4240	4240	4240	4240	4026	4240	2351
XEU										
Mean	1.3787	1.4027	1.4023	1.4029	1.4012	1.3995	1.3945	1.3883	1.3847	1.2764
Std dev	0.1518	0.1710	0.1707	0.1663	0.1655	0.1647	0.1623	0.1638	0.1578	0.1250
N	6066	4026	4026	4240	4240	4240	4240	4026	4240	2351
HKD										
Mean	12.8759	12.9589	12.9551	12.9295	12.9181	12.9079	12.8816	12.8739	12.8436	13.1786
Std dev	1.2527	1.3249	1.3227	1.2852	1.2769	1.2691	1.2471	1.2584	1.2140	1.2188
N	6066	4026	4026	4240	4240	4240	4240	4026	4240	2351
ILS										
Mean	6.0455	6.9504	6.9503	6.9498	6.9488	6.9479	6.9456	6.9465	6.9478	6.9822
Std dev	1.3956	1.1060	1.1049	1.1022	1.0995	1.0972	1.0908	1.0868	1.0826	1.0842
N	6066	2351	2351	2351	2351	2351	2351	2351	2351	2351
JPY										
Mean	184.4128	179.3534	179.1837	179.4890	178.8677	178.2506	176.4036	173.9672	172.7716	162.8856
Std dev	36.6938	33.7394	33.6447	32.7273	32.3986	32.0771	31.1399	30.9161	29.4620	33.1065
N	6066	4026	4026	4240	4240	4240	4240	4026	4240	2351
NOK										
Mean	11.1409	11.3122	11.3127	11.3223	11.3223	11.3223	11.3209	11.3226	11.3177	10.4757
Std dev	1.2537	1.4422	1.4412	1.4078	1.4038	1.4000	1.3892	1.4094	1.3702	1.0023
N	6066	4026	4026	4240	4240	4240	4240	4026	4240	2351
NZD										
Mean	2.7267	2.7250	2.7260	2.7133	2.7167	2.7201	2.7303	2.7573	2.7513	2.5507
Std dev	0.4296	0.4607	0.4604	0.4533	0.4524	0.4516	0.4493	0.4526	0.4450	0.3454
N	6066	4026	4026	4240	4240	4240	4240	4026	4240	2351
SGD										
Mean	2.6050	2.6095	2.6082	2.5930	2.5883	2.5837	2.5699	2.5687	2.5439	2.4464
Std dev	0.3777	0.3701	0.3693	0.3620	0.3596	0.3573	0.3508	0.3493	0.3390	0.3915
N	6066	4026	4026	4240	4240	4240	4240	4026	4240	2351
USD										
Mean	1.6577	1.6662	1.6658	1.6630	1.6616	1.6603	1.6564	1.6544	1.6492	1.7086
Std dev	0.1595	0.1693	0.1692	0.1648	0.1643	0.1639	0.1626	0.1652	0.1603	0.1618
N	6066	4026	4026	4240	4240	4240	4240	4026	4240	2351
AED										
Mean	6.0879	6.1198	6.1183	6.1075	6.1021	6.0969	6.0814	6.0733	6.0535	6.2668
Std dev	0.5855	0.6219	0.6208	0.6031	0.5996	0.5962	0.5870	0.5934	0.5721	0.5678
N	6066	4026	4026	4240	4240	4240	4240	4026	4240	2351
BRL										

Mean	2.5689	NA	3.5765	3.5957	3.6196	3.6439	3.7154	3.7764	3.8617	4.1720
Std dev	1.6157	NA	0.8196	0.8281	0.8391	0.8501	0.8843	0.8998	0.9544	1.1033
N	6066	0	2351	2351	2351	2351	2351	2351	2351	2351
CLP										
Mean	817.4939	NA	915.2716	915.7017	916.1646	916.6920	918.2406	919.8969	921.9700	935.6144
Std dev	177.7416	NA	128.1060	127.1324	125.9490	124.8433	121.6201	118.6665	116.0029	105.9258
N	6066	0	2351	2351	2351	2351	2351	2351	2351	2351
CNY										
Mean	12.1986	NA	12.6941	12.6679	12.6312	12.5931	12.4753	12.3619	12.2506	11.7878
Std dev	2.1060	NA	2.1077	2.0808	2.0464	2.0123	1.9192	1.8362	1.7581	1.6843
N	6066	0	2906	2906	2906	2906	2906	2906	2906	2351
COP										
Mean	2779.2325	NA	3636.6610	3641.8497	3649.8646	3658.8342	3687.3401	3717.6715	3750.4752	3886.9708
Std dev	1237.1979	NA	679.2436	679.5075	680.6536	682.9452	690.9893	698.9671	708.6841	730.6806
N	6066	0	2351	2351	2351	2351	2351	2351	2351	2351
CZK										
Mean	43.2364	42.6486	42.6482	43.0849	43.0986	43.1102	43.1362	42.6170	43.1779	34.5784
Std dev	9.4249	10.4521	10.4600	10.4283	10.4723	10.5139	10.6437	10.7465	10.9104	5.8685
N	6066	4026	4026	4240	4240	4240	4240	4026	4240	2351
HUF										
Mean	299.1596	362.7318	363.1883	364.4657	366.0245	367.5169	371.7745	375.7027	NA	371.3328
Std dev	99.7239	35.2453	35.2908	35.4540	35.6910	35.9445	36.7563	37.5400	NA	26.3459
N	6066	4026	4026	4026	4026	4026	4026	4026	0	2351
IDR										
Mean	11339.3332	15256.9296	15276.9303	14788.3415	14872.4544	14965.7130	15217.1043	16015.9548	15691.6271	NA
Std dev	5890.2031	2322.7691	2328.4433	3334.7444	3370.7809	3412.8595	3571.9522	2843.4256	3963.6941	NA
N	6066	4026	4026	4240	4240	4240	4240	4026	4240	0
INR										
Mean	66.2678	75.8674	75.9239	76.0661	76.2423	76.4099	76.8850	77.3298	77.7572	NA
Std dev	15.3510	6.6336	6.6336	6.6357	6.6290	6.6197	6.5832	6.5553	6.5455	NA
N	6066	4026	4026	4026	4026	4026	4026	4026	4026	0
MAD										
Mean	14.8510	14.5320	14.5377	14.5566	14.5816	14.6080	14.6890	14.7794	14.8772	15.3243
Std dev	1.3561	1.5565	1.5503	1.5320	1.5088	1.4859	1.4183	1.3548	1.2945	1.1182
N	6066	2351	2351	2351	2351	2351	2351	2351	2351	2351
MXN										
Mean	14.6438	NA	18.3186	18.1164	18.2100	18.3031	18.5874	19.1180	19.1573	21.9423
Std dev	5.9626	NA	2.9394	3.0782	3.0444	3.0118	2.9197	2.7053	2.7868	1.0940
N	6066	0	4026	4240	4240	4240	4240	4026	4240	2351
MYR										
Mean	5.9584	5.9585	5.9580	5.9562	5.9536	5.9509	5.9421	5.9334	5.9243	NA
Std dev	0.9034	0.9039	0.9012	0.8939	0.8852	0.8770	0.8541	0.8338	0.8157	NA
N	2413	2413	2413	2413	2413	2413	2413	2413	2413	0
PHP										
Mean	66.6098	78.8312	78.8874	77.3984	77.6164	77.8327	78.5235	80.8818	79.9244	NA
Std dev	20.4290	13.2385	13.2302	14.7740	14.7499	14.7337	14.7194	13.1232	14.8220	NA
N	6066	4026	4026	4240	4240	4240	4240	4026	4240	0
PKR										
Mean	88.7533	NA	126.3309	126.8185	127.4343	128.0547	129.9902	NA	NA	NA
Std dev	35.1497	NA	14.7431	15.0448	15.4023	15.7367	16.7163	NA	NA	NA
N	6066	0	2351	2351	2351	2351	2351	0	0	0
PLZ										
Mean	4.7978	5.4483	5.4507	5.4571	5.4648	5.4719	5.4918	5.5097	5.5261	5.3625
Std dev	1.4900	0.7567	0.7568	0.7571	0.7576	0.7581	0.7600	0.7617	0.7637	0.6443
N	6066	2906	2906	2906	2906	2906	2906	2906	2906	2351

RUR										
Mean	35.8236	49.1937	49.2323	49.3491	49.4902	49.6337	50.0649	50.4868	50.9431	NA
Std dev	18.7998	2.5994	2.5596	2.4744	2.4104	2.3859	2.4659	2.6486	2.9235	NA
N	5276	2351	2351	2351	2351	2351	2351	2351	2351	0
THB										
Mean	55.4154	62.1483	62.1600	61.4575	61.5061	61.5531	61.6637	62.4323	61.8783	NA
Std dev	12.1852	8.8723	8.8693	9.3474	9.3245	9.3134	9.2921	8.8773	9.3534	NA
N	6066	4026	4026	4240	4240	4240	4240	4026	4240	0
TRL										
Mean	1.4121	2.0462	2.0543	1.9849	2.0132	2.0418	2.1327	2.3286	2.3337	3.0787
Std dev	1.1581	0.8255	0.8260	0.9011	0.9054	0.9100	0.9282	0.8737	0.9826	0.3223
N	6066	4026	4026	4240	4240	4240	4240	4026	4240	2351
TWD										
Mean	50.4485	NA	53.8193	53.3386	53.2452	53.1507	52.8719	52.9845	52.3529	52.6184
Std dev	7.1479	NA	5.9559	6.0196	5.9503	5.8817	5.7008	5.4250	5.3976	4.9735
N	6066	0	4026	4240	4240	4240	4240	4026	4240	2351
ZAR										
Mean	10.0013	12.2541	12.2716	12.0758	12.1345	12.1919	12.3610	12.7719	12.6916	13.9584
Std dev	3.5904	1.9562	1.9591	2.1904	2.2012	2.2128	2.2506	2.0797	2.3285	1.7390
N	6066	4026	4026	4240	4240	4240	4240	4026	4240	2351

Statistics of exchange rates in levels. N is the number of observations.

Table 3.3 Summary statistics of Sterling exchange rate daily changes

	SP	TN	1W	1M	2M	3M	6M	9M	1Y	2Y
Developed Economies										
AUD										
Mean	-0.7152	-2.4843	-2.4778	-1.6610	-1.6438	-1.6292	-1.5825	-2.2586	-1.4855	NA
Std dev	11.9594	11.8665	11.8660	11.8565	11.8627	11.8488	11.7889	11.7657	11.6951	NA
CAD										
Mean	-0.2857	-2.0990	-2.0933	-2.0320	-2.0136	-1.9943	-1.9399	-1.9244	-1.8358	NA
Std dev	10.1631	9.9861	9.9869	9.9442	9.9396	9.9291	9.8972	9.9083	9.8180	NA
CHF										
Mean	-1.8808	-2.8224	-2.8153	-2.3373	-2.3188	-2.2974	-2.2361	-2.6153	-2.1120	-4.0558
Std dev	9.5014	9.8525	9.8558	9.9287	9.9252	9.9265	9.9169	9.8261	9.8666	10.6187
XEU										
Mean	-0.2737	-1.0977	-1.0944	-0.5438	-0.5356	-0.5268	-0.4955	-0.9966	-0.4271	-1.7905
Std dev	7.7427	7.9661	7.9651	8.0434	8.0334	8.0256	8.0021	7.9015	7.9323	7.9476
HKD										
Mean	0.1888	-0.0861	-0.1137	-0.2643	-0.2613	-0.2567	-0.2429	-0.3138	-0.2151	-0.8230
Std dev	9.5370	9.2449	9.2345	9.2150	9.2187	9.2395	9.2772	9.2689	9.3344	9.8413
ILS										
Mean	3.1022	-3.7984	-3.7943	-3.7885	-3.7829	-3.7751	-3.7508	-3.7373	-3.7077	-3.6582
Std dev	11.2956	10.8243	10.8253	10.8198	10.8113	10.7979	10.7457	10.7395	10.7585	11.0031
JPY										
Mean	-1.2725	-1.3492	-1.3402	-1.1147	-1.0876	-1.0591	-0.9725	-1.0488	-0.8057	-1.4828
Std dev	12.8344	13.5006	13.5007	13.4954	13.4961	13.4892	13.4718	13.4444	13.3924	13.8272
NOK										
Mean	-0.3592	-1.3324	-1.3248	-0.7628	-0.7438	-0.7248	-0.6661	-1.1348	-0.5495	-2.5635
Std dev	9.1953	9.8514	9.8559	10.0246	10.0219	10.0089	9.9789	9.7707	9.9365	10.4230
NZD										
Mean	-1.0184	-1.6994	-1.6967	-1.0189	-1.0101	-1.0025	-0.9743	-1.6044	-0.9089	-3.6414
Std dev	11.7883	12.1883	12.1966	12.1111	12.1289	12.1426	12.1496	12.2510	12.1625	12.0918
SGD										
Mean	-1.6609	-1.6915	-1.6955	-1.0180	-1.0007	-0.9825	-0.9356	-1.7626	-0.8548	-4.2794
Std dev	9.0226	8.9418	8.9622	9.1306	9.1887	9.2363	9.2996	9.1982	9.3123	8.6245
USD										
Mean	0.2072	-0.1095	-0.1077	-0.2838	-0.2814	-0.2782	-0.2673	-0.0542	-0.2428	-0.8299
Std dev	9.4992	9.2844	9.2825	9.2448	9.2298	9.2213	9.1788	9.1650	9.0808	9.9373
Emerging Economies										
AED										
Mean	0.2569	-0.1088	-0.1071	-0.2834	-0.2804	-0.2776	-0.2677	-0.0521	-0.2409	-0.8355
Std dev	9.8651	9.2859	9.2834	9.2450	9.2403	9.2326	9.1917	9.1831	9.1389	10.0025
BRL										
Mean	60.4825	NA	-4.9494	-4.9025	-4.8393	-4.7453	-4.4789	-4.1808	-3.8864	-2.5567
Std dev	38.5592	NA	15.0768	15.0712	15.0832	15.1406	15.2580	15.5610	15.8863	18.3102
CLP										
Mean	2.7607	NA	-4.1396	-4.0835	-4.0133	-3.9364	-3.7263	-3.5260	-3.3389	-2.7400
Std dev	12.6734	NA	12.2711	12.2639	12.2624	12.2664	12.2094	12.1588	12.1329	12.1298
CNY										
Mean	1.8442	NA	-1.4698	-1.4595	-1.4363	-1.4141	-1.3456	-1.2883	-1.2354	-2.7083
Std dev	14.3464	NA	9.8005	9.7412	9.6921	9.6620	9.6581	9.6685	9.6712	11.1842
COP										
Mean	7.0472	NA	-5.2868	-5.2686	-5.2776	-5.2911	-5.3341	-5.3798	-5.4264	-5.6297
Std dev	14.6707	NA	13.4817	13.5776	13.5671	13.5488	13.5196	13.4770	13.4874	13.7027
CZK										
Mean	2.4143	-3.3131	-3.3236	-2.0132	-2.0589	-2.0903	-2.1682	-3.7093	-2.3150	-4.3444

Std dev	16.7477	10.3603	10.3556	11.1234	10.9638	10.9375	11.0020	10.4404	10.9167	10.7035
HUF										
Mean	6.1326	1.3395	1.3263	1.2833	1.2468	1.2065	1.1096	0.9744	NA	0.0675
Std dev	11.8232	11.7466	11.7430	11.7523	11.7626	11.8203	12.0377	11.8349	NA	14.1462
IDR										
Mean	9.6815	9.3835	9.4063	11.4895	11.5782	11.6950	11.9420	9.4967	12.6484	NA
Std dev	23.3937	26.6244	26.7075	26.9677	27.3450	27.8539	28.8062	28.2728	32.0229	NA
INR										
Mean	5.4613	2.5218	2.5383	2.5727	2.6195	2.6660	2.7947	2.9165	3.0353	NA
Std dev	11.2327	9.5182	9.5557	9.5467	9.5570	9.5979	9.6835	9.8351	9.9857	NA
MAD										
Mean	0.9723	-2.1582	-2.1531	-2.1256	-2.1175	-2.0845	-1.9683	-1.9199	-1.7749	-1.2015
Std dev	13.3161	7.7385	7.7315	7.7196	7.7297	7.7218	7.7476	7.8070	8.0603	9.0571
MXN										
Mean	7.6125	NA	2.9546	2.7565	2.6980	2.6461	2.4958	2.6824	2.3064	0.2029
Std dev	16.3991	NA	12.6277	12.7510	12.8930	13.0587	13.4673	13.7111	14.5771	12.4043
MYR										
Mean	-3.4293	-3.4301	-3.4241	-3.4068	-3.3898	-3.3726	-3.3189	-3.2711	-3.2243	NA
Std dev	10.2705	10.2701	10.2717	10.2644	10.2417	10.2184	10.1667	10.1462	10.1273	NA
PHP										
Mean	3.3753	1.0860	1.0740	2.7433	2.7389	2.7282	2.6966	0.5485	2.6381	NA
Std dev	13.0431	11.6811	11.6983	12.5336	12.6444	12.7235	12.9442	12.1666	13.1624	NA
PKR										
Mean	7.3990	NA	4.6205	4.7032	4.8042	4.9148	5.2281	NA	NA	NA
Std dev	14.1795	NA	11.0879	11.0760	11.0500	11.1167	11.1607	NA	NA	NA
PLZ										
Mean	7.7492	-0.9338	-0.9420	-0.9605	-0.9963	-1.0212	-1.0901	-1.1368	-1.1779	-2.9051
Std dev	15.4482	12.0157	12.0182	12.0179	12.0103	12.0106	11.9971	12.0229	12.0037	12.9330
RUR										
Mean	25.0940	-0.4834	-0.4616	-0.3676	-0.2370	-0.1094	0.2487	0.4596	0.6175	NA
Std dev	28.9006	10.0298	10.0409	10.2615	10.8048	11.2839	12.5007	12.4944	12.7530	NA
THB										
Mean	1.1256	-1.5755	-1.5661	0.9465	0.9768	1.0175	1.1229	-1.3105	1.3137	NA
Std dev	11.9744	12.1255	12.1632	13.0136	13.2642	13.5938	14.3897	14.6957	15.6690	NA
TRL										
Mean	30.2524	17.4801	17.4731	19.6434	19.8044	19.9548	20.7280	20.1897	23.5708	1.1002
Std dev	20.2651	31.2016	31.9509	33.1806	36.0338	38.4987	47.3856	58.7520	67.4840	17.2280
TWD										
Mean	0.8399	NA	-0.2168	0.2703	0.2761	0.2811	0.2898	-0.1594	0.2983	-1.0880
Std dev	10.1641	NA	9.5884	9.7838	9.8505	9.9142	10.0136	9.9780	10.0819	9.5282
ZAR										
Mean	6.2320	4.9315	4.9161	4.6119	4.5842	4.5473	4.4783	4.8184	4.3768	3.3574
Std dev	14.0125	15.8741	15.8847	15.6606	15.6886	15.6877	15.8313	16.1688	16.0015	15.7550

The table presents summary statistics of the daily observations of daily Sterling exchange rates changes. Mean and standard deviations are annualized by 260 trading days (multiplied by 260×100 and $\sqrt{260} \times 100$).

Table 3.4: Sterling Spot return and forward premium

	TN	1W	1M	2M	3M	6M	9M	1Y	2Y
Developed Economies									
AUD									
Mean DSP	-0.0001**	-0.0003**	-0.0012**	-0.0025**	-0.0037**	-0.0072**	-0.0114**	-0.0161**	-0.0340**
Mean FP	-0.0001**	0.0002**	0.0010**	0.0019**	0.0028**	0.0055**	0.0092**	0.0110**	NA
Std DSP	0.0106	0.0166	0.0329	0.0451	0.0531	0.0702	0.0843	0.0934	0.1262
Std FP	0.0002	0.0004	0.0016	0.0030	0.0045	0.0088	0.0126	0.0172	NA
Var DSP/FP	2125.6318	1667.7862	419.7792	219.6769	139.0464	63.0415	44.8581	29.4908	NA
CAD									
Mean DSP	-0.0001**	-0.0002**	-0.0007**	-0.0016**	-0.0023**	-0.0043**	-0.0074**	-0.0110**	-0.0222**
Mean FP	0.0000**	-0.0002**	-0.0008**	-0.0017**	-0.0025**	-0.0048**	-0.0061**	-0.0088**	NA
Std DSP	0.0091	0.0143	0.0281	0.0377	0.0451	0.0652	0.0756	0.0800	0.0971
Std FP	0.0002	0.0003	0.0011	0.0019	0.0028	0.0055	0.0073	0.0103	NA
Var DSP/FP	1327.1526	2114.7981	707.0754	384.2984	256.5529	142.2195	107.4400	60.2401	NA
CHF									
Mean DSP	-0.0002**	-0.0005**	-0.0019**	-0.0038**	-0.0055**	-0.0104**	-0.0156**	-0.0209**	-0.0469**
Mean FP	0.0001**	-0.0005**	-0.0025**	-0.0049**	-0.0072**	-0.0143**	-0.0202**	-0.0278***	-0.0418***
Std DSP	0.0084	0.0132	0.0251	0.0356	0.0446	0.0650	0.0782	0.0933	0.1390
Std FP	0.0002	0.0004	0.0014	0.0027	0.0039	0.0076	0.0105	0.0142	0.0207
Var DSP/FP	1860.4447	1377.1579	319.1358	175.6566	127.5129	73.3972	55.1971	43.4366	45.0741
XEU									
Mean DSP	-0.0000**	-0.0001**	-0.0005**	-0.0011**	-0.0016**	-0.0026**	-0.0039**	-0.0053**	-0.0141**
Mean FP	0.0000**	-0.0003**	-0.0012**	-0.0023**	-0.0034**	-0.0068**	-0.0097**	-0.0136**	-0.0190**
Std DSP	0.0068	0.0105	0.0201	0.0286	0.0347	0.0497	0.0600	0.0706	0.1031
Std FP	0.0001	0.0002	0.0009	0.0018	0.0027	0.0052	0.0076	0.0101	0.0166
Var DSP/FP	2793.5556	1951.6730	472.3386	256.4276	170.9351	90.3956	62.0769	48.8625	38.5865
HKD									
Mean DSP	-0.0000**	-0.0001**	-0.0003**	-0.0006**	-0.0008**	-0.0012**	-0.0027**	-0.0049**	-0.0097**
Mean FP	0.0001**	-0.0002**	-0.0009**	-0.0017**	-0.0025**	-0.0044**	-0.0061**	-0.0071**	-0.0202**
Std DSP	0.0086	0.0136	0.0274	0.0397	0.0491	0.0724	0.0844	0.0920	0.1211
Std FP	0.0001	0.0003	0.0015	0.0028	0.0041	0.0082	0.0126	0.0166	0.0186
Var DSP/FP	3970.1533	1541.1019	331.6449	206.0281	145.4116	77.3321	44.8925	30.8604	42.1906
ILS									
Mean DSP	0.0002**	0.0005**	0.0018**	0.0037**	0.0057**	0.0119**	0.0173**	0.0221**	0.0394**
Mean FP	-0.0000**	0.0000**	-0.0000**	-0.0001**	-0.0002**	-0.0004**	-0.0001**	0.0002**	0.0052**
Std DSP	0.0097	0.0147	0.0283	0.0403	0.0489	0.0681	0.0809	0.0947	0.1400
Std FP	0.0001	0.0002	0.0009	0.0017	0.0024	0.0044	0.0061	0.0077	0.0129
Var DSP/FP	23624.2751	4356.0115	965.1974	570.9475	416.2087	240.1013	175.9463	152.9889	118.6893
JPY									
Mean DSP	-0.0002**	-0.0004**	-0.0017**	-0.0035**	-0.0053**	-0.0122**	-0.0203**	-0.0278**	-0.0571**
Mean FP	0.0001**	-0.0007**	-0.0033**	-0.0065**	-0.0097**	-0.0194**	-0.0282**	-0.0390**	-0.0577**
Std DSP	0.0116	0.0183	0.0365	0.0530	0.0673	0.0992	0.1155	0.1349	0.2083
Std FP	0.0002	0.0004	0.0019	0.0036	0.0054	0.0105	0.0153	0.0202	0.0328
Var DSP/FP	5356.9811	1849.5044	378.4814	214.9523	157.7484	88.9676	57.2161	44.6643	40.3131
NOK									
Mean DSP	-0.0001**	-0.0002**	-0.0007**	-0.0015**	-0.0022**	-0.0039**	-0.0061**	-0.0082**	-0.0188**
Mean FP	-0.0000**	0.0000**	0.0001**	0.0001**	0.0002**	0.0002**	0.0014**	0.0002**	0.0022**
Std DSP	0.0081	0.0124	0.0236	0.0319	0.0378	0.0499	0.0602	0.0700	0.0978
Std FP	0.0002	0.0004	0.0019	0.0035	0.0050	0.0095	0.0129	0.0175	0.0274
Var DSP/FP	1061.0032	784.6833	147.5108	85.3102	57.4257	27.7151	21.7724	16.0746	12.7370
NZD									
Mean DSP	-0.0001**	-0.0003**	-0.0013**	-0.0028**	-0.0041**	-0.0081**	-0.0127**	-0.0175**	-0.0370**
Mean FP	-0.0001**	0.0003**	0.0014**	0.0027**	0.0041**	0.0081**	0.0125**	0.0162**	0.0471***
Std DSP	0.0105	0.0164	0.0319	0.0431	0.0512	0.0715	0.0871	0.1010	0.1434
Std FP	0.0003	0.0004	0.0012	0.0021	0.0030	0.0056	0.0081	0.0106	0.0111

Var DSP/FP	1406.3504	1963.4247	708.4268	418.6076	291.6054	162.4034	116.5806	90.7989	166.3206
SGD									
Mean DSP	-0.0002**	-0.0004**	-0.0017**	-0.0033**	-0.0048**	-0.0095**	-0.0149**	-0.0204**	-0.0399**
Mean FP	0.0001**	-0.0004**	-0.0016**	-0.0033**	-0.0050**	-0.0101**	-0.0148**	-0.0198**	-0.0298**
Std DSP	0.0080	0.0124	0.0243	0.0344	0.0423	0.0605	0.0722	0.0847	0.1313
Std FP	0.0003	0.0004	0.0017	0.0028	0.0040	0.0073	0.0106	0.0135	0.0244
Var DSP/FP	980.8706	899.4118	214.5124	146.3762	111.5870	68.2390	46.5222	39.6164	28.8575
USD									
Mean DSP	-0.0000**	-0.0001**	-0.0003**	-0.0006**	-0.0007**	-0.0010**	-0.0025**	-0.0047**	-0.0096**
Mean FP	0.0000**	-0.0002**	-0.0008**	-0.0016**	-0.0024**	-0.0047**	-0.0069**	-0.0090**	-0.0123**
Std DSP	0.0086	0.0136	0.0275	0.0397	0.0490	0.0720	0.0838	0.0912	0.1201
Std FP	0.0001	0.0002	0.0010	0.0019	0.0028	0.0055	0.0082	0.0104	0.0154
Var DSP/FP	14281.8219	3710.7222	809.6050	447.8198	308.9784	171.4025	103.4913	77.0330	61.1165
Emerging Economies									
AED									
Mean DSP	-0.0000**	-0.0001**	-0.0003**	-0.0006**	-0.0007**	-0.0010**	-0.0025**	-0.0047**	-0.0095**
Mean FP	0.0000**	-0.0002**	-0.0009**	-0.0017**	-0.0025**	-0.0049**	-0.0072**	-0.0094**	-0.0133**
Std DSP	0.0087	0.0137	0.0276	0.0397	0.0491	0.0721	0.0839	0.0912	0.1201
Std FP	0.0001	0.0003	0.0013	0.0024	0.0036	0.0069	0.0101	0.0128	0.0219
Var DSP/FP	3687.6082	2009.0980	456.6534	273.0676	189.9124	109.5968	68.3129	50.9773	30.0580
BRL									
Mean DSP	0.0042**	0.0104**	0.0417**	0.0832**	0.1231**	0.2415**	0.3584**	0.4729**	0.9062**
Mean FP	NA	0.0017**	0.0069***	0.0132***	0.0196***	0.0382***	0.0545***	0.0752***	0.1492***
Std DSP	0.0286	0.0457	0.1093	0.1913	0.2692	0.4964	0.7166	0.9310	1.7347
Std FP	NA	0.0010	0.0028	0.0052	0.0076	0.0141	0.0172	0.0263	0.0471
Var DSP/FP	NA	2102.5655	1579.0093	1332.3094	1265.6784	1244.9228	1741.6482	1250.6670	1357.7285
CLP									
Mean DSP	0.0001**	0.0004**	0.0014**	0.0028**	0.0043**	0.0088**	0.0118**	0.0146**	0.0254**
Mean FP	NA	0.0002**	0.0008**	0.0015**	0.0022**	0.0044**	0.0067**	0.0093**	0.0255**
Std DSP	0.0111	0.0174	0.0345	0.0497	0.0606	0.0819	0.0895	0.0973	0.1324
Std FP	NA	0.0005	0.0023	0.0043	0.0062	0.0112	0.0157	0.0199	0.0331
Var DSP/FP	NA	1116.9440	228.6939	134.9578	96.5776	52.9740	32.4109	23.8736	15.9632
CNY									
Mean DSP	0.0001**	0.0002**	0.0006**	0.0013**	0.0021**	0.0046**	0.0063**	0.0071**	0.0105**
Mean FP	NA	-0.0005**	-0.0022**	-0.0047**	-0.0074**	-0.0158**	-0.0241**	-0.0323**	-0.0569**
Std DSP	0.0115	0.0180	0.0360	0.0510	0.0629	0.0920	0.1122	0.1289	0.1715
Std FP	NA	0.0009	0.0033	0.0064	0.0094	0.0178	0.0253	0.0328	0.0584
Var DSP/FP	NA	434.0254	118.7507	64.4375	44.5552	26.7210	19.6417	15.4539	8.6309
COP									
Mean DSP	0.0005**	0.0012**	0.0045**	0.0089**	0.0133**	0.0266**	0.0384**	0.0491**	0.0945**
Mean FP	NA	0.0004**	0.0019**	0.0041**	0.0065**	0.0141**	0.0221**	0.0307***	0.0666***
Std DSP	0.0128	0.0204	0.0411	0.0579	0.0681	0.0919	0.1097	0.1288	0.2012
Std FP	NA	0.0006	0.0027	0.0042	0.0055	0.0088	0.0120	0.0153	0.0283
Var DSP/FP	NA	1120.3430	231.6642	185.8976	154.6621	110.2687	83.1919	70.8633	50.6382
CZK									
Mean DSP	0.0001**	0.0002**	0.0005**	0.0007**	0.0009**	0.0023**	0.0030**	0.0011**	-0.0230**
Mean FP	0.0000**	-0.0000**	0.0002**	0.0004**	0.0004**	0.0004**	-0.0021**	0.0002**	-0.0190**
Std DSP	0.0131	0.0204	0.0392	0.0543	0.0666	0.1017	0.1301	0.1490	0.1849
Std FP	0.0003	0.0006	0.0031	0.0055	0.0078	0.0144	0.0180	0.0264	0.0222
Var DSP/FP	1806.5687	1360.8122	159.4401	95.9581	73.0441	49.8062	52.3117	31.7443	69.3848
HUF									
Mean DSP	0.0004**	0.0010**	0.0041**	0.0080**	0.0119**	0.0240**	0.0356**	0.0476**	0.0908**
Mean FP	-0.0002**	0.0011**	0.0046**	0.0088**	0.0128**	0.0243**	0.0347**	NA	0.0727***
Std DSP	0.0104	0.0163	0.0314	0.0437	0.0517	0.0726	0.0926	0.1094	0.1789
Std FP	0.0002	0.0006	0.0024	0.0046	0.0067	0.0125	0.0180	NA	0.0351
Var DSP/FP	1994.3398	756.3376	171.7164	90.6706	60.1663	33.5793	26.4893	NA	25.9985
IDR									
Mean DSP	0.0005**	0.0013**	0.0053**	0.0106**	0.0161**	0.0327**	0.0483**	0.0632**	0.1264**
Mean FP	-0.0031**	-0.0018**	0.0030**	0.0086**	0.0147**	0.0305**	0.0432**	0.0589**	NA

Std DSP	0.0212	0.0338	0.0703	0.1062	0.1328	0.1925	0.2520	0.2985	0.4012
Std FP	0.0242	0.0242	0.0249	0.0287	0.0337	0.0512	0.0693	0.0832	NA
Var DSP/FP	0.7672	1.9573	7.9969	13.6918	15.5461	14.1354	13.2333	12.8574	NA
INR									
Mean DSP	0.0004**	0.0009**	0.0036**	0.0071**	0.0109**	0.0223**	0.0327**	0.0424**	0.0746**
Mean FP	-0.0001**	0.0006**	0.0025**	0.0048**	0.0071**	0.0134**	0.0192**	0.0248**	NA
Std DSP	0.0098	0.0152	0.0311	0.0441	0.0536	0.0742	0.0852	0.0955	0.1349
Std FP	0.0003	0.0007	0.0026	0.0049	0.0071	0.0135	0.0198	0.0257	NA
Var DSP/FP	1322.1979	467.2030	145.4969	82.2735	57.7921	30.1242	18.5571	13.7844	NA
MAD									
Mean DSP	0.0000**	0.0000**	-0.0000**	-0.0002**	-0.0001**	-0.0000**	-0.0010**	-0.0022**	-0.0083**
Mean FP	-0.0000**	0.0004**	0.0018**	0.0037**	0.0057**	0.0118**	0.0184**	0.0254**	0.0561**
Std DSP	0.0096	0.0114	0.0210	0.0296	0.0360	0.0519	0.0604	0.0682	0.0948
Std FP	0.0001	0.0005	0.0023	0.0045	0.0067	0.0128	0.0186	0.0241	0.0421
Var DSP/FP	9327.3200	439.7168	81.6154	42.4794	29.3322	16.4343	10.5868	7.9814	5.0706
MXN									
Mean DSP	0.0005**	0.0012**	0.0048**	0.0096**	0.0147**	0.0299**	0.0442**	0.0584**	0.1187**
Mean FP	NA	0.0012**	0.0058**	0.0115**	0.0170**	0.0337**	0.0470**	0.0658**	0.0697***
Std DSP	0.0140	0.0214	0.0453	0.0641	0.0793	0.1150	0.1388	0.1651	0.2518
Std FP	NA	0.0012	0.0053	0.0103	0.0151	0.0288	0.0401	0.0529	0.0213
Var DSP/FP	NA	313.6614	72.1351	38.4540	27.4693	16.0073	12.0050	9.7477	139.3170
MYR									
Mean DSP	-0.0003**	-0.0008**	-0.0033**	-0.0066**	-0.0097**	-0.0188**	-0.0284**	-0.0386**	-0.0879**
Mean FP	-0.0000**	-0.0000**	-0.0001**	-0.0003**	-0.0006**	-0.0015**	-0.0025**	-0.0036**	NA
Std DSP	0.0088	0.0133	0.0243	0.0345	0.0435	0.0631	0.0712	0.0746	0.0946
Std FP	0.0001	0.0004	0.0018	0.0034	0.0050	0.0095	0.0135	0.0171	NA
Var DSP/FP	7303.8202	1075.0695	189.9809	102.6218	75.9500	44.4547	27.9551	19.0788	NA
PHP									
Mean DSP	0.0002**	0.0005**	0.0018**	0.0036**	0.0056**	0.0116**	0.0163**	0.0196**	0.0362**
Mean FP	-0.0001**	0.0006**	0.0031**	0.0060**	0.0090**	0.0181**	0.0265**	0.0362**	NA
Std DSP	0.0114	0.0176	0.0350	0.0519	0.0657	0.0988	0.1165	0.1281	0.1834
Std FP	0.0004	0.0008	0.0029	0.0054	0.0078	0.0148	0.0215	0.0288	NA
Var DSP/FP	663.6116	546.2681	143.7786	91.4466	70.9903	44.5307	29.4449	19.8523	NA
PKR									
Mean DSP	0.0005**	0.0012**	0.0048**	0.0096**	0.0146**	0.0295**	0.0435**	0.0568**	0.1119**
Mean FP	NA	0.0011**	0.0047**	0.0093**	0.0139**	0.0281**	NA	NA	NA
Std DSP	0.0112	0.0157	0.0306	0.0432	0.0525	0.0723	0.0779	0.0786	0.0981
Std FP	NA	0.0009	0.0038	0.0070	0.0100	0.0188	NA	NA	NA
Var DSP/FP	NA	287.9484	66.2321	38.1012	27.7150	14.8217	NA	NA	NA
PLZ									
Mean DSP	0.0005**	0.0013**	0.0041**	0.0078**	0.0116**	0.0236**	0.0350**	0.0464**	0.0907**
Mean FP	-0.0001**	0.0004**	0.0016**	0.0030**	0.0043**	0.0080**	0.0113**	0.0142**	0.0248**
Std DSP	0.0126	0.0197	0.0344	0.0487	0.0586	0.0856	0.1082	0.1256	0.1897
Std FP	0.0002	0.0004	0.0016	0.0030	0.0044	0.0082	0.0114	0.0143	0.0251
Var DSP/FP	4546.9564	2422.1206	471.6907	258.3881	177.2263	109.2602	89.5526	77.1801	57.2289
RUR									
Mean DSP	0.0016**	0.0041**	0.0158**	0.0313**	0.0465**	0.0890**	0.1313**	0.1730**	0.3217**
Mean FP	-0.0000**	0.0008**	0.0033**	0.0062**	0.0091**	0.0177**	0.0260**	0.0347**	NA
Std DSP	0.0247	0.0388	0.0715	0.1103	0.1418	0.2226	0.2921	0.3522	0.5449
Std FP	0.0002	0.0028	0.0080	0.0137	0.0189	0.0307	0.0407	0.0485	NA
Var DSP/FP	18058.5552	190.0770	80.8575	64.6305	56.5289	52.4364	51.5407	52.8304	NA
THB									
Mean DSP	0.0000**	0.0001**	0.0002**	0.0004**	0.0008**	0.0022**	0.0028**	0.0030**	0.0065**
Mean FP	-0.0000**	0.0002**	0.0012**	0.0021**	0.0029**	0.0049**	0.0048**	0.0084**	NA
Std DSP	0.0108	0.0169	0.0352	0.0522	0.0659	0.0961	0.1165	0.1322	0.1832
Std FP	0.0003	0.0010	0.0047	0.0078	0.0106	0.0175	0.0220	0.0298	NA
Var DSP/FP	1255.9173	280.8382	57.1692	44.7714	38.8097	30.2720	27.9230	19.6303	NA
TRL									
Mean DSP	0.0022**	0.0054**	0.0218**	0.0435**	0.0655**	0.1321**	0.1984**	0.2651**	0.5351**
Mean FP	-0.0354**	-0.0299**	-0.0115**	0.0087**	0.0286**	0.0881**	0.1291**	0.2043**	0.1796***

Std DSP	0.0172	0.0258	0.0531	0.0842	0.1097	0.1752	0.2351	0.2912	0.5006
Std FP	0.1484	0.1497	0.1510	0.1591	0.1688	0.2062	0.2449	0.2991	0.0615
Var DSP/FP	0.0135	0.0297	0.1237	0.2804	0.4222	0.7220	0.9211	0.9479	66.3659
TWD									
Mean DSP	0.0000**	0.0001**	0.0002**	0.0003**	0.0005**	0.0010**	0.0005**	-0.0008**	-0.0016**
Mean FP	NA	-0.0004**	-0.0015**	-0.0032**	-0.0048**	-0.0098**	-0.0151**	-0.0192**	-0.0388**
Std DSP	0.0089	0.0137	0.0274	0.0395	0.0492	0.0707	0.0829	0.0941	0.1348
Std FP	NA	0.0009	0.0027	0.0046	0.0064	0.0114	0.0153	0.0193	0.0411
Var DSP/FP	NA	220.7291	104.1396	74.8548	58.4481	38.6283	29.5004	23.6856	10.7918
ZAR									
Mean DSP	0.0004**	0.0010**	0.0040**	0.0078**	0.0118**	0.0236**	0.0342**	0.0446**	0.0856**
Mean FP	-0.0002**	0.0012***	0.0052***	0.0101***	0.0149***	0.0287***	0.0408***	0.0550***	0.0913***
Std DSP	0.0125	0.0196	0.0396	0.0558	0.0663	0.0938	0.1120	0.1329	0.1898
Std FP	0.0003	0.0006	0.0023	0.0043	0.0061	0.0112	0.0153	0.0199	0.0247
Var DSP/FP	1825.6802	1152.4109	289.7401	171.7755	117.9280	70.0124	53.7963	44.7222	59.1578

Mean and standard deviation spot return (DSP) and forward premium(FP). * indicates the significance level of a t test that the mean is equal to zero.

* Significant at the 10% level

** Significant at the 5% level

*** Significant at the 1% level

Table 3.5 ADF test for Sterling spot and forward exchange rates

	SP	TN	1W	1M	2M	3M	6M	9M	1Y	2Y
AED										
ADF trend	-2.4601	-1.6975	-1.6997	-1.8372	-1.8471	-1.8560	-1.8762	-1.7534	-1.9128	-2.5605
ADF const	-2.4814	-1.7378	-1.7401	-1.8519	-1.8610	-1.8692	-1.8874	-1.7948	-1.9205	-1.4480
ADF 1st.diff	-76.6554***	-60.9339***	-60.9708***	-62.4116***	-62.5622***	-62.7016***	-62.7374***	-61.5502***	-63.3366***	-48.1207***
AUD										
ADF trend	-1.6197	-2.6467	-2.6472	-2.4629	-2.4592	-2.4531	-2.4360	-2.6708	-2.4047	
ADF const	-0.8346	-0.2023	-0.2031	-0.2629	-0.2719	-0.2771	-0.2908	-0.2276	-0.3247	
ADF 1st.diff	-76.6605***	-64.6725***	-64.6638***	-66.0445***	-66.1050***	-66.1285***	-66.2278***	-65.2185***	-66.6819***	
BRL										
ADF trend	-5.3251***		-1.7958	-1.7810	-1.7674	-1.7587	-1.7368	-1.8046	-1.8192	-2.1326
ADF const	-7.3291***		-1.8750	-1.8335	-1.7828	-1.7348	-1.6033	-1.5259	-1.3993	-1.1490
ADF 1st.diff	-9.3009***		-49.7683***	-49.6546***	-49.5963***	-49.8758***	-49.8450***	-50.5242***	-50.3028***	-50.8046***
CAD										
ADF trend	-2.3074	-2.9412	-2.9472	-2.6709	-2.6810	-2.6909	-2.7215	-3.1334*	-2.7831	
ADF const	-1.3517	-0.6973	-0.6984	-0.7514	-0.7564	-0.7597	-0.7703	-0.7258	-0.7870	
ADF 1st.diff	-74.9920***	-63.1331***	-63.1418***	-64.3603***	-64.3811***	-64.4116***	-64.4675***	-63.4717***	-64.7195***	
CHF										
ADF trend	-1.3498	-2.0824	-2.0849	-2.2180	-2.2208	-2.2258	-2.2376	-2.1383	-2.2557	-2.1428
ADF const	-0.5291	-0.2676	-0.2700	-0.2218	-0.2296	-0.2375	-0.2576	-0.3116	-0.2876	-0.6715
ADF 1st.diff	-75.6748***	-61.9675***	-61.9457***	-63.9822***	-63.9284***	-64.0230***	-64.0355***	-61.9502***	-63.9760***	-47.8268***
CLP										
ADF trend	-1.7350		-3.3606*	-3.3660*	-3.3652*	-3.3578*	-3.3589*	-3.3593*	-3.3771*	-3.4758**
ADF const	-2.5406		-1.4341	-1.4479	-1.4613	-1.4715	-1.5004	-1.5252	-1.5560	-1.5120
ADF 1st.diff	-77.8182***		-45.1516***	-45.0122***	-45.0480***	-45.1822***	-45.1723***	-45.1915***	-45.1451***	-45.9734***
CNY										

ADF trend	-2.0201		-2.3979	-2.4052	-2.4216	-2.4352	-2.4710	-2.4990	-2.5254	-2.7632
ADF const	-2.4086		-0.2950	-0.3016	-0.3173	-0.3366	-0.4094	-0.4812	-0.5545	-0.8838
ADF 1st.diff	-76.9509***		-52.9564***	-53.4110***	-53.6667***	-53.9878***	-54.7468***	-55.5449***	-55.8519***	-53.4835***
COP										
ADF trend	-0.9617		-3.2826*	-3.2768*	-3.2520*	-3.2284*	-3.1853*	-3.1473*	-3.1338*	-3.3981*
ADF const	-2.8841**		-1.3041	-1.3126	-1.3174	-1.3161	-1.3142	-1.3096	-1.3048	-1.4144
ADF 1st.diff	-75.9657***		-46.3250***	-46.9447***	-46.8353***	-46.7295***	-46.8946***	-46.8451***	-47.0804***	-45.4879***
CZK										
ADF trend	-4.1819***	-2.4769	-2.4801	-3.1858*	-3.2199*	-3.2360*	-3.2947*	-2.5800	-3.4229**	-1.8401
ADF const	-2.3469	-0.7722	-0.7756	-0.4050	-0.4167	-0.4127	-0.4249	-0.9459	-0.4625	-1.8198
ADF 1st.diff	-76.9869***	-46.3509***	-46.3465***	-50.6062***	-49.6801***	-49.7279***	-49.9021***	-46.4461***	-48.3243***	-47.8637***
XEU										
ADF trend	-1.6917	-2.5428	-2.5435	-2.8377	-2.8364	-2.8358	-2.8389	-2.5585	-2.8451	-1.8789
ADF const	-1.4267	-0.9614	-0.9627	-1.0020	-1.0077	-1.0139	-1.0336	-0.9985	-1.0699	-1.3702
ADF 1st.diff	-78.6452***	-61.6013***	-61.5842***	-63.7679***	-63.7680***	-63.8180***	-63.8300***	-61.7747***	-63.9263***	-47.7545***
HKD										
ADF trend	-2.4794	-1.6738	-1.6766	-1.8098	-1.8215	-1.8364	-1.8731	-1.8018	-1.9278	-2.3219
ADF const	-2.5001	-1.7191	-1.7191	-1.8295	-1.8406	-1.8550	-1.8906	-1.8168	-1.9435	-1.4020
ADF 1st.diff	-73.9237***	-61.0124***	-61.0141***	-62.6018***	-62.7486***	-62.9322***	-63.2559***	-62.2336***	-63.5906***	-48.6091***
HUF										
ADF trend	-1.4808	-3.3854*	-3.3884*	-3.3916*	-3.4067*	-3.4227**	-3.4890**	-3.4712**		-3.4614**
ADF const	-2.6941*	-2.4672	-2.4625	-2.4481	-2.4341	-2.4256	-2.4139	-2.3303		-3.339545**
ADF 1st.diff	-76.4252***	-61.1531***	-61.0899***	-61.1532***	-61.0504***	-61.3267***	-62.4136***	-61.0114***		-45.0277***
IDR										
ADF trend	-1.7786	-6.3337***	-6.3408***	-4.0002***	-4.0112***	-4.0219***	-4.0637***	-6.2772***	-3.7006**	
ADF const	-1.5470	-6.382585***	-6.392701***	-4.300069***	-4.303847***	-4.312065***	-4.324582***	-6.322118***	-4.020844***	
ADF 1st.diff	-10.9419***	-10.2097***	-10.1719***	-10.2988***	-10.2365***	-10.1961***	-10.1720***	-9.8987***	-17.0066***	
ILS										
ADF trend	-1.5031	-2.1905	-2.1902	-2.1886	-2.1856	-2.1844	-2.1785	-2.1823	-2.1915	-2.2563
ADF const	-2.6807*	-0.9009	-0.9037	-0.9096	-0.9172	-0.9197	-0.9289	-0.9429	-0.9570	-1.0232
ADF 1st.diff	-81.4074***	-46.4617***	-46.4872***	-46.4801***	-46.4920***	-46.5604***	-46.6187***	-46.6748***	-47.0035***	-47.6978***
INR										

ADF trend	-3.3881*	-3.0002	-3.0235	-3.0559	-3.1061	-3.1607*	-3.3025*	-3.4249**	-3.5204**	
ADF const	-3.4342***	-2.820459*	-2.833881*	-2.847401*	-2.871929**	-2.899953**	-2.980652**	-3.061655**	-3.135245**	
ADF 1st.diff	-78.5969***	-63.3652***	-63.6414***	-63.3683***	-63.2650***	-63.3419***	-63.3477***	-63.4593***	-63.4427***	
JPY										
ADF trend	-1.8546	-1.6690	-1.6711	-1.7570	-1.7641	-1.7703	-1.7890	-1.7253	-1.8139	-1.8652
ADF const	-1.6646	-1.2222	-1.2256	-1.2635	-1.2774	-1.2897	-1.3272	-1.3176	-1.3926	-0.9688
ADF 1st.diff	-74.0449***	-38.1820***	-38.1753***	-62.7462***	-62.7789***	-62.7996***	-39.3211***	-38.2864***	-62.8390***	-47.7935***
MAD										
ADF trend	-1.9912	-1.7488	-1.7577	-1.7839	-1.8347	-1.8740	-1.9956	-2.1590	-2.3695	-2.7416
ADF const	-1.8564	-1.2377	-1.2406	-1.2540	-1.2641	-1.2801	-1.3533	-1.4074	-1.5191	-1.8846
ADF 1st.diff	-24.1059***	-47.0959***	-47.1148***	-47.1466***	-47.3432***	-47.2991***	-47.6795***	-48.4870***	-49.4348***	-52.4123***
MXN										
ADF trend	-1.2072		-2.0278	-2.0729	-2.1152	-2.1603	-2.2719	-2.2429	-2.5022	-3.6263**
ADF const	-1.8848		-1.9671	-1.7924	-1.8081	-1.8295	-1.8974	-1.9441	-2.0895	-3.558915***
ADF 1st.diff	-14.6474***		-64.1169***	-64.4269***	-63.9749***	-64.0653***	-64.1628***	-64.0789***	-65.6106***	-47.0248***
MYR										
ADF trend	-2.8956	-2.8948	-2.8990	-2.9085	-2.9170	-2.9253	-2.9557	-2.9932	-3.0280	
ADF const	-0.7151	-0.7144	-0.7193	-0.7328	-0.7471	-0.7615	-0.8079	-0.8542	-0.9006	
ADF 1st.diff	-51.1074***	-51.1085***	-51.1022***	-51.1282***	-51.1712***	-51.2004***	-51.2194***	-51.3209***	-51.3707***	
NOK										
ADF trend	-1.9324	-3.7235**	-3.7393**	-3.6093**	-3.6253**	-3.6392**	-3.6742**	-4.0520***	-3.7045**	-3.8050**
ADF const	-1.4680	-0.9437	-0.9458	-1.0439	-1.0531	-1.0601	-1.0838	-0.9760	-1.1359	-1.6706
ADF 1st.diff	-77.5135***	-61.6849***	-61.6746***	-63.5526***	-63.5243***	-63.5294***	-63.5450***	-61.7355***	-63.7195***	-48.2891***
NZD										
ADF trend	-1.7721	-3.5526**	-3.5489**	-2.8267	-2.8209	-2.8148	-2.7998	-3.4702**	-2.7774	-2.6710
ADF const	-0.9227	-0.4635	-0.4659	-0.5995	-0.6080	-0.6149	-0.6325	-0.5125	-0.6723	-0.6915
ADF 1st.diff	-76.0388***	-62.1774***	-62.1809***	-63.8373***	-63.8458***	-63.8746***	-64.0095***	-62.5170***	-64.3625***	-49.3069***
PHP										
ADF trend	-0.9004	-1.4719	-1.4728	-1.8314	-1.8581	-1.8813	-1.9408	-1.4863	-2.0539	
ADF const	-1.8883	-1.6192	-1.6157	-2.4393	-2.4452	-2.4481	-2.4530	-1.4532	-2.4547	
ADF 1st.diff	-77.7254***	-61.2984***	-61.2678***	-47.3725***	-47.3158***	-47.1923***	-46.9207***	-45.9325***	-46.7920***	
PKR										

ADF trend	-2.8596		-3.6875**	-3.7086**	-3.7254**	-3.7776**	-3.8560**			
ADF const	-1.3095		-1.4417	-1.4386	-1.4359	-1.4526	-1.4867			
ADF 1st.diff	-23.4910***		-47.7257***	-47.6511***	-47.6610***	-47.9490***	-48.4096***			
PLZ										
ADF trend	-3.3961*	-2.2535	-2.2504	-2.2401	-2.2240	-2.2122	-2.1756	-2.1522	-2.1238	-2.4473
ADF const	-4.8004***	-1.4674	-1.4704	-1.4782	-1.4879	-1.4971	-1.5212	-1.5467	-1.5646	-2.712821*
ADF 1st.diff	-77.5874***	-53.4533***	-53.4738***	-53.4445***	-53.4168***	-53.4052***	-53.4545***	-53.4604***	-53.3415***	-46.8370***
RUR										
ADF trend	-3.0135	-3.5922**	-3.6988**	-3.8485**	-3.8354**	-3.9778***	-3.2201*	-3.0724	-2.9325	
ADF const	-4.8345***	-3.088337**	-3.175914**	-3.315950**	-3.331684**	-3.513190***	-2.995991**	-2.976350**	-2.895967**	
ADF 1st.diff	-14.4655***	-45.0714***	-30.3068***	-45.3206***	-46.5195***	-47.3768***	-14.6441***	-14.4838***	-14.0860***	
SGD										
ADF trend	-1.2433	-1.5234	-1.5230	-1.6277	-1.6434	-1.6588	-1.6942	-1.5357	-1.7495	-2.8758
ADF const	-0.9618	-0.2575	-0.2655	-0.4434	-0.4681	-0.4906	-0.5407	-0.4243	-0.6145	-0.4224
ADF 1st.diff	-47.4656***	-40.0271***	-39.9866***	-40.9216***	-40.9081***	-40.7897***	-40.8500***	-39.7222***	-40.8340***	-49.1344***
THB										
ADF trend	-0.8415	-1.7417	-1.7500	-2.6953	-2.7262	-2.7580	-2.8420	-2.0302	-2.9891	
ADF const	-1.3909	-0.7891	-0.7946	-1.6478	-1.6573	-1.6773	-1.7300	-1.0373	-1.8268	
ADF 1st.diff	-47.0887***	-39.7073***	-39.7078***	-40.3783***	-40.7614***	-40.9322***	-41.2108***	-42.1403***	-41.6054***	
TRL										
ADF trend	-0.1207	-2.3004	-2.2967	-2.2827	-2.2874	-2.3041	-2.3618	-2.6109	-2.5380	-2.6151
ADF const	-5.5964***	-3.436994***	-3.396456**	-3.670190***	-3.512468***	-3.394977**	-3.083749**	-2.833361*	-2.846043*	-2.5250
ADF 1st.diff	-49.3584***	-64.0515***	-63.9570***	-65.7340***	-66.2361***	-66.6144***	-67.1472***	-65.8101***	-68.5988***	-50.0972***
TWD										
ADF trend	-1.6537		-1.4797	-1.6870	-1.7242	-1.7615	-1.8516	-1.7326	-1.9044	-2.1997
ADF const	-1.8946		-1.3300	-1.6721	-1.7018	-1.7312	-1.7975	-1.5182	-1.8031	-1.2618
ADF 1st.diff	-78.3771***		-66.4744***	-67.3057***	-67.4502***	-67.6790***	-67.7789***	-67.6301***	-68.1157***	-54.4480***
USD										
ADF trend	-2.5047	-1.6969	-1.6978	-1.8310	-1.8334	-1.8370	-1.8436	-1.7119	-1.8493	-2.3662
ADF const	-2.5245	-1.7372	-1.7381	-1.8457	-1.8477	-1.8507	-1.8558	-1.7549	-1.8588	-1.3683
ADF 1st.diff	-73.6568***	-60.9163***	-60.9279***	-62.3932***	-62.4254***	-62.4772***	-62.5908***	-61.2630***	-62.7724***	-47.9278***
ZAR										

ADF trend	-1.7580	-2.6735	-2.6675	-2.2181	-2.2138	-2.2035	-2.1911	-2.6336	-2.2775	-2.0930
ADF const	-1.7287	-2.728800*	-2.721614*	-2.1664	-2.1596	-2.1471	-2.1244	-2.647921*	-2.1696	-2.0430
ADF 1st.diff	-74.8231***	-61.0554***	-61.0569***	-62.4332***	-62.4084***	-62.2185***	-62.2541***	-60.3374***	-61.4505***	-45.5777***

Exchange rates are in natural logarithms. t-statistics of ADF tests are reported in the table. For each economy we carried out ADF test sequentially. The first test equation has both constant and a linear time trend. Second test equation has constant only. In the last equation variables are tested in first difference. Standard currency short codes are employed in the above table.

* Significance at 10%

** Significance at 5%

*** Significance at 1%

Table 3.6.1: Simple efficiency hypothesis FMOLS test equation for Sterling exchange rates

	TN	1W	1M	2M	3M	6M	9M	1Y	2Y
AUD									
a	0.0002	-0.0016	-0.0072	-0.0145	-0.0228	-0.0458	-0.0930	-0.0811	
Se a	0.0005	0.0014	0.0056	0.0084	0.0103	0.0150	0.0184	0.0256	
β	0.9997***	1.0015***	1.0059***	1.0117***	1.0188***	1.0379***	1.0727***	1.0596***	
Se β	0.0005	0.0017	0.0067	0.0101	0.0124	0.0178	0.0216	0.0299	
t β=1	-0.4837	0.8920	0.8799	1.1598	1.5209	2.1300**	3.3701***	1.9935**	
Wald	0.2563	2.3882	4.2395	8.1867**	12.4729***	24.7815***	81.8263***	42.8018***	
ADF	-13.7030***	-11.1783***	-9.0782***	-7.9340***	-6.8347***	-5.1082***	-4.5742***	-3.6108***	
R2	0.9974	0.9938	0.9751	0.9545	0.9370	0.8865	0.8605	0.7532	
CAD									
a	0.0001	-0.0003	-0.0011	-0.0036	-0.0045	-0.0029	-0.0054	-0.0208	
Se a	0.0004	0.0013	0.0052	0.0073	0.0090	0.0137	0.0167	0.0192	
β	0.9997***	1.0003***	1.0006***	1.0028***	1.0031***	0.9972***	0.9903***	1.0125***	
Se β	0.0006	0.0018	0.0070	0.0099	0.0121	0.0185	0.0225	0.0257	
t β=1	-0.4651	0.1790	0.0899	0.2884	0.2604	-0.1508	-0.4330	0.4876	
Wald	0.7375	0.0377	0.3644	1.0542	1.4546	3.2054	14.1669***	10.4426***	
ADF	-15.8438***	-11.1395***	-9.2261***	-8.5540***	-7.1848***	-4.9863***	-4.1889***	-3.8632***	
R2	0.9970	0.9929	0.9732	0.9552	0.9363	0.8701	0.8292	0.7898	
CHF									
a	0.0000	-0.0007	-0.0039	-0.0092	-0.0118	-0.0186	-0.0238	-0.0292	-0.0381
Se a	0.0004	0.0011	0.0042	0.0063	0.0080	0.0122	0.0151	0.0185	0.0405
β	0.9998***	1.0014***	1.0061***	1.0133***	1.0171***	1.0270***	1.0301***	1.0420***	0.9538***
Se β	0.0005	0.0015	0.0055	0.0082	0.0105	0.0162	0.0203	0.0248	0.0607
t β=1	-0.4674	0.9374	1.1142	1.6119	1.6339	1.6648*	1.4854	1.6935*	-0.7610
Wald	2.5379	2.3708	1.5941	2.7373	2.8326	2.9205	2.5002	2.9764	57.3795***
ADF	-13.5593***	-11.9756***	-9.9006***	-8.3785***	-6.9736***	-4.7067***	-3.8889***	-3.3464***	-1.5318
R2	0.9980	0.9952	0.9831	0.9690	0.9526	0.9028	0.8664	0.8109	0.5123
XEU									
a	0.0000	0.0001	0.0017	0.0033	0.0051	0.0135*	0.0184**	0.0320***	0.0995***

Se a	0.0002	0.0007	0.0026	0.0039	0.0049	0.0070	0.0084	0.0100	0.0162
β	0.9997***	1.0002***	0.9967***	0.9924***	0.9880***	0.9664***	0.9452***	0.9153***	0.4948***
Se β	0.0006	0.0019	0.0073	0.0112	0.0138	0.0200	0.0242	0.0289	0.0586
t β=1	-0.5531	0.1112	-0.4523	-0.6760	-0.8717	-1.6793*	-2.2637**	-2.9319***	-8.6240***
Wald	1.0102	0.5964	0.6052	0.8073	1.2007	3.8486	5.1499*	10.3405***	99.8086***
ADF	-13.8261***	-11.4322***	-9.5321***	-8.0943***	-6.7368***	-4.5051***	-3.5384***	-3.2608***	-1.6579*
R2	0.9968	0.9922	0.9701	0.9423	0.9177	0.8428	0.7928	0.7082	0.2308
HKD									
a	0.0017	0.0029	0.0498*	0.1221***	0.2031***	0.5186***	0.7880***	1.0220***	1.9412***
Se a	0.0023	0.0070	0.0272	0.0424	0.0532	0.0813	0.1014	0.1101	0.1927
β	0.9993***	0.9989***	0.9807***	0.9526***	0.9212***	0.7982***	0.6930***	0.6015***	0.2464***
Se β	0.0009	0.0027	0.0106	0.0166	0.0208	0.0318	0.0397	0.0431	0.0743
t β=1	-0.7573	-0.3831	-1.8114*	-2.8560***	-3.7831***	-6.3378***	-7.7323***	-9.2360***	-10.1464***
Wald	1.0654	0.5965	3.5892	8.6446**	15.1284***	41.5415***	61.0463***	87.0583***	106.2772***
ADF	-12.8159***	-9.5313***	-8.7701***	-7.7850***	-6.2407***	-3.6346***	-2.8679***	-2.5077**	-1.2575
R2	0.9932	0.9835	0.9347	0.8692	0.8059	0.5885	0.4331	0.3197	0.0441
ILS									
a	0.0008	-0.0001	0.0088	0.0251	0.0452	0.1264***	0.1943***	0.2851***	0.5709***
Se a	0.0017	0.0052	0.0179	0.0271	0.0326	0.0444	0.0521	0.0611	0.0883
β	0.9996***	0.9998***	0.9940***	0.9839***	0.9720***	0.9260***	0.8872***	0.8358***	0.6666***
Se β	0.0009	0.0027	0.0093	0.0140	0.0168	0.0229	0.0268	0.0314	0.0448
t β=1	-0.4828	-0.0597	-0.6495	-1.1510	-1.6666*	-3.2339***	-4.2064***	-5.2320***	-7.4419***
Wald	0.4467	0.7226	4.0892	8.8009**	14.2074***	32.0653***	50.1457***	72.5750***	205.7373***
ADF	-11.5810***	-8.3876***	-7.0770***	-6.4321***	-5.2192***	-3.3397***	-2.8297***	-2.6187***	-1.9708**
R2	0.9963	0.9911	0.9706	0.9439	0.9225	0.8489	0.7957	0.7232	0.4821
JPY									
a	0.0028	-0.0032	0.0236	0.0737	0.1509*	0.3655***	0.4737***	0.5887***	1.4333***
Se a	0.0034	0.0105	0.0405	0.0632	0.0827	0.1312	0.1572	0.1919	0.3860
β	0.9994***	1.0007***	0.9959***	0.9865***	0.9719***	0.9311***	0.9094***	0.8891***	0.7119***
Se β	0.0007	0.0020	0.0078	0.0122	0.0160	0.0254	0.0305	0.0372	0.0751
t β=1	-0.8527	0.3553	-0.5306	-1.1074	-1.7561*	-2.7116***	-2.9723***	-2.9809***	-3.8354***
Wald	2.5473	2.2032	2.3439	3.9438	6.6559**	11.8663***	10.3853***	16.2694***	26.0867***
ADF	-14.3360***	-9.7526***	-8.2774***	-7.6079***	-5.8609***	-3.7921***	-3.3909***	-2.8914***	-1.4188
R2	0.9962	0.9907	0.9650	0.9296	0.8860	0.7570	0.6920	0.5797	0.2759
NOK									

a	0.0006	-0.0005	0.0087	0.0124	0.0173	0.0253	0.0253	0.0978	0.0778
Se a	0.0017	0.0052	0.0204	0.0298	0.0369	0.0504	0.0583	0.0727	0.1396
β	0.9997***	1.0001***	0.9961***	0.9941***	0.9916***	0.9869***	0.9832***	0.9542***	0.9391***
Se β	0.0007	0.0022	0.0084	0.0123	0.0152	0.0208	0.0240	0.0299	0.0588
t β=1	-0.3601	0.0602	-0.4663	-0.4816	-0.5532	-0.6310	-0.6999	-1.5324	-1.0362
Wald	0.1402	0.3412	0.8124	1.7890	2.8956	6.8607**	27.9191***	17.1114***	182.2298***
ADF	-15.9222***	-11.0489***	-9.3944***	-8.6048***	-7.2708***	-5.4300***	-4.6028***	-3.9488***	-2.7143***
R2	0.9956	0.9896	0.9606	0.9308	0.9021	0.8378	0.8057	0.7106	0.5115
NZD									
a	0.0002	-0.0010	-0.0016	-0.0041	-0.0052	0.0025	-0.0438	0.0399	-0.1852
Se a	0.0007	0.0020	0.0079	0.0114	0.0140	0.0212	0.0255	0.0348	0.0686
β	0.9998***	1.0005***	0.9991***	0.9991***	0.9979***	0.9835***	1.0119***	0.9316***	1.0599***
Se β	0.0006	0.0020	0.0079	0.0114	0.0139	0.0210	0.0248	0.0338	0.0695
t β=1	-0.2871	0.2741	-0.1098	-0.0794	-0.1505	-0.7874	0.4776	-2.0226**	0.8619
Wald	0.2030	1.9268	3.2207	6.6000**	9.6585***	17.4819***	64.6076***	36.6866***	331.7089***
ADF	-14.6575***	-11.0358***	-9.0035***	-8.0384***	-6.8129***	-4.7355***	-4.5576***	-3.2556***	-2.3454**
R2	0.9963	0.9909	0.9660	0.9406	0.9173	0.8349	0.8048	0.6479	0.4900
SGD									
a	0.0001	-0.0012	-0.0030	-0.0053	-0.0044	0.0006	-0.0414	0.0261	-0.0929
Se a	0.0005	0.0016	0.0062	0.0096	0.0122	0.0189	0.0223	0.0303	0.0420
β	0.9997***	1.0016***	1.0041***	1.0073***	1.0073***	1.0049***	1.0437***	0.9815***	1.0183***
Se β	0.0006	0.0017	0.0065	0.0101	0.0128	0.0198	0.0234	0.0320	0.0445
t β=1	-0.4923	0.9400	0.6356	0.7260	0.5751	0.2446	1.8724*	-0.5792	0.4120
Wald	2.1804	1.8728	1.1955	1.7519	2.3154	3.6732	3.5061	4.8951*	153.9177***
ADF	-13.1468***	-10.7539***	-9.5326***	-8.1735***	-5.9528***	-4.5373***	-4.0590***	-2.8647***	-1.9529**
R2	0.9973	0.9938	0.9762	0.9534	0.9303	0.8559	0.8336	0.6951	0.6887
USD									
a	0.0002	0.0010	0.0120**	0.0280***	0.0452***	0.1088***	0.1599***	0.2030***	0.3843***
Se a	0.0005	0.0014	0.0055	0.0085	0.0106	0.0158	0.0195	0.0209	0.0400
β	0.9994***	0.9982***	0.9771***	0.9465***	0.9137***	0.7907***	0.6906***	0.6070***	0.2632***
Se β	0.0009	0.0028	0.0107	0.0166	0.0206	0.0310	0.0382	0.0412	0.0715
t β=1	-0.6149	-0.6389	-2.1304**	-3.2324***	-4.1890***	-6.7582***	-8.1033***	-9.5491***	-10.3103***
Wald	0.6923	0.6628	4.7631*	10.8401***	18.2978***	47.3587***	67.4179***	94.5174***	116.1581***
ADF	-12.8776***	-9.6660***	-8.8339***	-7.7931***	-6.2598***	-3.8412***	-2.8888***	-2.5564**	-1.3132
R2	0.9930	0.9831	0.9332	0.8683	0.8070	0.5974	0.4505	0.3447	0.0538

AED									
a	0.0014	0.0022	0.0370*	0.0890***	0.1453***	0.3553***	0.5154***	0.6444***	1.2283***
Se a	0.0017	0.0050	0.0195	0.0302	0.0377	0.0565	0.0692	0.0744	0.1376
β	0.9992***	0.9989***	0.9798***	0.9513***	0.9205***	0.8051***	0.7168***	0.6460***	0.3253***
Se β	0.0009	0.0028	0.0108	0.0167	0.0208	0.0313	0.0384	0.0413	0.0743
t β=1	-0.8551	-0.4116	-1.8699*	-2.9174***	-3.8139***	-6.2277***	-7.3767***	-8.5695***	-9.0828***
Wald	1.0587	0.4476	3.7524	8.9570**	15.3838***	40.6853***	56.4899***	77.3254***	91.3968***
ADF	-12.9010***	-9.6545***	-8.8173***	-7.8230***	-6.2993***	-3.8887***	-2.9691***	-2.6633***	-1.3647
R2	0.9930	0.9831	0.9329	0.8675	0.8058	0.6014	0.4665	0.3714	0.0742
BRL									
a		0.0033	0.0270**	0.0599***	0.0969***	0.1975***	0.2845***	0.3989***	0.4592***
Se a		0.0033	0.0127	0.0178	0.0206	0.0244	0.0298	0.0335	0.0374
β		0.9957***	0.9700***	0.9347***	0.8967***	0.7947***	0.7080***	0.6005***	0.4891***
Se β		0.0026	0.0099	0.0138	0.0160	0.0186	0.0224	0.0247	0.0255
t β=1		-1.6646*	-3.0196***	-4.7147***	-6.4591***	-11.0502***	-13.0439***	-16.1997***	-20.0646***
Wald		17.0539***	33.6982***	77.4726***	135.6450***	377.2750***	534.0811***	787.0964***	2456.3520***
ADF		-9.7567***	-7.6149***	-6.2874***	-5.4800***	-4.1932***	-3.6713***	-3.1857***	-2.5265**
R2		0.9917	0.9653	0.9402	0.9181	0.8614	0.7789	0.6839	0.6056
CLP									
a		0.0002	0.0543	0.1606	0.3308**	0.7605***	0.9443***	1.0328***	1.2624***
Se a		0.0256	0.0926	0.1348	0.1675	0.2133	0.2426	0.2568	0.3833
β		0.9999***	0.9915***	0.9752***	0.9495***	0.8847***	0.8561***	0.8416***	0.8022***
Se β		0.0038	0.0136	0.0198	0.0246	0.0313	0.0355	0.0376	0.0558
t β=1		-0.0266	-0.6286	-1.2537	-2.0546**	-3.6884***	-4.0496***	-4.2153***	-3.5444***
Wald		0.9368	4.8374*	11.4704***	20.3473***	55.3051***	89.9085***	134.5693***	276.5088***
ADF		-8.8923***	-6.4564***	-6.0098***	-5.1947***	-3.8955***	-3.3583***	-3.0000***	-2.5148**
R2		0.9832	0.9405	0.8914	0.8420	0.7313	0.6723	0.6459	0.4585
CNY									
a		-0.0078	-0.0279	-0.0483	-0.0584	-0.0521	-0.0854	-0.1410	0.1146
Se a		0.0053	0.0200	0.0324	0.0424	0.0686	0.0849	0.0992	0.1435
β		1.0032***	1.0114***	1.0200***	1.0245***	1.0239***	1.0388***	1.0624***	0.9418***
Se β		0.0021	0.0079	0.0128	0.0168	0.0272	0.0337	0.0394	0.0574
t β=1		1.5272	1.4450	1.5589	1.4628	0.8790	1.1513	1.5826	-1.0132
Wald		3.1015	2.6789	3.4300	3.8311	4.5255	7.4257**	10.6281***	16.6940***
ADF		-8.8912***	-6.9608***	-5.8351***	-4.6859***	-3.0641***	-2.7105***	-2.5022**	-1.8764*

R2		0.9936	0.9742	0.9453	0.9145	0.8140	0.7535	0.7045	0.5312
COP									
a		0.0164	0.1388	0.3095**	0.4908***	0.8955***	1.2235***	1.5043***	1.6196***
Se a		0.0254	0.0918	0.1351	0.1590	0.1856	0.2101	0.2372	0.3338
β		0.9979***	0.9823***	0.9606***	0.9376***	0.8857***	0.8433***	0.8068***	0.7833***
Se β		0.0031	0.0112	0.0165	0.0194	0.0226	0.0255	0.0288	0.0402
t β=1		-0.6788	-1.5754	-2.3888**	-3.2173***	-5.0541***	-6.1327***	-6.7096***	-5.3930***
Wald		2.6954	10.3027***	24.2152***	44.1176***	128.3093***	226.8997***	320.3254***	755.6698***
ADF		-8.8770***	-7.2627***	-6.1194***	-4.7524***	-3.7425***	-3.3364***	-2.9094***	-2.3753**
R2		0.9887	0.9576	0.9214	0.8943	0.8398	0.7947	0.7421	0.6121
CZK									
a	0.0000	0.0029	0.0169	0.0295	0.0438	0.1004**	0.2124***	0.2418***	1.1919***
Se a	0.0015	0.0044	0.0179	0.0264	0.0324	0.0451	0.0549	0.0621	0.1409
β	1.0000***	0.9992***	0.9950***	0.9910***	0.9866***	0.9696***	0.9363***	0.9274***	0.6430***
Se β	0.0004	0.0012	0.0048	0.0071	0.0086	0.0120	0.0147	0.0165	0.0395
t β=1	-0.0519	-0.7123	-1.0501	-1.2764	-1.5514	-2.5286**	-4.3423***	-4.3904***	-9.0408***
Wald	0.2967	0.8872	3.3893	6.8910**	10.6547***	25.3378***	64.3497***	69.5067***	231.4904***
ADF	-14.3642***	-11.2426***	-9.1172***	-7.4770***	-6.0939***	-4.8049***	-3.6430***	-3.6780***	-1.7227*
R2	0.9987	0.9969	0.9870	0.9762	0.9660	0.9375	0.9111	0.8847	0.5278
HUF									
a	0.0056	0.0245	0.2463***	0.5022***	0.6852***	1.1498***	1.6971***		5.0994***
Se a	0.0068	0.0207	0.0803	0.1157	0.1339	0.1674	0.1986		0.4492
β	0.9991***	0.9957***	0.9575***	0.9134***	0.8818***	0.8016***	0.7079***		0.1231
Se β	0.0012	0.0035	0.0136	0.0196	0.0227	0.0283	0.0335		0.0759
t β=1	-0.7920	-1.2329	-3.1209***	-4.4136***	-5.2089***	-7.0111***	-8.7189***		-11.5470***
Wald	3.8124	10.3292***	19.7682***	38.1567***	56.6241***	116.4671***	172.5091***		356.1801***
ADF	-14.0703***	-11.2033***	-9.3729***	-7.9817***	-6.8531***	-5.2486***	-4.0955***		-2.1504**
R2	0.9887	0.9722	0.8991	0.8237	0.7742	0.6552	0.5224		0.0106
IDR									
a	0.1119	0.2328***	0.4910***	1.2475***	2.0879***	4.5617***	8.6916***	9.9088***	
Se a	0.0713	0.0830	0.0999	0.1535	0.1927	0.2386	0.3620	0.2010	
β	0.9887***	0.9760***	0.9488***	0.8698***	0.7822***	0.5250***	0.0970***	-0.0290	
Se β	0.0074	0.0086	0.0104	0.0160	0.0201	0.0249	0.0374	0.0209	
t β=1	-1.5257	-2.7774***	-4.9040***	-8.1191***	-10.8225***	-19.1012***	-24.1174***	-49.2488***	
Wald	9.5115***	10.1142***	24.2618***	66.0723***	117.3559***	365.5660***	615.6370***	2429.4700***	

ADF	-6.8739***	-7.4922***	-9.0204***	-10.0337***	-7.9780***	-4.5976***	-4.5075***	-4.4158***	
R2	0.9559	0.9204	0.9325	0.8496	0.7631	0.4886	0.0116	0.0050	
INR									
a	0.0039	0.0139	0.1733***	0.3705***	0.5365***	1.0150***	1.3641***	1.5971***	
Se a	0.0046	0.0138	0.0548	0.0843	0.1029	0.1465	0.1773	0.1932	
β	0.9991***	0.9967***	0.9596***	0.9138***	0.8754***	0.7648***	0.6842***	0.6305***	
Se β	0.0011	0.0032	0.0127	0.0195	0.0237	0.0338	0.0409	0.0445	
t β=1	-0.8234	-1.0468	-3.1908***	-4.4278***	-5.2485***	-6.9610***	-7.7245***	-8.3015***	
Wald	3.3789	4.4620	11.9774***	21.7420***	29.9763***	50.7904***	62.4482***	72.7670***	
ADF	-13.7733***	-10.1163***	-8.7411***	-7.2078***	-5.8175***	-4.1141***	-3.6200***	-3.3543***	
R2	0.9908	0.9779	0.9105	0.8251	0.7550	0.5516	0.4085	0.3130	
MAD									
a	0.0024	-0.0059	-0.0067	-0.0070	0.0040	0.0596	0.0320	0.0569	0.5183***
Se a	0.0025	0.0078	0.0280	0.0432	0.0547	0.0780	0.0925	0.1117	0.1984
β	0.9991***	1.0020***	1.0012***	0.9998***	0.9943***	0.9696***	0.9760***	0.9627***	0.7752***
Se β	0.0010	0.0029	0.0105	0.0161	0.0204	0.0290	0.0343	0.0413	0.0724
t β=1	-0.9339	0.6889	0.1117	-0.0117	-0.2815	-1.0484	-0.6987	-0.9015	-3.1061***
Wald	0.8899	3.9311	10.3399***	20.0714***	30.1464***	62.3287***	102.7779***	139.1504***	329.7045***
ADF	-10.0172***	-8.7198***	-6.7177***	-5.7354***	-4.9636***	-3.1893***	-2.8488***	-2.5879***	-1.9052*
R2	0.9959	0.9899	0.9641	0.9291	0.8943	0.7934	0.7425	0.6659	0.3227
MXN									
a		-0.0065	0.0050	0.0314	0.0546	0.1719**	0.4180***	0.6192***	3.3622***
Se a		0.0062	0.0232	0.0364	0.0455	0.0711	0.1018	0.1134	0.1957
β		1.0018***	0.9967***	0.9864***	0.9772***	0.9335***	0.8471***	0.7754***	-0.1105
Se β		0.0021	0.0080	0.0126	0.0157	0.0244	0.0346	0.0386	0.0634
t β=1		0.8650	-0.4066	-1.0846	-1.4517	-2.7226***	-4.4134***	-5.8222***	-17.5226***
Wald		10.7889***	9.6629***	14.0008***	19.3274***	35.0807***	53.8957***	78.6061***	716.9326***
ADF		-10.6058***	-9.0949***	-7.4892***	-6.1962***	-4.2934***	-3.1242***	-2.8080***	-3.3014***
R2		0.9901	0.9637	0.9277	0.8944	0.7705	0.5989	0.4947	0.0118
MYR									
a	0.0011	-0.0036	-0.0104	-0.0122	-0.0080	0.0146	0.0106	-0.0181	
Se a	0.0015	0.0044	0.0150	0.0233	0.0306	0.0477	0.0537	0.0583	
β	0.9994***	1.0019***	1.0044***	1.0037***	0.9997***	0.9827***	0.9804***	0.9919***	
Se β	0.0008	0.0025	0.0084	0.0131	0.0172	0.0267	0.0300	0.0325	
t β=1	-0.7720	0.7580	0.5237	0.2796	-0.0153	-0.6464	-0.6546	-0.2489	

Wald	0.8668	1.3284	4.2463	8.3927**	10.9954***	18.1565***	34.8021***	55.1839***	
ADF	-10.2856***	-8.8191***	-7.0918***	-6.5820***	-5.1897***	-3.3945***	-2.8267***	-3.1506***	
R2	0.9967	0.9926	0.9752	0.9501	0.9214	0.8356	0.7885	0.7691	
PHP									
a	0.0015	-0.0002	0.0741**	0.1993***	0.3420***	0.8376***	0.3787***	1.4538***	
Se a	0.0030	0.0089	0.0292	0.0463	0.0588	0.0888	0.1156	0.1139	
β	0.9997***	0.9999***	0.9825***	0.9533***	0.9202***	0.8058***	0.9075***	0.6635***	
Se β	0.0007	0.0020	0.0067	0.0107	0.0135	0.0204	0.0263	0.0260	
t β=1	-0.4689	-0.0503	-2.5982***	-4.3717***	-5.8900***	-9.5191***	-3.5122***	-12.9360***	
Wald	1.1052	3.5782	8.6692**	21.2619***	37.1304***	93.9934***	56.7745***	180.3056***	
ADF	-13.3705***	-10.1802***	-8.7678***	-7.7854***	-6.0960***	-4.3511***	-3.7372***	-2.7259***	
R2	0.9959	0.9902	0.9719	0.9408	0.9060	0.7809	0.7491	0.6118	
PKR									
a		0.0361**	0.2212***	0.4556***	0.6675***	1.2687***			
Se a		0.0180	0.0602	0.0891	0.1122	0.1536			
β		0.9924***	0.9538***	0.9051***	0.8611***	0.7367***			
Se β		0.0037	0.0124	0.0184	0.0232	0.0317			
t β=1		-2.0460**	-3.7130***	-5.1530***	-5.9945***	-8.3156***			
Wald		7.6249**	16.0552***	28.9587***	38.8030***	73.3042***			
ADF		-8.7279***	-6.7897***	-5.9164***	-4.7875***	-3.0224***			
R2		0.9831	0.9434	0.8899	0.8294	0.6513			
PLZ									
a	0.0010	0.0029	0.0322*	0.0749**	0.1098***	0.2485***	0.3939***	0.4784***	1.0148***
Se a	0.0017	0.0051	0.0189	0.0296	0.0360	0.0512	0.0612	0.0664	0.0729
β	0.9995***	0.9980***	0.9793***	0.9524***	0.9304***	0.8445***	0.7547***	0.7018***	0.3522***
Se β	0.0010	0.0030	0.0112	0.0175	0.0212	0.0301	0.0359	0.0389	0.0434
t β=1	-0.5351	-0.6593	-1.8518*	-2.7232***	-3.2807***	-5.1729***	-6.8356***	-7.6717***	-14.9359***
Wald	0.4460	1.6803	6.3115**	12.4464***	18.1580***	40.0732***	67.8139***	87.1865***	384.5890***
ADF	-10.7334***	-8.9869***	-7.3095***	-6.0173***	-4.9858***	-3.5355***	-2.7988***	-2.4724**	-2.2092**
R2	0.9942	0.9859	0.9464	0.8908	0.8479	0.7063	0.5837	0.5182	0.2153
RUR									
a	0.0142	-0.0286	0.1716	0.6021***	0.9633***	2.0404***	3.3702***	3.9715***	
Se a	0.0099	0.0301	0.1050	0.1676	0.1963	0.2167	0.2261	0.2086	
β	0.9964***	1.0071***	0.9550***	0.8437***	0.7503***	0.4729***	0.1322**	-0.0217	
Se β	0.0025	0.0077	0.0269	0.0430	0.0503	0.0554	0.0577	0.0531	

t β=1	-1.4253	0.9227	-1.6731*	-3.6385***	-4.9683***	-9.5154***	-15.0451***	-19.2301***	
Wald	2.0523	5.7034*	11.3737***	27.0419***	47.5782***	151.8289***	326.5188***	540.6915***	
ADF	-9.1554***	-9.9810***	-7.4307***	-6.2749***	-5.3469***	-3.9906***	-3.4112***	-3.3539***	
R2	0.9712	0.9332	0.7704	0.5515	0.4257	0.1872	0.0172	0.0004	
THB									
a	0.0016	0.0017	0.0745*	0.2159***	0.3962***	1.0033***	0.4822***	1.7313***	
Se a	0.0032	0.0098	0.0392	0.0637	0.0836	0.1231	0.1203	0.1648	
β	0.9996***	0.9995***	0.9816***	0.9471***	0.9032***	0.7560***	0.8780***	0.5785***	
Se β	0.0008	0.0024	0.0095	0.0155	0.0203	0.0299	0.0291	0.0399	
t β=1	-0.5188	-0.2130	-1.9279*	-3.4182***	-4.7631***	-8.1694***	-4.1945***	-10.5632***	
Wald	0.3873	1.3869	4.2108	12.1140***	23.0207***	66.8168***	47.7070***	113.3533***	
ADF	-11.5413***	-10.2572***	-8.1837***	-6.6685***	-4.9353***	-3.1114***	-3.1679***	-2.9733***	
R2	0.9946	0.9874	0.9456	0.8807	0.8073	0.5929	0.6945	0.3360	
TRL									
a	0.0676***	0.0626***	0.0385***	0.0351***	0.0327***	0.0255*	0.0847***	0.0462**	1.2085***
Se a	0.0099	0.0102	0.0092	0.0101	0.0110	0.0137	0.0221	0.0219	0.0521
β	0.9444***	0.9466***	0.9692***	0.9628***	0.9555***	0.9322***	0.8295***	0.8388***	-0.2400
Se β	0.0118	0.0121	0.0104	0.0115	0.0126	0.0156	0.0249	0.0240	0.0467
t β=1	-4.7155***	-4.4110***	-2.9566***	-3.2343***	-3.5478***	-4.3567***	-6.8375***	-6.7225***	-26.5504***
Wald	46.8755***	38.0431***	18.1659***	14.3130***	13.6773***	20.8048***	56.0818***	65.6495***	1734.1180***
ADF	-3.0450***	-3.1842***	-3.8276***	-3.6765***	-3.7146***	-3.3386***	-2.9267***	-2.8412***	-2.4285**
R2	0.9395	0.9363	0.9521	0.9422	0.9313	0.8952	0.7376	0.7499	0.0967
TWD									
a		-0.0054	0.0347	0.1074*	0.2044***	0.5169***	0.4660***	1.2784***	1.1928***
Se a		0.0097	0.0369	0.0582	0.0745	0.1125	0.1397	0.1681	0.3253
β		1.0014***	0.9916***	0.9737***	0.9498***	0.8724***	0.8847***	0.6822***	0.6988***
Se β		0.0024	0.0093	0.0147	0.0188	0.0284	0.0352	0.0424	0.0817
t β=1		0.5895	-0.8996	-1.7902*	-2.6763***	-4.5009***	-3.2778***	-7.4861***	-3.6866***
Wald		1.5672	2.9727	7.2459**	13.5566***	33.2107***	16.2985***	78.3748***	14.3141***
ADF		-11.6196***	-9.0916***	-7.8368***	-6.3018***	-4.1282***	-3.4543***	-2.7192***	-1.3232
R2		0.9871	0.9505	0.8994	0.8444	0.6843	0.6122	0.3828	0.2346
ZAR									
a	0.0023	0.0079	0.0630***	0.1609***	0.2506***	0.5556***	1.0882***	1.2098***	3.5608***
Se a	0.0024	0.0071	0.0236	0.0364	0.0436	0.0612	0.0845	0.0815	0.1283
β	0.9992***	0.9964***	0.9733***	0.9331***	0.8965***	0.7729***	0.5624***	0.5110***	-0.3809

Se β	0.0009	0.0029	0.0095	0.0147	0.0175	0.0245	0.0333	0.0323	0.0488
t β=1	-0.8452	-1.2425	-2.8085***	-4.5672***	-5.9081***	-9.2818***	-13.1246***	-15.1354***	-28.2852***
Wald	4.2499	6.2014**	10.8599***	23.8982***	38.4592***	91.3360***	183.5436***	240.1844***	901.7290***
ADF	-13.0110***	-11.0426***	-9.1769***	-7.3542***	-6.4629***	-4.6431***	-3.2254***	-2.9998***	-2.8418***
R2	0.9922	0.9811	0.9462	0.8935	0.8505	0.6949	0.4095	0.3745	0.1955
Mean									
a	0.0092	0.0111	0.0626	0.1552	0.2514	0.5426	0.7675	0.9717	1.1829
Se a	0.0055	0.0110	0.0329	0.0501	0.0616	0.0831	0.0981	0.0987	0.1642
β	0.9966	0.9972	0.9852	0.9639	0.9418	0.8705	0.8199	0.7586	0.5253
se β	0.0016	0.0031	0.0099	0.0149	0.0183	0.0255	0.0306	0.0338	0.0583
t β=1	-0.1708	-0.0530	-0.2291	-0.3677	-0.4906	-0.8241	-0.9260	-1.3617	-1.8864
Wald	3.6145	4.6961	7.8823	16.2357	26.1906	66.0258	105.4878	202.6224	433.8629
R2	0.9902	0.9826	0.9496	0.9030	0.8613	0.7386	0.6472	0.5633	0.3266

We use the Fully Modified OLS (FMOLS) estimator. For each economy we test for different time forward rates with different time to maturity. We report the values and standard errors of α and β, R squares of the equation, also the t statistics of testing β=1, the Wald statistics of joint test for α=1 and β=1, and the test statistics of unit root test (ADF) for the residuals of the equation. We calculate the mean of these statistics across the economies. Empty entries due to missing data in forward rates. Standard currency short codes are employed.

* Significance at 10%

** Significance at 5%

*** Significance at 1%

Table 3.6.2: Simple efficiency hypothesis FMOLS test equation for USD exchange rates

	TN	1W	1M	2M	3M	6M	9M	1Y	2Y
AUD									
a	0.0001	-0.0007	-0.0021	-0.0031	-0.0042	-0.0035	-0.0138	0.0002	0.0017
Se a	0.0002	0.0007	0.0026	0.0042	0.0054	0.0086	0.0114	0.0138	0.0236
β	0.9997***	-1.0004	-0.9976	-0.9908	-0.9847	-0.9540	-0.9304	-0.8872	-0.4583
Se β	0.0006	0.0018	0.0070	0.0111	0.0144	0.0227	0.0291	0.0351	0.0857
t β=1	-0.4812	-1136.5212***	-283.6479***	-178.8950***	-137.4584***	-86.0626***	-66.3493***	-53.7880***	-17.0241***
Wald	0.4781	3773101.0000***	245436.0000***	99841.2600***	60350.7700***	25647.6900***	15817.7000***	11860.4500***	2191.5240***
ADF	-13.5342***	-9.7691***	-7.9239***	-7.1877***	-5.9778***	-3.9166***	-3.2343***	-2.7743***	-1.8642*
R2	0.9971	0.9929	0.9717	0.9415	0.9102	0.8022	0.7206	0.6096	0.1059
CAD									
a	-0.0000	-0.0001	-0.0002	-0.0002	-0.0005	0.0003	-0.0015	-0.0002	0.0216***
Se a	0.0001	0.0004	0.0016	0.0024	0.0031	0.0048	0.0061	0.0071	0.0070
β	0.9999***	0.9996***	0.9961***	0.9906***	0.9849***	0.9610***	0.9306***	0.9212***	0.3042***
Se β	0.0005	0.0016	0.0058	0.0086	0.0110	0.0171	0.0217	0.0249	0.0499
t β=1	-0.1913	-0.2623	-0.6782	-1.0940	-1.3663	-2.2810**	-3.1915***	-3.1686***	-13.9376***
Wald	0.0986	0.4655	1.6656	3.8249	6.2248**	14.2633***	32.6224***	31.0739***	356.6592***
ADF	-15.8795***	-9.7596***	-8.5909***	-8.0309***	-6.5246***	-4.3168***	-3.5272***	-3.0759***	-2.4220**
R2	0.9977	0.9944	0.9809	0.9639	0.9452	0.8782	0.8218	0.7700	0.1329
CHF									
a	-0.0000	0.0002	0.0010	0.0013	0.0013	0.0016	0.0009	0.0039	-0.0489
Se a	0.0002	0.0005	0.0020	0.0031	0.0037	0.0054	0.0066	0.0077	0.0091
β	0.9997***	1.0002***	0.9968***	0.9931***	0.9904***	0.9814***	0.9649***	0.9573***	1.0172***
Se β	0.0005	0.0016	0.0066	0.0101	0.0123	0.0180	0.0224	0.0260	0.0695
t β=1	-0.4954	0.1090	-0.4910	-0.6801	-0.7734	-1.0328	-1.5634	-1.6416	0.2476
Wald	0.9871	0.5837	0.2799	0.4916	0.7584	1.6941	5.1395*	4.2500	66.7246***
ADF	-13.5557***	-10.7310***	-9.3707***	-7.4653***	-6.3083***	-4.5248***	-3.6371***	-3.1701***	-2.1345**
R2	0.9976	0.9943	0.9755	0.9529	0.9335	0.8739	0.8232	0.7672	0.4690

XEU									
a	-0.0001	-0.0002	-0.0025	-0.0062	-0.0097	-0.0215	-0.0332	-0.0449	-0.2507
Se a	0.0002	0.0005	0.0019	0.0030	0.0036	0.0052	0.0064	0.0074	0.0201
β	0.9996***	0.9988***	0.9873***	0.9706***	0.9559***	0.9048***	0.8535***	0.8007***	0.1776***
Se β	0.0007	0.0020	0.0078	0.0122	0.0150	0.0216	0.0264	0.0304	0.0668
t β=1	-0.5553	-0.6181	-1.6347	-2.4089**	-2.9417***	-4.4066***	-5.5492***	-6.5619***	-12.3199***
Wald	0.3473	0.3828	2.7074	6.0101**	9.2148**	21.0683***	33.4829***	46.5622***	156.0804***
ADF	-12.6065***	-9.9070***	-8.3444***	-6.7076***	-5.4209***	-3.8461***	-3.0442***	-2.7593***	-2.3836**
R2	0.9969	0.9922	0.9669	0.9318	0.9017	0.8071	0.7203	0.6365	0.0277
GBP									
a	-0.0002	-0.0010	-0.0120	-0.0280	-0.0452	-0.1088	-0.1600	-0.2031	-0.3843
Se a	0.0005	0.0014	0.0055	0.0085	0.0106	0.0158	0.0195	0.0209	0.0400
β	0.9994***	0.9982***	0.9771***	0.9465***	0.9137***	0.7907***	0.6905***	0.6070***	0.2632***
Se β	0.0009	0.0028	0.0107	0.0166	0.0206	0.0310	0.0382	0.0412	0.0715
t β=1	-0.6044	-0.6362	-2.1286**	-3.2310***	-4.1886***	-6.7591***	-8.1043***	-9.5497***	-10.3093***
Wald	0.7381	0.6403	4.7478*	10.8248***	18.2876***	47.3630***	67.4301***	94.5220***	116.1469***
ADF	-12.9120***	-11.0602***	-8.8678***	-7.7821***	-6.2534***	-3.8381***	-2.8911***	-2.5590**	-1.3123
R2	0.9930	0.9831	0.9332	0.8683	0.8070	0.5973	0.4504	0.3447	0.0538
HKD									
a	0.0117***	-0.0222	0.1530***	0.8541***	1.6144***	2.2310***	2.2040***	2.1310***	2.3167***
Se a	0.0035	0.0135	0.0590	0.0865	0.0856	0.0469	0.0285	0.0211	0.0621
β	0.9943***	1.0108***	0.9255***	0.5836***	0.2129***	-0.0877	-0.0744	-0.0389	-0.1302
Se β	0.0017	0.0066	0.0288	0.0422	0.0418	0.0228	0.0139	0.0103	0.0304
t β=1	-3.3131***	1.6508*	-2.5898***	-9.8743***	-18.8502***	-47.6137***	-77.4360***	-101.2196***	-37.1544***
Wald	17.6883***	8.5342**	7.8204**	98.4550***	355.7213***	2272.6340***	6027.6030***	10437.4900***	4010.4620***
ADF	-14.0938***	-10.5181***	-8.0093***	-5.4961***	-4.0341***	-3.8319***	-3.6765***	-3.8024***	-2.9784***
R2	0.9780	0.9385	0.6406	0.2601	0.0457	0.0303	0.0644	0.0322	0.0646
ILS									
a	0.0011	0.0033	0.0384**	0.0925***	0.1417***	0.3510***	0.5197***	0.6046***	0.8192***
Se a	0.0017	0.0053	0.0195	0.0293	0.0356	0.0510	0.0603	0.0643	0.0658
β	0.9992***	0.9974***	0.9707***	0.9300***	0.8929***	0.7381***	0.6134***	0.5491***	0.3766***
Se β	0.0012	0.0038	0.0141	0.0211	0.0256	0.0366	0.0432	0.0460	0.0464
t β=1	-0.6353	-0.6966	-2.0828**	-3.3233***	-4.1848***	-7.1474***	-8.9409***	-9.8009***	-13.4335***
Wald	0.4058	1.2949	7.0159**	16.3345***	25.4392***	64.5739***	98.9655***	124.3897***	375.6740***
ADF	-10.4153***	-7.8235***	-6.5934***	-5.7682***	-4.2590***	-2.6114***	-2.1565**	-1.9748**	-2.3558**

R2	0.9932	0.9823	0.9329	0.8680	0.8114	0.5785	0.4168	0.3453	0.2148
JPY									
a	0.0028	-0.0014	0.0357	0.0985*	0.1729**	0.3071***	0.3561***	0.3512**	0.0124
Se a	0.0031	0.0095	0.0386	0.0595	0.0770	0.1160	0.1319	0.1647	0.3657
β	0.9994***	1.0004***	0.9927***	0.9795***	0.9638***	0.9354***	0.9238***	0.9266***	0.9918***
Se β	0.0007	0.0020	0.0083	0.0127	0.0165	0.0249	0.0283	0.0354	0.0798
t β=1	-0.9356	0.1992	-0.8806	-1.6090	-2.1948**	-2.5990***	-2.6878***	-2.0748**	-0.1024
Wald	2.3379	2.0225	2.5373	4.7105*	7.2757**	9.3037***	7.3974**	8.5561**	10.4543***
ADF	-14.3820***	-10.2362***	-8.1728***	-7.2090***	-5.8888***	-3.8635***	-3.8216***	-3.1559***	-1.6676*
R2	0.9960	0.9904	0.9611	0.9231	0.8793	0.7671	0.7272	0.6237	0.3936
NOK									
a	0.0003	0.0029	0.0286*	0.0660***	0.1041***	0.2201***	0.3254***	0.4239***	1.7065***
Se a	0.0014	0.0041	0.0160	0.0248	0.0319	0.0467	0.0570	0.0636	0.1322
β	0.9999***	0.9983***	0.9844***	0.9641***	0.9433***	0.8803***	0.8207***	0.7699***	0.0392
Se β	0.0007	0.0021	0.0083	0.0129	0.0166	0.0242	0.0294	0.0328	0.0725
t β=1	-0.1909	-0.7851	-1.8821*	-2.7851***	-3.4265***	-4.9469***	-6.0915***	-7.0163***	-13.2592***
Wald	0.1428	1.4208	4.5151	9.7413***	15.0016***	31.6715***	55.3359***	65.1448***	255.1698***
ADF	-15.0295***	-9.5921***	-8.0691***	-7.5835***	-6.0304***	-4.2557***	-3.3272***	-3.0041***	-2.6625***
R2	0.9956	0.9895	0.9598	0.9183	0.8743	0.7529	0.6606	0.5726	0.0011
NZD									
a	0.0002	-0.0005	0.0004	0.0023	0.0045	0.0226*	0.0252	0.0702***	0.3401***
Se a	0.0003	0.0010	0.0039	0.0061	0.0078	0.0127	0.0168	0.0203	0.0381
β	-0.9997	-0.9998	-0.9932	-0.9832	-0.9726	-0.9191	-0.8800	-0.7939	0.0342
Se β	0.0006	0.0019	0.0075	0.0116	0.0147	0.0236	0.0304	0.0366	0.0867
t β=1	-3187.4572***	-1047.7808***	-264.6240***	-171.5147***	-134.0507***	-81.1966***	-61.8861***	-49.0395***	-11.1372***
Wald	63182323.0000***	6851117.0000***	453346.0000***	195181.1000***	122300.5000***	49299.6200***	30198.8300***	22043.8500***	10071.3500***
ADF	-15.2496***	-9.8554***	-8.4052***	-7.3056***	-6.0786***	-3.7944***	-3.1658***	-2.5372**	-1.6312*
R2	0.9965	0.9916	0.9678	0.9364	0.9040	0.7757	0.6774	0.5337	0.0006
SGD									
a	0.0000	-0.0002	0.0007	0.0018	0.0022	0.0018	-0.0230	0.0095	0.0049
Se a	0.0002	0.0006	0.0027	0.0044	0.0056	0.0083	0.0092	0.0130	0.0189
β	0.9998***	1.0007***	0.9992***	0.9974***	0.9968***	0.9988***	1.0403***	0.9816***	0.8461***
Se β	0.0005	0.0014	0.0060	0.0096	0.0123	0.0182	0.0201	0.0285	0.0482
t β=1	-0.4839	0.4913	-0.1268	-0.2748	-0.2602	-0.0637	2.0035**	-0.6452	-3.1937***

Wald	1.6844	0.7282	0.2822	0.3828	0.3772	0.3727	9.1181**	0.6125	219.8662***
ADF	-13.8162***	-10.6335***	-8.6901***	-7.1375***	-5.9120***	-4.2696***	-3.9311***	-3.4850***	-1.8595*
R2	0.9981	0.9954	0.9794	0.9569	0.9354	0.8757	0.8706	0.7417	0.5652
AED									
a	0.6092***	0.9913***	1.2550***	1.2749***	1.2887***	1.3027***	1.3037***	1.3026***	1.3018***
Se a	0.0351	0.0165	0.0075	0.0044	0.0030	0.0018	0.0014	0.0011	0.0010
β	0.5317***	0.2380***	0.0353***	0.0200***	0.0095***	-0.0013	-0.0021	-0.0013	-0.0007
Se β	0.0270	0.0127	0.0057	0.0034	0.0023	0.0014	0.0011	0.0008	0.0008
t β=1	-17.3587***	-60.1457***	-167.8483***	-292.0967***	-422.8578***	-713.8526***	-921.9265***	-1191.7628***	-1259.0592***
Wald	301.5244***	3620.9830***	28254.4500***	85624.1900***	179463.0000***	512508.9000***	856370.3000***	1429739.0000***	1609516.0000***
ADF	-8.4325***	-14.1234***	-11.3459***	-11.0920***	-10.9547***	-10.6005***	-10.2663***	-10.4449***	-7.7993***
R2	0.0554	0.1473	0.0330	0.0349	0.0153	0.0009	0.0039	0.0024	0.0013
BRL									
a		0.0027	0.0249***	0.0619***	0.1047***	0.2272***	0.3210***	0.3912***	0.4820***
Se a		0.0025	0.0090	0.0137	0.0175	0.0230	0.0265	0.0270	0.0291
β		0.9931***	0.9510***	0.8851***	0.8122***	0.6111***	0.4605***	0.3465***	0.1743***
Se β		0.0034	0.0123	0.0185	0.0233	0.0298	0.0336	0.0331	0.0315
t β=1		-2.0145**	-3.9930***	-6.2129***	-8.0562***	-13.0503***	-16.0447***	-19.7178***	-26.1904***
Wald		17.1716***	37.9711***	78.8747***	122.4765***	299.9464***	465.4917***	742.7979***	2133.0990***
ADF		-8.3947***	-6.4000***	-5.7412***	-4.5776***	-3.1766***	-2.7220***	-2.5363**	-2.1572**
R2		0.9853	0.9436	0.8819	0.8059	0.5848	0.3995	0.2861	0.1132
CLP									
a		0.0291	0.3223***	0.8439***	1.4680***	3.2328***	4.6885***	5.2832***	6.2384***
Se a		0.0328	0.1246	0.1861	0.2392	0.3034	0.3415	0.3532	0.3939
β		0.9953***	0.9481***	0.8643***	0.7642***	0.4816***	0.2488***	0.1536***	0.0004
Se β		0.0052	0.0199	0.0297	0.0381	0.0483	0.0543	0.0562	0.0624
t β=1		-0.9021	-2.6118***	-4.5704***	-6.1837***	-10.7271***	-13.8251***	-15.0722***	-16.0275***
Wald		1.8730	9.8677***	27.3531***	48.3793***	141.8844***	237.4127***	294.4967***	466.2828***
ADF		-8.1177***	-5.3654***	-4.8004***	-4.2843***	-3.0198***	-2.4711**	-2.0799**	-2.1275**
R2		0.9664	0.8683	0.7332	0.5849	0.2492	0.0691	0.0269	-0.0000
CNY									
a		-0.0067	-0.0307	-0.0586	-0.0852	-0.1356	-0.1497	-0.1386	0.3415***
Se a		0.0011	0.0038	0.0061	0.0081	0.0155	0.0225	0.0309	0.0769

β		1.0033***	1.0151***	1.0289***	1.0422***	1.0677***	1.0754***	1.0704***	0.8196***
Se β		0.0006	0.0019	0.0030	0.0040	0.0078	0.0113	0.0155	0.0395
t β=1		5.9437***	7.8926***	9.5502***	10.4580***	8.7100***	6.6795***	4.5333***	-4.5667***
Wald		35.3751***	67.8723***	98.5759***	115.5861***	76.5390***	44.6850***	21.2724***	29.7540***
ADF		-9.7120***	-7.5697***	-6.8080***	-5.9966***	-4.4117***	-3.3151***	-3.0084***	-2.0982**
R2		0.9997	0.9986	0.9969	0.9949	0.9832	0.9668	0.9401	0.6432
COP									
a		0.0314	0.3090***	0.7917***	1.3009***	2.5855***	3.5351***	3.7518***	4.2458***
Se a		0.0297	0.1131	0.1789	0.2257	0.2854	0.3183	0.3242	0.3713
β		0.9958***	0.9589***	0.8950***	0.8276***	0.6576***	0.5319***	0.5021***	0.4320***
Se β		0.0039	0.0148	0.0234	0.0295	0.0372	0.0415	0.0421	0.0479
t β=1		-1.0856	-2.7757***	-4.4873***	-5.8440***	-9.1936***	-11.2901***	-11.8140***	-11.8655***
Wald		3.9955	14.4555***	34.0139***	56.9693***	146.4882***	243.8317***	334.9830***	841.3440***
ADF		-7.9003***	-5.6919***	-5.2001***	-3.8194***	-2.6374***	-2.1988**	-2.1257**	-2.0078**
R2		0.9810	0.9214	0.8288	0.7364	0.5143	0.3715	0.3438	0.2519
CZK									
a	0.0001	0.0040	0.0299*	0.0630**	0.0936***	0.1985***	0.3175***	0.3566***	2.0116***
Se a	0.0014	0.0043	0.0180	0.0280	0.0348	0.0506	0.0612	0.0645	0.1367
β	1.0000***	0.9987***	0.9900***	0.9790***	0.9686***	0.9334***	0.8923***	0.8788***	0.3129***
Se β	0.0004	0.0013	0.0055	0.0086	0.0107	0.0156	0.0189	0.0198	0.0453
t β=1	-0.0375	-1.0055	-1.7968*	-2.4350**	-2.9319***	-4.2766***	-5.7097***	-6.1362***	-15.1620***
Wald	0.0014	1.7003	5.2629*	10.0788***	15.3592***	33.0165***	63.5964***	79.9227***	326.7667***
ADF	-13.5052***	-9.8707***	-8.7902***	-7.2618***	-5.6715***	-3.9773***	-3.0511***	-3.2210***	-2.1914**
R2	0.9984	0.9959	0.9820	0.9637	0.9469	0.8929	0.8503	0.8289	0.1643
HUF									
a	0.0034	0.0173	0.1693***	0.3837***	0.5781***	1.1868***	1.6876***	1.9252***	5.0763***
Se a	0.0050	0.0152	0.0615	0.0943	0.1154	0.1616	0.1900	0.1909	0.3673
β	0.9994***	0.9966***	0.9677***	0.9272***	0.8904***	0.7758***	0.6817***	0.6366***	0.0414
Se β	0.0009	0.0028	0.0114	0.0175	0.0214	0.0299	0.0350	0.0351	0.0685
t β=1	-0.6215	-1.2170	-2.8281***	-4.1667***	-5.1315***	-7.5116***	-9.0922***	-10.3522***	-14.0008***
Wald	3.6614	9.0861**	15.2497***	29.2330***	43.8094***	89.7351***	132.1756***	185.2012***	279.8635***
ADF	-13.0628***	-9.8849***	-8.6045***	-7.1713***	-5.7096***	-3.9615***	-3.1523***	-2.8151***	-1.9246*
R2	0.9927	0.9819	0.9275	0.8581	0.7983	0.6193	0.4872	0.4322	0.0015
IDR									
a	0.3541**	0.5529***	0.6643***	1.4546***	2.3416***	4.7627***	10.4459***	9.7810***	

Se a	0.1672	0.1725	0.1132	0.1593	0.1942	0.2236	0.2757	0.1515	
β	0.9595***	0.9376***	0.9247***	0.8375***	0.7398***	0.4744***	-0.1435	-0.0716	
Se β	0.0183	0.0189	0.0125	0.0175	0.0213	0.0245	0.0299	0.0165	
t β=1	-2.2118**	-3.3077***	-6.0450***	-9.2759***	-12.1937***	-21.4524***	-38.2113***	-64.8677***	
Wald	44.5532***	57.0176***	62.4482***	102.4072***	162.7976***	476.4150***	1791.5660***	4264.1240***	
ADF	-3.8748***	-4.2029***	-7.3082***	-9.1818***	-7.9509***	-5.4725***	-4.4069***	-6.1717***	
R2	0.8442	0.7964	0.9076	0.8152	0.7203	0.4429	0.0578	0.0425	
INR									
a	-0.0003	0.0218**	0.1572***	0.3172***	0.4761***	0.9282***	1.5503***	2.1927***	
Se a	0.0027	0.0086	0.0386	0.0622	0.0791	0.1136	0.1482	0.1714	
β	1.0001***	0.9941***	0.9584***	0.9162***	0.8743***	0.7557***	0.5930***	0.4255***	
Se β	0.0007	0.0022	0.0101	0.0163	0.0207	0.0296	0.0386	0.0446	
t β=1	0.1963	-2.6306***	-4.1200***	-5.1543***	-6.0817***	-8.2401***	-10.5361***	-12.8730***	
Wald	12.2975***	22.4087***	23.5154***	34.0427***	45.8495***	80.3922***	126.7797***	184.2659***	
ADF	-12.3272***	-9.4415***	-7.9756***	-6.2329***	-4.8827***	-3.1851***	-2.4390**	-1.6090	
R2	0.9955	0.9880	0.9393	0.8693	0.8028	0.6067	0.3633	0.1694	
MAD									
a	0.0041	0.0117	0.1562***	0.3602***	0.5254***	1.1302***	1.5545***	1.6390***	1.7861***
Se a	0.0042	0.0124	0.0480	0.0727	0.0861	0.1102	0.1240	0.1288	0.1191
β	0.9981***	0.9942***	0.9253***	0.8282***	0.7494***	0.4636***	0.2641***	0.2238***	0.1492***
Se β	0.0020	0.0058	0.0225	0.0341	0.0403	0.0514	0.0577	0.0598	0.0544
t β=1	-0.9710	-0.9866	-3.3132***	-5.0433***	-6.2122***	-10.4302***	-12.7561***	-12.9872***	-15.6356***
Wald	1.4156	3.7886	15.9527***	35.2608***	55.1648***	147.9562***	228.0052***	267.2788***	741.6160***
ADF	-10.7424***	-8.2542***	-6.7412***	-4.9821***	-4.2581***	-2.8243***	-2.3961**	-2.2341**	-2.4087**
R2	0.9830	0.9580	0.8240	0.6649	0.5504	0.2143	0.0687	0.0481	0.0294
MXN									
a		-0.0066	-0.0004	0.0237	0.0533	0.1935***	0.5179***	0.6038***	2.0141***
Se a		0.0054	0.0197	0.0320	0.0420	0.0672	0.0967	0.1023	0.1564
β		1.0022***	0.9981***	0.9862***	0.9722***	0.9090***	0.7726***	0.7328***	0.1882***
Se β		0.0023	0.0083	0.0134	0.0176	0.0279	0.0397	0.0419	0.0616
t β=1		0.9734	-0.2290	-1.0262	-1.5849	-3.2626***	-5.7307***	-6.3697***	-13.1778***
Wald		18.8858***	16.7495***	23.4948***	30.9693***	57.6730***	94.8473***	129.4498***	228.3096***
ADF		-9.5575***	-7.8587***	-7.2038***	-5.8214***	-4.0390***	-3.0623***	-2.9407***	-2.0620**
R2		0.9883	0.9619	0.9170	0.8701	0.7099	0.4868	0.4245	0.0373
MYR									

a	0.0774***	0.0758***	0.1480***	0.2218***	0.2428***	0.3893***	0.4540***	0.5771***	
Se a	0.0058	0.0065	0.0144	0.0195	0.0225	0.0280	0.0307	0.0312	
β	0.9339***	0.9350***	0.8728***	0.8094***	0.7902***	0.6642***	0.6076***	0.5033***	
Se β	0.0047	0.0053	0.0116	0.0157	0.0181	0.0222	0.0243	0.0245	
t β=1	-14.1705***	-12.3442***	-10.9556***	-12.1616***	-11.6143***	-15.0973***	-16.1547***	-20.2802***	
Wald	294.6921***	238.6900***	195.9375***	244.4565***	241.3266***	408.7303***	494.5018***	739.3583***	
ADF	-3.5234***	-3.7898***	-4.1936***	-4.4444***	-3.9451***	-2.7917***	-2.2992**	-2.1376**	
R2	0.9903	0.9853	0.9477	0.9034	0.8744	0.7725	0.6871	0.6043	
PHP									
a	0.0007	0.0075	0.0979***	0.2512***	0.4143***	0.9711***	0.7725***	1.8629***	
Se a	0.0026	0.0080	0.0233	0.0378	0.0481	0.0690	0.1038	0.0924	
β	0.9999***	0.9978***	0.9738***	0.9334***	0.8905***	0.7448***	0.7931***	0.5127***	
Se β	0.0007	0.0021	0.0061	0.0099	0.0125	0.0179	0.0267	0.0238	
t β=1	-0.2052	-1.0388	-4.3150***	-6.7526***	-8.7473***	-14.2411***	-7.7539***	-20.4600***	
Wald	3.5314	11.0020***	24.4779***	52.1562***	84.7707***	217.5302***	162.6223***	459.8111***	
ADF	-12.1079***	-10.3861***	-9.8650***	-9.4109***	-5.1186***	-3.8878***	-3.2700***	-2.2536**	
R2	0.9958	0.9895	0.9756	0.9463	0.9135	0.7949	0.6871	0.5246	
PKR									
a		0.0140***	0.0579***	0.1086***	0.1609***	0.3325***			
Se a		0.0039	0.0158	0.0245	0.0333	0.0551			
β		0.9965***	0.9861***	0.9741***	0.9617***	0.9213***			
Se β		0.0009	0.0037	0.0057	0.0078	0.0128			
t β=1		-3.8334***	-3.7914***	-4.5507***	-4.9411***	-6.1528***			
Wald		39.8177***	21.3353***	27.0875***	30.6874***	44.6147***			
ADF		-8.2234***	-5.2722***	-4.6304***	-3.5572***	-1.8203*			
R2		0.9990	0.9953	0.9897	0.9813	0.9445			
PLZ									
a	0.0006	0.0054	0.0486***	0.1113***	0.1675***	0.3616***	0.5166***	0.5825***	1.0719***
Se a	0.0014	0.0041	0.0150	0.0236	0.0289	0.0411	0.0464	0.0475	0.0644
β	0.9995***	0.9947***	0.9548***	0.8973***	0.8457***	0.6705***	0.5302***	0.4680***	0.0035
Se β	0.0012	0.0035	0.0128	0.0202	0.0246	0.0348	0.0392	0.0400	0.0569
t β=1	-0.3967	-1.5217	-3.5359***	-5.0935***	-6.2670***	-9.4598***	-11.9989***	-13.3168***	-17.5199***
Wald	0.4355	3.9973	16.0480***	32.1285***	48.5563***	106.4765***	172.3220***	218.7118***	346.3151***
ADF	-10.2896***	-8.8548***	-7.6500***	-5.9404***	-4.6164***	-2.9960***	-2.5909***	-2.3364**	-1.8908*
R2	0.9924	0.9809	0.9246	0.8422	0.7705	0.5288	0.3678	0.3116	-0.0000

RUR									
a	0.0004	0.0307**	0.2078***	0.4718***	0.7227***	1.5263***	2.1204***	2.3818***	
Se a	0.0045	0.0139	0.0504	0.0818	0.0994	0.1318	0.1482	0.1510	
β	0.9999***	0.9906***	0.9370***	0.8575***	0.7820***	0.5414***	0.3643***	0.2865***	
Se β	0.0014	0.0042	0.0150	0.0244	0.0296	0.0391	0.0439	0.0446	
t β=1	-0.0620	-2.2681**	-4.1914***	-5.8468***	-7.3743***	-11.7263***	-14.4857***	-15.9853***	
Wald	0.4129	10.5868***	23.8334***	42.1304***	65.5373***	156.2984***	234.0859***	286.6966***	
ADF	-9.0565***	-8.2985***	-7.2221***	-5.2781***	-4.1012***	-2.7015***	-2.0108**	-1.7177*	
R2	0.9913	0.9784	0.9099	0.8037	0.7083	0.3921	0.1983	0.1326	
THB									
a	0.0013	0.0071	0.0961***	0.2664***	0.4576***	1.0526***	0.6946***	1.8252***	
Se a	0.0025	0.0078	0.0329	0.0559	0.0742	0.1040	0.0992	0.1363	
β	0.9996***	0.9979***	0.9729***	0.9254***	0.8722***	0.7074***	0.8014***	0.4927***	
Se β	0.0007	0.0021	0.0091	0.0155	0.0205	0.0288	0.0273	0.0375	
t β=1	-0.5383	-0.9787	-2.9709***	-4.8196***	-6.2221***	-10.1746***	-7.2809***	-13.5179***	
Wald	0.3107	4.7468*	10.4014***	24.7463***	40.2503***	105.1955***	111.7793***	190.8736***	
ADF	-10.3348***	-10.3627***	-7.5445***	-6.1159***	-4.9173***	-3.0052***	-2.6919***	-2.8190***	
R2	0.9958	0.9896	0.9471	0.8726	0.7943	0.5766	0.6835	0.2923	
TRL									
a	0.0392***	0.0351***	0.0214***	0.0115	0.0021	-0.0272	-0.0388	-0.0746	0.3666***
Se a	0.0074	0.0075	0.0074	0.0077	0.0080	0.0091	0.0127	0.0135	0.0465
β	0.9538***	0.9561***	0.9797***	0.9784***	0.9755***	0.9649***	0.8973***	0.8959***	0.0830
Se β	0.0124	0.0128	0.0104	0.0111	0.0118	0.0141	0.0239	0.0224	0.0818
t β=1	-3.7126***	-3.4370***	-1.9500*	-1.9504*	-2.0766**	-2.4912**	-4.3042***	-4.6453***	-11.2058***
Wald	37.9729***	29.9582***	12.3375***	5.9455*	4.3407	17.7429***	50.8155***	80.9694***	416.3438***
ADF	-3.1958***	-3.1504***	-3.7258***	-3.7090***	-3.8835***	-3.1004***	-2.8427***	-2.6636***	-1.3663
R2	0.9342	0.9308	0.9530	0.9474	0.9409	0.9175	0.7819	0.7973	0.0041
TWD									
a		0.0141	0.1425***	0.3566***	0.5877***	1.2882***	1.4141***	2.4153***	3.5186***
Se a		0.0095	0.0358	0.0597	0.0768	0.1098	0.1336	0.1332	0.3313
β		0.9960***	0.9592***	0.8978***	0.8314***	0.6302***	0.5934***	0.3060***	-0.0212
Se β		0.0027	0.0103	0.0172	0.0222	0.0317	0.0385	0.0385	0.0966
t β=1		-1.4678	-3.9516***	-5.9384***	-7.6053***	-11.6760***	-10.5637***	-18.0384***	-10.5764***
Wald		3.3521	18.2403***	39.7794***	64.3118***	149.1210***	113.9154***	353.7586***	132.1732***
ADF		-10.7093***	-8.0127***	-6.3141***	-5.0164***	-3.3356***	-2.9162***	-1.8940*	-1.0696

R2		0.9834	0.9331	0.8438	0.7481	0.4748	0.3717	0.1317	0.0002
ZAR									
a	0.0015	0.0063	0.0465**	0.1225***	0.2034***	0.4679***	0.8990***	1.0282***	2.0991***
Se a	0.0018	0.0055	0.0185	0.0291	0.0370	0.0530	0.0714	0.0708	0.1043
β	0.9994***	0.9963***	0.9745***	0.9349***	0.8931***	0.7577***	0.5451***	0.4766***	-0.0325
Se β	0.0009	0.0027	0.0094	0.0147	0.0186	0.0265	0.0351	0.0349	0.0501
t β=1	-0.6201	-1.3639	-2.7231***	-4.4381***	-5.7452***	-9.1501***	-12.9656***	-14.9873***	-20.5972***
Wald	4.6468*	7.3366**	11.0961***	23.8821***	37.7096***	91.1651***	181.4951***	239.8593***	459.1531***
ADF	-15.3825***	-10.0708***	-8.2131***	-7.0841***	-5.8817***	-4.0949***	-2.8550***	-2.6133***	-2.2978**
R2	0.9928	0.9827	0.9482	0.8911	0.8324	0.6509	0.3717	0.3073	0.0017
Mean									
a	0.0461	0.0589	0.1343	0.2747	0.4221	0.8057	1.1935	1.3678	1.4622
Se a	0.0105	0.0131	0.0298	0.0455	0.0562	0.0735	0.0869	0.0875	0.1242
β	0.8903	0.8392	0.8104	0.7664	0.7223	0.6116	0.5153	0.4544	0.2338
se β	0.0033	0.0040	0.0105	0.0157	0.0192	0.0255	0.0308	0.0326	0.0585
t β=1	-27.5232	-13.2067	-4.5586	-4.3578	-4.8488	-6.5328	-8.2995	-10.4259	-13.3294
Wald	2632627.2235	342850.8337	23473.2604	12314.9346	11737.6588	19121.4863	30455.7951	49450.9911	68072.7972
R2	0.9459	0.9501	0.9068	0.8428	0.7851	0.6326	0.5076	0.4208	0.1366

We use the Fully Modified OLS (FMOLS) estimator. For each economy we test for different time forward rates with different time to maturity. We report the values and standard errors of α and β, R squares of the equation, also the t statistics of testing β=1, the Wald statistics of joint test for α=1 and β=1, and the test statistics of unit root test (ADF) for the residuals of the equation. We calculate the mean of these statistics across the economies. Empty entries due to missing data in forward rates. Standard currency short codes are employed.

* Significance at 10%

** Significance at 5%

*** Significance at 1%

Table 3.6.3: Simple efficiency hypothesis FMOLS test equation for EURO exchange rates

	TN	1W	1M	2M	3M	6M	9M	1Y	2Y
AUD									
a	0.0003	-0.0004	-0.3428	0.0047	0.0077	0.0116	0.0140	0.0330	0.1171*
Se a	0.0005	0.0015	0.0324	0.0079	0.0099	0.0151	0.0202	0.0259	0.0604
β	0.9994***	0.9994***	1.5946***	0.9733***	0.9594***	0.9297***	0.9040***	0.8472***	0.5543***
Se β	0.0011	0.0031	0.0631	0.0162	0.0202	0.0300	0.0395	0.0497	0.1084
t β=1	-0.5638	-0.2028	9.4176***	-1.6462*	-2.0118**	-2.3448**	-2.4274**	-3.0752***	-4.1099***
Wald	0.6514	4.1483	216.5395***	22.5291***	32.9335***	60.0148***	86.9449***	113.2649***	244.9696***
ADF	-17.0196***	-10.6450***	-2.7874***	-7.8191***	-6.8009***	-5.0666***	-3.9496***	-3.3350***	-1.3887
R2	0.9919	0.9805	0.5825	0.8837	0.8330	0.6921	0.5599	0.4185	0.0993
CAD									
a	0.0005	0.0020	0.0205***	0.0418***	0.0631***	0.1217***	0.1662***	0.2358***	0.2787***
Se a	0.0005	0.0016	0.0059	0.0086	0.0104	0.0148	0.0177	0.0203	0.0319
β	0.9986***	0.9941***	0.9422***	0.8825***	0.8235***	0.6623***	0.5394***	0.3556***	0.1966**
Se β	0.0014	0.0042	0.0152	0.0219	0.0266	0.0375	0.0444	0.0505	0.0781
t β=1	-0.9914	-1.4144	-3.8145***	-5.3630***	-6.6444***	-9.0080***	-10.3814***	-12.7575***	-10.2855***
Wald	0.9860	2.4877	16.4553***	32.3566***	49.2019***	90.9910***	125.6299***	188.1041***	192.3797***
ADF	-14.5904***	-11.9968***	-8.6453***	-7.4966***	-5.8480***	-4.2089***	-3.3473***	-2.7305***	-1.7879*
R2	0.9862	0.9660	0.8755	0.7740	0.6761	0.4199	0.2621	0.1073	0.0254
CHF									
a	0.0000	-0.0001	0.0005	-0.0006	-0.0008	-0.0070	-0.0078	-0.0090	-0.1148
Se a	0.0003	0.0008	0.0030	0.0044	0.0053	0.0076	0.0102	0.0130	0.0368
β	0.9998***	1.0006***	0.9988***	1.0004***	1.0004***	1.0127***	1.0112***	1.0091***	1.1939***
Se β	0.0007	0.0020	0.0073	0.0108	0.0131	0.0190	0.0255	0.0325	0.0918
t β=1	-0.3465	0.2956	-0.1662	0.0376	0.0308	0.6678	0.4375	0.2809	2.1126**
Wald	1.5953	0.5066	0.0284	0.1721	0.2693	1.8587	2.6860	4.2829	44.6193***
ADF	-13.7344***	-13.2748***	-9.6393***	-10.6047***	-6.8537***	-5.2168***	-3.8456***	-3.1112***	-1.3711
R2	0.9966	0.9918	0.9705	0.9490	0.9286	0.8713	0.7934	0.7084	0.4193
GBP									
a	-0.0001	-0.0001	-0.0011	-0.0022	-0.0035	-0.0100	-0.0162	-0.0261	-0.0995

Se a	0.0002	0.0007	0.0025	0.0038	0.0047	0.0067	0.0080	0.0095	0.0162
β	0.9996***	1.0000***	0.9968***	0.9926***	0.9877***	0.9659***	0.9455***	0.9120***	0.4948***
Se β	0.0006	0.0020	0.0072	0.0109	0.0134	0.0191	0.0232	0.0275	0.0586
t β=1	-0.6618	-0.0177	-0.4487	-0.6837	-0.9193	-1.7810*	-2.3520**	-3.2002***	-8.6242***
Wald	1.1508	0.2827	0.2123	0.4854	0.9281	3.3588	5.7559*	10.6724***	99.8114***
ADF	-13.3399***	-10.8341***	-8.7070***	-7.6192***	-6.4153***	-4.3566***	-3.6237***	-3.2713***	-1.6581*
R2	0.9970	0.9926	0.9728	0.9475	0.9247	0.8589	0.8032	0.7334	0.2308
HKD									
a	0.0008	0.0021	0.0261	0.0624**	0.0953***	0.2093***	0.3251***	0.4480***	1.9890***
Se a	0.0015	0.0044	0.0173	0.0273	0.0338	0.0492	0.0606	0.0703	0.1577
β	0.9997***	0.9991***	0.9885***	0.9727***	0.9585***	0.9088***	0.8581***	0.8040***	0.1561**
Se β	0.0007	0.0020	0.0077	0.0122	0.0151	0.0220	0.0271	0.0315	0.0675
t β=1	-0.5319	-0.4614	-1.4795	-2.2337**	-2.7423***	-4.1404***	-5.2319***	-6.2272***	-12.5080***
Wald	0.2831	0.2459	2.3853	5.5764*	8.7424**	19.9820***	31.5159***	43.7527***	173.3888***
ADF	-12.5936***	-9.8071***	-8.2615***	-6.6847***	-5.3932***	-3.8238***	-3.0294***	-2.7584***	-2.3455**
R2	0.9969	0.9923	0.9671	0.9315	0.9003	0.8024	0.7115	0.6216	0.0212
ILS									
a	0.0023	0.0086	0.0900**	0.2053***	0.2539***	0.4739***	0.6048***	0.7450***	0.4913***
Se a	0.0036	0.0106	0.0368	0.0542	0.0594	0.0719	0.0776	0.0831	0.0699
β	0.9986***	0.9946***	0.9450***	0.8749***	0.8450***	0.7112***	0.6305***	0.5440***	0.6807***
Se β	0.0021	0.0064	0.0220	0.0324	0.0355	0.0429	0.0461	0.0493	0.0408
t β=1	-0.6435	-0.8438	-2.4951**	-3.8610***	-4.3639***	-6.7356***	-8.0108***	-9.2578***	-7.8188***
Wald	0.4272	1.5852	8.2693**	18.5731***	25.4541***	61.0170***	96.1245***	144.7567***	479.7557***
ADF	-10.3856***	-7.8964***	-6.9430***	-5.8802***	-5.3687***	-3.9765***	-3.5563***	-3.1181***	-4.0942***
R2	0.9792	0.9513	0.8387	0.7064	0.6630	0.4750	0.3920	0.3026	0.5211
JPY									
a	0.0024	0.0094	0.1034**	0.2441***	0.3895***	0.7979***	1.0821***	1.3770***	1.7423***
Se a	0.0044	0.0133	0.0482	0.0750	0.0940	0.1378	0.1654	0.1856	0.4606
β	0.9995***	0.9981***	0.9789***	0.9501***	0.9203***	0.8361***	0.7776***	0.7173***	0.6394***
Se β	0.0009	0.0028	0.0100	0.0155	0.0195	0.0286	0.0343	0.0385	0.0944
t β=1	-0.5813	-0.6752	-2.1104**	-3.2109***	-4.0909***	-5.7335***	-6.4797***	-7.3341***	-3.8194***
Wald	1.0231	1.3690	5.7344*	12.3361***	19.6302***	36.5715***	46.7916***	61.9318***	17.2879***
ADF	-13.2359***	-10.0369***	-8.2737***	-6.9053***	-5.3892***	-3.4987***	-2.9684***	-2.9611***	-1.5558
R2	0.9942	0.9855	0.9450	0.8878	0.8317	0.6716	0.5587	0.4645	0.1615
NOK									

a	0.0037	0.0111	0.1185***	0.2631***	0.3992***	0.7237***	1.1724***	1.7065***	2.3693***
Se a	0.0032	0.0095	0.0351	0.0523	0.0640	0.0881	0.1080	0.1213	0.1756
β	0.9982***	0.9945***	0.9422***	0.8719***	0.8059***	0.6487***	0.4332***	0.1780***	-0.1360
Se β	0.0016	0.0046	0.0168	0.0250	0.0307	0.0421	0.0514	0.0577	0.0829
t β=1	-1.1426	-1.1972	-3.4338***	-5.1139***	-6.3311***	-8.3464***	-11.0198***	-14.2529***	-13.7052***
Wald	1.7293	4.3687	17.8413***	38.3194***	58.8129***	109.6281***	183.1777***	291.3776***	295.5109***
ADF	-16.8337***	-10.4375***	-8.2792***	-6.9060***	-5.9607***	-4.2862***	-3.1770***	-2.6486***	-1.8158*
R2	0.9828	0.9590	0.8492	0.7179	0.6030	0.3545	0.1426	0.0224	0.0106
NZD									
a	0.0006	0.0010	0.0150	0.0305**	0.0466***	0.0878***	0.1325***	0.2149***	0.6111***
Se a	0.0009	0.0026	0.0092	0.0132	0.0163	0.0238	0.0305	0.0375	0.0684
β	0.9991***	0.9973***	0.9710***	0.9416***	0.9118***	0.8356***	0.7559***	0.6240***	0.0242
Se β	0.0013	0.0040	0.0139	0.0199	0.0244	0.0350	0.0443	0.0536	0.0939
t β=1	-0.6486	-0.6678	-2.0872**	-2.9342***	-3.6103***	-4.6936***	-5.5081***	-7.0189***	-10.3977***
Wald	0.8638	4.2725	13.6390***	26.6243***	39.8417***	75.5614***	115.9256***	165.7945***	272.1010***
ADF	-13.7592***	-10.8675***	-8.6419***	-8.1397***	-6.8590***	-4.7252***	-3.7697***	-2.9880***	-1.0415
R2	0.9875	0.9696	0.8993	0.8243	0.7532	0.5697	0.4114	0.2494	0.0003
SGD									
a	0.0001	0.0010	0.0095*	0.0217**	0.0329***	0.0662***	0.1096***	0.1704***	-0.1758
Se a	0.0005	0.0015	0.0056	0.0087	0.0106	0.0154	0.0196	0.0238	0.0532
β	0.9997***	0.9985***	0.9845***	0.9647***	0.9467***	0.8931***	0.8237***	0.7263***	1.1918***
Se β	0.0008	0.0024	0.0089	0.0140	0.0169	0.0246	0.0314	0.0380	0.0781
t β=1	-0.3599	-0.6057	-1.7345*	-2.5317**	-3.1474***	-4.3429***	-5.6213***	-7.2080***	2.4570**
Wald	0.6213	0.4261	3.0107	6.4157**	9.9063***	18.8705***	31.6450***	52.0694***	105.3107***
ADF	-12.5348***	-10.1765***	-8.6483***	-6.9460***	-5.8545***	-4.1664***	-3.1932***	-2.6328***	-2.3175**
R2	0.9951	0.9888	0.9563	0.9117	0.8755	0.7586	0.6284	0.4771	0.4912
USD									
a	0.0001	0.0002	0.0025	0.0062**	0.0097***	0.0215***	0.0332***	0.0449***	0.2507***
Se a	0.0002	0.0005	0.0019	0.0030	0.0036	0.0052	0.0064	0.0074	0.0201
β	0.9996***	0.9988***	0.9873***	0.9706***	0.9559***	0.9048***	0.8535***	0.8007***	0.1776***
Se β	0.0007	0.0020	0.0078	0.0122	0.0150	0.0216	0.0264	0.0304	0.0668
t β=1	-0.5563	-0.6184	-1.6347	-2.4089**	-2.9417***	-4.4067***	-5.5492***	-6.5620***	-12.3199***
Wald	0.3484	0.3831	2.7075	6.0103**	9.2148**	21.0686***	33.4831***	46.5626***	156.0812***
ADF	-12.6063***	-9.9065***	-8.3443***	-6.7075***	-5.4209***	-3.8461***	-3.0441***	-2.7592***	-2.3836**
R2	0.9969	0.9922	0.9669	0.9318	0.9017	0.8071	0.7203	0.6365	0.0277

AED									
a	0.0006	0.0014	0.1389***	0.0417**	0.0636***	0.1380***	0.2110***	0.2867***	1.3112***
Se a	0.0010	0.0030	0.0169	0.0182	0.0225	0.0324	0.0394	0.0453	0.1177
β	0.9996***	0.9990***	0.9110***	0.9725***	0.9584***	0.9100***	0.8624***	0.8128***	0.1837**
Se β	0.0007	0.0020	0.0114	0.0122	0.0151	0.0218	0.0265	0.0305	0.0738
t β=1	-0.6077	-0.4852	-7.8097***	-2.2458**	-2.7546***	-4.1348***	-5.1929***	-6.1449***	-11.0656***
Wald	0.3881	0.2359	76.5397***	5.2909*	8.2277**	18.9671***	30.0227***	41.7625***	128.1744***
ADF	-13.5561***	-9.8667***	-4.9846***	-6.6959***	-5.4061***	-3.8521***	-3.0745***	-2.7973***	-2.3797**
R2	0.9969	0.9922	0.9311	0.9314	0.9007	0.8067	0.7233	0.6418	0.0242
BRL									
a		0.0064	0.0518***	0.1139***	0.1748***	0.3423***	0.4896***	0.6506***	0.7927***
Se a		0.0040	0.0156	0.0222	0.0255	0.0302	0.0340	0.0340	0.0354
β		0.9914***	0.9382***	0.8665***	0.7972***	0.6101***	0.4507***	0.2834***	0.1249***
Se β		0.0040	0.0155	0.0219	0.0250	0.0289	0.0319	0.0310	0.0294
t β=1		-2.1367**	-3.9804***	-6.0899***	-8.1207***	-13.4956***	-17.2161***	-23.0916***	-29.8109***
Wald		20.0374***	37.3622***	81.3335***	140.9077***	383.9162***	641.1748***	1147.1250***	3138.3040***
ADF		-9.3266***	-7.6602***	-6.0648***	-5.2486***	-3.9600***	-3.7227***	-3.3864***	-2.5431**
R2		0.9786	0.9128	0.8431	0.7818	0.6005	0.4116	0.2305	0.0691
CLP									
a		0.0196	0.2648*	0.6123***	0.9580***	1.8569***	3.3475***	4.5662***	7.7876***
Se a		0.0384	0.1402	0.2051	0.2475	0.3170	0.4025	0.4504	0.5015
β		0.9969***	0.9592***	0.9057***	0.8525***	0.7142***	0.4862***	0.3002***	-0.1882
Se β		0.0059	0.0214	0.0313	0.0377	0.0483	0.0612	0.0684	0.0759
t β=1		-0.5237	-1.9092*	-3.0153***	-3.9089***	-5.9203***	-8.3918***	-10.2269***	-15.6612***
Wald		1.3951	6.2903**	14.7180***	24.7203***	61.3923***	112.4941***	167.1293***	389.8765***
ADF		-9.3765***	-6.5861***	-5.8428***	-4.6621***	-3.6650***	-2.6863***	-2.0922**	-1.7452*
R2		0.9592	0.8533	0.7378	0.6422	0.4213	0.1809	0.0656	0.0237
CNY									
a		0.0023	0.0709**	0.1838***	0.2902***	0.5955***	0.9051***	1.1872***	-0.4537
Se a		0.0079	0.0312	0.0495	0.0613	0.0911	0.1129	0.1316	0.2053
β		0.9991***	0.9692***	0.9199***	0.8736***	0.7400***	0.6040***	0.4796***	1.2025***
Se β		0.0035	0.0139	0.0221	0.0274	0.0407	0.0506	0.0590	0.0917
t β=1		-0.2565	-2.2157**	-3.6251***	-4.6195***	-6.3844***	-7.8331***	-8.8212***	2.2084**
Wald		0.8179	6.7843**	17.4544***	29.0381***	56.1035***	85.7320***	111.5248***	4.8868*
ADF		-8.7797***	-6.9181***	-5.4294***	-4.5775***	-3.0793***	-2.4528**	-1.9090*	-2.8887***

R2		0.9813	0.9164	0.8257	0.7454	0.4995	0.3089	0.1744	0.4047
COP									
a		0.0474	0.3803***	0.8451***	1.3238***	2.4625***	3.4397***	3.9865***	3.9728***
Se a		0.0401	0.1434	0.2090	0.2520	0.3119	0.3581	0.3863	0.4394
β		0.9939***	0.9514***	0.8921***	0.8311***	0.6858***	0.5612***	0.4910***	0.4878***
Se β		0.0051	0.0181	0.0263	0.0318	0.0392	0.0449	0.0484	0.0546
t β=1		-1.2049	-2.6856***	-4.0951***	-5.3195***	-8.0107***	-9.7641***	-10.5204***	-9.3834***
Wald		4.1237	13.6031***	31.0810***	52.7712***	134.1398***	229.4658***	334.0455***	762.6284***
ADF		-8.5904***	-6.4182***	-5.5415***	-4.6677***	-3.3642***	-2.8859***	-2.4661**	-2.3119**
R2		0.9688	0.8882	0.7949	0.7090	0.5077	0.3558	0.2735	0.2468
CZK									
a	-0.0000	0.0059	0.0440**	0.1035***	0.1654***	0.3462***	0.4964***	0.6321***	1.7708***
Se a	0.0017	0.0052	0.0182	0.0267	0.0327	0.0457	0.0545	0.0586	0.1026
β	1.0000***	0.9982***	0.9864***	0.9681***	0.9491***	0.8934***	0.8469***	0.8047***	0.4494***
Se β	0.0005	0.0015	0.0054	0.0079	0.0097	0.0135	0.0161	0.0173	0.0310
t β=1	0.0047	-1.1819	-2.5210**	-4.0421***	-5.2623***	-7.8948***	-9.5078***	-11.2919***	-17.7628***
Wald	0.0363	2.4694	12.3189***	31.6804***	52.7181***	120.0380***	184.0067***	270.0956***	695.4369***
ADF	-12.7873***	-10.9044***	-8.5377***	-7.6866***	-6.4453***	-4.3668***	-3.6195***	-3.2195***	-2.5433**
R2	0.9982	0.9955	0.9842	0.9698	0.9554	0.9126	0.8722	0.8458	0.4657
HUF									
a	0.0069	0.0195	0.2236**	0.6237***	1.0739***	2.3949***	3.3355***	3.5046***	4.5137***
Se a	0.0085	0.0257	0.0912	0.1408	0.1807	0.2472	0.2775	0.2894	0.3074
β	0.9988***	0.9963***	0.9591***	0.8866***	0.8053***	0.5674***	0.3985***	0.3678***	0.1922***
Se β	0.0015	0.0046	0.0164	0.0253	0.0324	0.0442	0.0495	0.0516	0.0543
t β=1	-0.7853	-0.8018	-2.4995**	-4.4878***	-6.0103***	-9.7807***	-12.1430***	-12.2589***	-14.8700***
Wald	7.3292**	15.5373***	24.6259***	49.5840***	75.1470***	174.9520***	279.7336***	352.7221***	415.5178***
ADF	-12.7088***	-9.9232***	-7.7834***	-7.3443***	-5.7032***	-3.7829***	-3.0831***	-2.9392***	-2.2479**
R2	0.9829	0.9587	0.8595	0.7178	0.5754	0.2761	0.1341	0.1100	0.0485
IDR									
a	0.1005**	0.0975*	0.1788*	0.3398**	0.4713***	1.0278***	1.7465***	2.9613***	
Se a	0.0484	0.0523	0.0945	0.1399	0.1745	0.2398	0.2838	0.3257	
β	0.9894***	0.9896***	0.9806***	0.9629***	0.9484***	0.8879***	0.8106***	0.6802***	
Se β	0.0052	0.0056	0.0102	0.0150	0.0187	0.0257	0.0304	0.0348	
t β=1	-2.0341**	-1.8466*	-1.9154*	-2.4671**	-2.7542***	-4.3589***	-6.2298***	-9.1833***	
Wald	8.1065**	4.0955	4.8258*	9.5317***	14.1818***	31.7111***	52.9790***	103.1987***	

ADF	-7.0988***	-7.2268***	-8.3203***	-6.7117***	-5.5672***	-5.1197***	-3.5365***	-3.6423***	
R2	0.9840	0.9781	0.9464	0.8994	0.8547	0.7401	0.6347	0.4858	
INR									
a	0.0005	0.0023	0.0296	0.0615	0.0866	0.1431*	0.2112**	0.3325***	
Se a	0.0025	0.0076	0.0291	0.0451	0.0554	0.0784	0.0981	0.1222	
β	0.9999***	0.9993***	0.9921***	0.9839***	0.9775***	0.9632***	0.9461***	0.9161***	
Se β	0.0006	0.0019	0.0072	0.0112	0.0138	0.0195	0.0244	0.0303	
t β=1	-0.1186	-0.3917	-1.0870	-1.4307	-1.6315	-1.8877*	-2.2117**	-2.7691***	
Wald	3.9750	5.2586*	4.0036	4.6723*	5.3340*	5.8514*	6.9716**	9.1069**	
ADF	-14.2686***	-10.1398***	-8.3005***	-6.9353***	-5.8784***	-4.5425***	-3.7349***	-3.3662***	
R2	0.9972	0.9930	0.9719	0.9436	0.9191	0.8543	0.7875	0.6973	
MAD									
a	0.0058	0.0295*	0.2611***	0.5999***	0.9176***	1.9746***	2.5254***	2.6154***	2.3972***
Se a	0.0055	0.0160	0.0572	0.0850	0.0991	0.1061	0.0940	0.0810	0.0527
β	0.9976***	0.9875***	0.8908***	0.7498***	0.6177***	0.1806***	-0.0459	-0.0824	0.0075
Se β	0.0023	0.0066	0.0237	0.0352	0.0409	0.0437	0.0386	0.0331	0.0212
t β=1	-1.0261	-1.8793*	-4.6084***	-7.1148***	-9.3392***	-18.7593***	-27.1148***	-32.6913***	-46.7759***
Wald	10.7059***	52.2910***	94.7180***	173.8868***	278.6992***	849.2599***	1803.5460***	3024.3410***	10099.0000***
ADF	-12.4768***	-7.9898***	-6.1138***	-4.7988***	-3.8578***	-2.6234***	-2.3270**	-2.3328**	-2.6701***
R2	0.9778	0.9499	0.7990	0.6061	0.4476	0.0540	0.0050	0.0220	0.0005
MXN									
a		-0.0041	-0.0070	-0.0059	0.0003	0.0321	0.0848	0.2160***	1.9104***
Se a		0.0040	0.0155	0.0249	0.0323	0.0496	0.0631	0.0811	0.1473
β		1.0011***	1.0010***	0.9994***	0.9958***	0.9806***	0.9576***	0.9053***	0.3123***
Se β		0.0015	0.0059	0.0096	0.0124	0.0189	0.0239	0.0306	0.0520
t β=1		0.7436	0.1751	-0.0650	-0.3358	-1.0233	-1.7698*	-3.0920***	-13.2326***
Wald		8.3280**	7.3121**	8.8620**	10.5962***	15.5142***	22.3746***	29.4956***	212.6578***
ADF		-10.0309***	-7.7867***	-6.3738***	-5.3716***	-4.1552***	-3.4554***	-2.9558***	-2.5859***
R2		0.9954	0.9811	0.9593	0.9351	0.8653	0.7958	0.6849	0.1303
MYR									
a	0.0018	0.0008	0.0342	0.0882**	0.1414***	0.3726***	0.6150***	0.7775***	
Se a	0.0024	0.0070	0.0255	0.0400	0.0498	0.0792	0.0972	0.1131	
β	0.9988***	0.9993***	0.9762***	0.9392***	0.9032***	0.7482***	0.5865***	0.4773***	
Se β	0.0016	0.0046	0.0168	0.0264	0.0328	0.0520	0.0636	0.0739	

t β=1	-0.7313	-0.1586	-1.4149	-2.3037**	-2.9530***	-4.8378***	-6.4979***	-7.0773***	
Wald	0.5378	0.9940	4.1817	9.1538**	13.6939***	31.2919***	56.5354***	74.0087***	
ADF	-10.2625***	-8.4337***	-7.4672***	-5.6139***	-4.6745***	-2.9440***	-2.2013**	-2.1052**	
R2	0.9878	0.9734	0.9014	0.8070	0.7234	0.4331	0.2282	0.1285	
PHP									
a	0.0020	0.0008	0.0378	0.0998**	0.1637***	0.3945***	0.5854***	0.7837***	
Se a	0.0026	0.0076	0.0289	0.0454	0.0561	0.0813	0.0957	0.1093	
β	0.9995***	0.9996***	0.9900***	0.9741***	0.9579***	0.8997***	0.8515***	0.8018***	
Se β	0.0006	0.0019	0.0071	0.0112	0.0138	0.0200	0.0234	0.0267	
t β=1	-0.7122	-0.2046	-1.4021	-2.3109**	-3.0459***	-5.0213***	-6.3317***	-7.4215***	
Wald	2.3464	4.3737	6.4197**	11.4650***	17.3823***	39.4642***	63.3902***	88.8892***	
ADF	-14.3314***	-10.1696***	-8.4394***	-7.0159***	-6.0643***	-4.4696***	-3.5931***	-3.1704***	
R2	0.9971	0.9930	0.9718	0.9421	0.9146	0.8287	0.7650	0.6926	
PKR									
a		0.0163*	0.0989***	0.1941***	0.2786***	0.5840***		5.7799***	
Se a		0.0096	0.0347	0.0501	0.0619	0.0894		1.3954	
β		0.9962***	0.9781***	0.9574***	0.9390***	0.8724***		-0.1978	
Se β		0.0021	0.0076	0.0109	0.0135	0.0195		0.2867	
t β=1		-1.7867*	-2.8894***	-3.9008***	-4.5210***	-6.5597***		-4.1785***	
Wald		6.7815**	8.9636**	15.3916***	20.5587***	43.2115***		81.7279***	
ADF		-8.7251***	-6.6248***	-5.7301***	-4.7824***	-3.0430***		-1.5417	
R2		0.9947	0.9801	0.9636	0.9456	0.8741		0.0087	
PLZ									
a	0.0014	0.0081	0.0758***	0.1920***	0.3146***	0.6739***	0.9348***	1.1432***	1.4512***
Se a	0.0020	0.0060	0.0214	0.0348	0.0439	0.0618	0.0694	0.0736	0.0744
β	0.9991***	0.9939***	0.9446***	0.8610***	0.7731***	0.5160***	0.3298***	0.1825***	-0.0510
Se β	0.0014	0.0043	0.0152	0.0247	0.0312	0.0437	0.0489	0.0517	0.0523
t β=1	-0.6055	-1.4313	-3.6325***	-5.6202***	-7.2689***	-11.0719***	-13.6991***	-15.8087***	-20.0903***
Wald	1.8805	3.8737	15.1843***	33.8810***	55.4989***	128.5447***	198.9681***	264.6686***	472.2340***
ADF	-10.2832***	-8.0131***	-6.9131***	-5.9081***	-4.3713***	-2.8057***	-2.2805**	-2.0219**	-1.9835**
R2	0.9880	0.9705	0.8931	0.7597	0.6299	0.2942	0.1248	0.0395	0.0039
RUR									
a	-0.0005	0.0325**	0.1841***	0.4167***	0.6357***	1.2127***	1.6460***	2.0394***	
Se a	0.0048	0.0147	0.0447	0.0714	0.0897	0.1138	0.1259	0.1358	
β	1.0002***	0.9908***	0.9485***	0.8840***	0.8234***	0.6640***	0.5446***	0.4365***	

Se β	0.0013	0.0040	0.0123	0.0196	0.0246	0.0311	0.0344	0.0370	
t β=1	0.1270	-2.2632**	-4.1946***	-5.9170***	-7.1842***	-10.7945***	-13.2557***	-15.2490***	
Wald	0.7135	11.1940***	25.8655***	44.9949***	63.7602***	139.0805***	209.9088***	278.3262***	
ADF	-9.9699***	-9.4195***	-6.4470***	-6.1983***	-4.0414***	-3.3348***	-2.6111***	-2.0462**	
R2	0.9921	0.9809	0.9406	0.8651	0.7946	0.6076	0.4717	0.3383	
THB									
a	0.0020	0.0043	0.0742*	0.1879***	0.2917***	0.6186***	0.9395***	1.3285***	
Se a	0.0040	0.0117	0.0426	0.0667	0.0818	0.1144	0.1375	0.1601	
β	0.9995***	0.9988***	0.9799***	0.9496***	0.9219***	0.8352***	0.7502***	0.6473***	
Se β	0.0011	0.0031	0.0112	0.0176	0.0216	0.0302	0.0362	0.0421	
t β=1	-0.5012	-0.3970	-1.7847*	-2.8631***	-3.6204***	-5.4667***	-6.9034***	-8.3790***	
Wald	0.2737	1.5398	5.4129*	11.1123***	16.7442***	34.9109***	54.4270***	79.5850***	
ADF	-12.5000***	-10.2910***	-8.9260***	-7.4169***	-6.1394***	-4.4932***	-3.5074***	-2.9218***	
R2	0.9917	0.9814	0.9309	0.8610	0.8038	0.6451	0.5123	0.3709	
TRL									
a	0.0870***	0.0844***	0.0842***	0.0857***	0.0890***	0.1049***	0.1389***	0.1865***	0.4470***
Se a	0.0097	0.0100	0.0106	0.0113	0.0122	0.0143	0.0171	0.0196	0.0628
β	0.8606***	0.8602***	0.8505***	0.8364***	0.8191***	0.7589***	0.6708***	0.5696***	0.3155***
Se β	0.0141	0.0145	0.0153	0.0163	0.0174	0.0201	0.0233	0.0259	0.0731
t β=1	-9.8775***	-9.6719***	-9.7491***	-10.0206***	-10.3828***	-11.9747***	-14.1195***	-16.5887***	-9.3591***
Wald	115.4138***	107.5451***	103.5789***	104.7742***	109.6041***	143.7169***	203.9124***	287.1793***	449.2780***
ADF	-5.8229***	-6.1285***	-5.9046***	-5.4616***	-5.1913***	-4.4634***	-3.9292***	-3.5676***	-2.2470**
R2	0.7617	0.7556	0.7387	0.7186	0.6950	0.6242	0.5250	0.4132	0.0693
TWD									
a		-0.0032	0.0131	0.0481	0.0829	0.1945**	0.3727***	0.6476***	3.9301***
Se a		0.0074	0.0276	0.0445	0.0561	0.0815	0.1031	0.1272	0.3373
β		1.0009***	0.9967***	0.9874***	0.9783***	0.9489***	0.9012***	0.8269***	-0.0486
Se β		0.0020	0.0075	0.0122	0.0154	0.0223	0.0283	0.0349	0.0906
t β=1		0.4661	-0.4412	-1.0323	-1.4121	-2.2901**	-3.4960***	-4.9588***	-11.5806***
Wald		0.6574	0.8948	2.6320	4.7169*	11.6023***	22.4225***	37.3421***	158.7509***
ADF		-10.0007***	-8.3425***	-7.1510***	-5.5837***	-4.1813***	-3.3215***	-2.8258***	-1.6165
R2		0.9921	0.9689	0.9338	0.9008	0.8114	0.7120	0.5832	0.0011
ZAR									
a	0.0031	0.0055	0.0391*	0.0888***	0.1357***	0.3330***	0.5094***	0.7715***	2.2157***
Se a	0.0021	0.0055	0.0206	0.0317	0.0389	0.0571	0.0665	0.0780	0.1074

β	0.9988***	0.9971***	0.9807***	0.9571***	0.9349***	0.8432***	0.7620***	0.6434***	0.0501
Se β	0.0009	0.0025	0.0094	0.0143	0.0176	0.0257	0.0297	0.0346	0.0452
t β=1	-1.2662	-1.1744	-2.0597**	-2.9949***	-3.7071***	-6.1052***	-8.0041***	-10.2916***	-21.0163***
Wald	7.7077**	5.0046*	7.3848**	12.9573***	18.9068***	45.4160***	77.0666***	122.4682***	460.7182***
ADF	-15.6979***	-11.8380***	-8.4131***	-7.1294***	-5.8381***	-4.2817***	-3.2248***	-2.7528***	-2.5922***
R2	0.9949	0.9878	0.9527	0.9065	0.8647	0.7194	0.6149	0.4622	0.0049
Mean									
a	0.0092	0.0133	0.0748	0.1870	0.2888	0.5903	0.8717	1.2689	1.6461
Se a	0.0046	0.0107	0.0357	0.0523	0.0641	0.0864	0.1018	0.1553	0.1517
β	0.9931	0.9924	0.9843	0.9306	0.8959	0.7912	0.6936	0.5763	0.3421
se β	0.0018	0.0038	0.0139	0.0181	0.0220	0.0300	0.0360	0.0486	0.0669
t β=1	-0.2140	-0.1912	-0.3975	-0.6118	-0.7585	-1.1393	-1.4717	-1.7187	-2.5296
Wald	7.0456	8.9235	24.2933	27.2211	40.9078	95.7422	169.8271	258.9455	811.1950
R2	0.9814	0.9726	0.9079	0.8533	0.7945	0.6341	0.5049	0.3874	0.1459

We use the Fully Modified OLS (FMOLS) estimator. For each economy we test for different time forward rates with different time to maturity. We report the values and standard errors of α and β, R squares of the equation, also the t statistics of testing β=1, the Wald statistics of joint test for α=1 and β=1, and the test statistics of unit root test (ADF) for the residuals of the equation. We calculate the mean of these statistics across the economies. Empty entries due to missing data in forward rates. Standard currency short codes are employed.

* Significance at 10%

** Significance at 5%

*** Significance at 1%

Table 3.6.4: Simple efficiency hypothesis DOLS test equation for Sterling exchange rates

	TN	1W	1M	2M	3M	6M	9M	1Y	2Y
AUD									
a	0.0002	-0.0018	-0.0069	-0.0139	-0.0217	-0.0447	-0.0919	-0.0803	
Se a	0.0005	0.0017	0.0058	0.0085	0.0104	0.0151	0.0175	0.0257	
β	0.9997***	1.0013***	1.0051***	1.0106***	1.0173***	1.0364***	1.0711***	1.0583***	
Se β	0.0006	0.0021	0.0069	0.0102	0.0124	0.0179	0.0205	0.0300	
t β=1	-0.5615	0.6196	0.7397	1.0446	1.3906	2.0350**	3.4606***	1.9441*	
Wald	0.7365	3.4404	4.6015	8.4089**	12.4446***	24.7713***	91.0312***	43.0751***	
ADF	-63.3702***	-12.3502***	-9.4529***	-7.5201***	-6.7558***	-4.9551***	-4.5162***	-3.3432***	
R2	0.9987	0.9950	0.9763	0.9555	0.9380	0.8876	0.8616	0.7545	
CAD									
a	0.0002	0.0002	0.0000	-0.0023	-0.0034	-0.0014	-0.0039	-0.0186	
Se a	0.0005	0.0017	0.0053	0.0074	0.0091	0.0138	0.0159	0.0192	
β	0.9995***	0.9993***	0.9987***	1.0008***	1.0014***	0.9949***	0.9880***	1.0095***	
Se β	0.0006	0.0023	0.0071	0.0099	0.0122	0.0185	0.0214	0.0257	
t β=1	-0.8435	-0.3030	-0.1782	0.0798	0.1141	-0.2752	-0.5602	0.3701	
Wald	2.6406	0.6253	0.6558	1.2177	1.6995	3.5077	16.1595***	10.5056***	
ADF	-63.3396***	-13.1825***	-10.3379***	-8.5571***	-6.8899***	-5.0007***	-4.0033***	-3.7605***	
R2	0.9985	0.9942	0.9744	0.9563	0.9376	0.8713	0.8301	0.7908	
CHF									
a	0.0000	-0.0007	-0.0040	-0.0091	-0.0119	-0.0182	-0.0232	-0.0295	-0.0392
Se a	0.0004	0.0014	0.0043	0.0063	0.0081	0.0123	0.0144	0.0186	0.0407
β	0.9997***	1.0010***	1.0058***	1.0127***	1.0167***	1.0260***	1.0289***	1.0418***	0.9544***
Se β	0.0005	0.0018	0.0056	0.0083	0.0106	0.0163	0.0193	0.0249	0.0609
t β=1	-0.6924	0.5657	1.0275	1.5320	1.5746	1.5970	1.4953	1.6799*	-0.7481
Wald	6.5768**	0.3252	1.1262	2.3779	2.5234	2.6384	2.6635	2.8751	58.1359***
ADF	-63.3869***	-11.7243***	-10.0532***	-7.7625***	-6.5506***	-4.3122***	-3.5632***	-3.3089***	-1.5480
R2	0.9990	0.9961	0.9840	0.9698	0.9535	0.9036	0.8672	0.8120	0.5132
XEU									
a	0.0001	0.0005	0.0021	0.0039	0.0058	0.0143**	0.0191**	0.0326***	0.0997***
Se a	0.0002	0.0008	0.0027	0.0040	0.0049	0.0070	0.0080	0.0100	0.0162

β	0.9992***	0.9987***	0.9948***	0.9903***	0.9857***	0.9637***	0.9427***	0.9132***	0.4929***
Se β	0.0006	0.0023	0.0075	0.0113	0.0139	0.0201	0.0230	0.0290	0.0587
t β=1	-1.2214	-0.5815	-0.6844	-0.8611	-1.0310	-1.8054*	-2.4859**	-2.9922***	-8.6325***
Wald	3.1831	0.3584	0.6900	0.9882	1.4309	4.2176	6.1970**	10.5965***	100.3479***
ADF	-63.3507***	-10.7516***	-9.5011***	-8.0241***	-6.1979***	-4.3699***	-3.3316***	-3.3922***	-1.7807*
R2	0.9985	0.9938	0.9716	0.9436	0.9191	0.8441	0.7938	0.7099	0.2319
HKD									
a	0.0044*	0.0128	0.0635**	0.1372***	0.2160***	0.5313***	0.7970***	1.0311***	1.9444***
Se a	0.0023	0.0088	0.0283	0.0431	0.0541	0.0821	0.0967	0.1106	0.1934
β	0.9983***	0.9951***	0.9753***	0.9467***	0.9161***	0.7933***	0.6894***	0.5980***	0.2451***
Se β	0.0009	0.0034	0.0111	0.0169	0.0212	0.0321	0.0379	0.0433	0.0745
t β=1	-1.9287*	-1.4427	-2.2314**	-3.1567***	-3.9616***	-6.4343***	-8.2023***	-9.2814***	-10.1259***
Wald	4.3955	2.2254	5.1789*	10.3887***	16.4466***	42.7118***	68.6180***	87.8680***	105.8962***
ADF	-63.3648***	-10.5351***	-9.1930***	-7.6038***	-6.1140***	-3.6705***	-2.9217***	-2.4468**	-1.3833
R2	0.9967	0.9867	0.9383	0.8727	0.8093	0.5922	0.4351	0.3216	0.0454
ILS									
a	0.0017	0.0034	0.0129	0.0301	0.0499	0.1307***	0.1986***	0.2895***	0.5739***
Se a	0.0016	0.0061	0.0184	0.0273	0.0328	0.0445	0.0522	0.0612	0.0886
β	0.9990***	0.9979***	0.9916***	0.9811***	0.9694***	0.9236***	0.8848***	0.8334***	0.6649***
Se β	0.0008	0.0032	0.0095	0.0141	0.0169	0.0230	0.0269	0.0315	0.0449
t β=1	-1.1807	-0.6749	-0.8826	-1.3419	-1.8087*	-3.3268***	-4.2830***	-5.2969***	-7.4626***
Wald	3.1258	2.6758	5.4600*	10.0117***	15.3508***	33.0695***	51.2407***	73.7535***	206.7388***
ADF	-48.3931***	-9.2361***	-7.5127***	-5.7243***	-4.6464***	-3.0336***	-2.5213**	-2.3383**	-1.8798*
R2	0.9982	0.9928	0.9721	0.9452	0.9238	0.8499	0.7967	0.7241	0.4827
JPY									
a	0.0058*	0.0082	0.0379	0.0876	0.1631*	0.3754***	0.4843***	0.5988***	1.4295***
Se a	0.0034	0.0131	0.0420	0.0645	0.0846	0.1320	0.1496	0.1930	0.3875
β	0.9988***	0.9985***	0.9930***	0.9837***	0.9695***	0.9291***	0.9073***	0.8870***	0.7124***
Se β	0.0007	0.0025	0.0081	0.0125	0.0163	0.0256	0.0290	0.0374	0.0754
t β=1	-1.7798*	-0.5999	-0.8588	-1.3043	-1.8668*	-2.7734***	-3.1950***	-3.0177***	-3.8124***
Wald	6.4737**	0.8702	2.1823	3.9304	6.4383**	11.8203***	11.7578***	16.0028***	26.2721***
ADF	-63.4438***	-10.7781***	-8.7190***	-7.5302***	-5.8988***	-3.8317***	-3.1340***	-2.8714***	-1.4218
R2	0.9982	0.9925	0.9668	0.9314	0.8883	0.7587	0.6933	0.5818	0.2778
NOK									
a	0.0017	0.0037	0.0147	0.0183	0.0243	0.0342	0.0331	0.1054	0.0944

Se a	0.0017	0.0065	0.0209	0.0301	0.0371	0.0505	0.0556	0.0729	0.1400
β	0.9993***	0.9983***	0.9935***	0.9916***	0.9886***	0.9832***	0.9800***	0.9510***	0.9321***
Se β	0.0007	0.0027	0.0086	0.0124	0.0153	0.0208	0.0229	0.0300	0.0589
t β=1	-1.0349	-0.6208	-0.7530	-0.6792	-0.7426	-0.8073	-0.8756	-1.6345	-1.1517
Wald	1.4240	1.3058	1.3675	2.2207	3.2973	7.2649**	31.5654***	17.6164***	182.1603***
ADF	-63.2928***	-12.3747***	-9.4472***	-7.7345***	-6.7772***	-5.4376***	-4.3305***	-3.6119***	-2.5584**
R2	0.9979	0.9916	0.9625	0.9326	0.9037	0.8394	0.8073	0.7122	0.5137
NZD									
a	0.0004	-0.0004	0.0002	-0.0022	-0.0032	0.0049	-0.0413	0.0420	-0.1789
Se a	0.0007	0.0025	0.0081	0.0116	0.0141	0.0213	0.0243	0.0349	0.0688
β	0.9996***	0.9997***	0.9972***	0.9970***	0.9958***	0.9809***	1.0092***	0.9295***	1.0534***
Se β	0.0007	0.0025	0.0081	0.0115	0.0140	0.0211	0.0236	0.0339	0.0698
t β=1	-0.6009	-0.1227	-0.3492	-0.2562	-0.2980	-0.9058	0.3879	-2.0794**	0.7657
Wald	0.4111	2.6340	3.6804	6.9510**	9.9505***	17.8731***	72.2156***	37.1771***	331.0796***
ADF	-63.3377***	-11.6008***	-9.5163***	-8.2944***	-6.3943***	-4.7784***	-4.6641***	-3.1404***	-2.2984**
R2	0.9982	0.9927	0.9675	0.9419	0.9187	0.8362	0.8064	0.6495	0.4919
SGD									
a	0.0001	-0.0013	-0.0027	-0.0043	-0.0037	0.0018	-0.0407	0.0271	-0.0920
Se a	0.0006	0.0020	0.0064	0.0098	0.0123	0.0190	0.0213	0.0305	0.0422
β	0.9997***	1.0014***	1.0036***	1.0061***	1.0064***	1.0034***	1.0427***	0.9802***	1.0171***
Se β	0.0006	0.0021	0.0067	0.0102	0.0129	0.0199	0.0223	0.0321	0.0446
t β=1	-0.5447	0.6489	0.5301	0.5992	0.4973	0.1688	1.9174*	-0.6149	0.3828
Wald	4.3793	0.4408	0.7298	1.3464	1.9325	3.4283	3.6857	4.6959*	154.3243***
ADF	-63.3452***	-12.2240***	-9.9209***	-7.7996***	-6.4603***	-4.1741***	-3.6035***	-3.2757***	-1.7534*
R2	0.9986	0.9949	0.9775	0.9546	0.9316	0.8570	0.8347	0.6969	0.6894
USD									
a	0.0008	0.0030*	0.0147**	0.0310***	0.0477***	0.1112***	0.1617***	0.2048***	0.3850***
Se a	0.0005	0.0018	0.0057	0.0086	0.0107	0.0159	0.0186	0.0210	0.0401
β	0.9984***	0.9942***	0.9716***	0.9404***	0.9085***	0.7858***	0.6870***	0.6035***	0.2618***
Se β	0.0009	0.0035	0.0112	0.0168	0.0209	0.0312	0.0364	0.0413	0.0717
t β=1	-1.8091*	-1.6691*	-2.5511**	-3.5371***	-4.3708***	-6.8582***	-8.5980***	-9.5988***	-10.2895***
Wald	3.7461	2.8488	6.6429**	12.8472***	19.7937***	48.6476***	75.8293***	95.4217***	115.7760***
ADF	-63.4076***	-10.6891***	-9.2798***	-7.5403***	-6.0638***	-3.7379***	-2.9471***	-2.6956***	-1.4589
R2	0.9967	0.9864	0.9368	0.8716	0.8103	0.6010	0.4524	0.3466	0.0553
AED									

a	0.0033**	0.0094	0.0470**	0.1000***	0.1547***	0.3645***	0.5224***	0.6513***	1.2317***
Se a	0.0017	0.0063	0.0203	0.0307	0.0382	0.0569	0.0660	0.0747	0.1382
β	0.9981***	0.9949***	0.9742***	0.9452***	0.9153***	0.8000***	0.7130***	0.6422***	0.3234***
Se β	0.0009	0.0035	0.0112	0.0170	0.0212	0.0315	0.0366	0.0415	0.0746
t β=1	-2.0453**	-1.4841	-2.3009**	-3.2296***	-4.0048***	-6.3400***	-7.8463***	-8.6313***	-9.0724***
Wald	4.6726*	2.2749	5.4549*	10.8179***	16.8141***	42.0247***	63.8233***	78.3394***	91.2527***
ADF	-63.3837***	-10.6475***	-9.2487***	-7.5813***	-6.0847***	-3.7530***	-2.9446***	-2.7402***	-1.4666
R2	0.9967	0.9864	0.9366	0.8709	0.8091	0.6047	0.4683	0.3732	0.0755
BRL									
a		0.0071*	0.0319**	0.0644***	0.1017***	0.2009***	0.2879***	0.4013***	0.4613***
Se a		0.0040	0.0130	0.0179	0.0207	0.0244	0.0299	0.0336	0.0375
β		0.9922***	0.9655***	0.9308***	0.8926***	0.7918***	0.7051***	0.5983***	0.4877***
Se β		0.0032	0.0102	0.0139	0.0161	0.0186	0.0224	0.0247	0.0255
t β=1		-2.4574**	-3.3895***	-4.9745***	-6.6853***	-11.1766***	-13.1385***	-16.2440***	-20.0867***
Wald		20.9897***	38.0156***	81.7242***	140.2990***	381.3005***	538.0024***	789.4593***	2451.0860***
ADF		-10.1510***	-7.8557***	-5.7338***	-5.1356***	-3.9688***	-3.6579***	-3.0763***	-2.3342**
R2		0.9932	0.9670	0.9415	0.9193	0.8626	0.7802	0.6856	0.6069
CLP									
a		0.0256	0.0882	0.1983	0.3708**	0.7984***	0.9776***	1.0646***	1.3043***
Se a		0.0297	0.0937	0.1359	0.1682	0.2136	0.2431	0.2574	0.3845
β		0.9961***	0.9864***	0.9696***	0.9436***	0.8791***	0.8513***	0.8370***	0.7961***
Se β		0.0044	0.0138	0.0199	0.0247	0.0313	0.0356	0.0377	0.0560
t β=1		-0.8927	-0.9871	-1.5239	-2.2851**	-3.8611***	-4.1796***	-4.3298***	-3.6422***
Wald		3.0095	6.2312**	12.9952***	22.0387***	56.9434***	91.2784***	135.9806***	276.5435***
ADF		-9.8825***	-6.6813***	-6.5397***	-5.0829***	-4.3599***	-3.5227***	-3.2595***	-2.6546***
R2		0.9868	0.9433	0.8941	0.8443	0.7331	0.6736	0.6474	0.4606
CNY									
a		-0.0069	-0.0274	-0.0465	-0.0570	-0.0497	-0.0829	-0.1381	0.1193
Se a		0.0064	0.0208	0.0330	0.0431	0.0691	0.0852	0.0996	0.1439
β		1.0028***	1.0111***	1.0191***	1.0239***	1.0228***	1.0377***	1.0612***	0.9398***
Se β		0.0025	0.0082	0.0130	0.0170	0.0274	0.0338	0.0396	0.0576
t β=1		1.1069	1.3603	1.4689	1.4032	0.8343	1.1161	1.5449	-1.0459
Wald		1.3226	2.1568	2.9296	3.3944	4.1789	7.1017**	10.2189***	17.0435***
ADF		-9.5584***	-7.3710***	-6.2126***	-4.5557***	-3.0842***	-2.6097***	-2.3205**	-1.6306*
R2		0.9948	0.9757	0.9469	0.9162	0.8159	0.7548	0.7062	0.5322

COP									
a		0.0421	0.1682*	0.3417**	0.5201***	0.9193***	1.2456***	1.5254***	1.6445***
Se a		0.0293	0.0936	0.1358	0.1595	0.1859	0.2103	0.2378	0.3346
β		0.9947***	0.9787***	0.9566***	0.9339***	0.8828***	0.8406***	0.8042***	0.7803***
Se β		0.0036	0.0114	0.0166	0.0195	0.0226	0.0256	0.0289	0.0403
t β=1		-1.4826	-1.8652*	-2.6166***	-3.3943***	-5.1750***	-6.2307***	-6.7835***	-5.4545***
Wald		6.4066**	12.6950***	26.4922***	46.2521***	130.2048***	228.0215***	321.6380***	753.1623***
ADF		-9.3584***	-7.1238***	-6.2849***	-5.1827***	-4.2970***	-3.6578***	-2.7481***	-2.6992***
R2		0.9910	0.9597	0.9229	0.8957	0.8410	0.7958	0.7431	0.6135
CZK									
a	0.0006	0.0052	0.0188	0.0316	0.0463	0.1029**	0.2165***	0.2447***	1.1976***
Se a	0.0015	0.0055	0.0184	0.0267	0.0326	0.0453	0.0523	0.0622	0.1412
β	0.9998***	0.9984***	0.9944***	0.9904***	0.9858***	0.9688***	0.9351***	0.9266***	0.6413***
Se β	0.0004	0.0015	0.0049	0.0071	0.0087	0.0121	0.0140	0.0165	0.0396
t β=1	-0.5221	-1.0436	-1.1388	-1.3532	-1.6263	-2.5808***	-4.6477***	-4.4378***	-9.0621***
Wald	2.5939	3.2626	4.3241	7.7566**	11.5072***	26.3800***	73.1371***	70.8430***	231.2673***
ADF	-63.2648***	-12.2818***	-9.3987***	-7.2814***	-6.1207***	-4.5287***	-3.3965***	-3.5868***	-1.6189*
R2	0.9994	0.9975	0.9876	0.9768	0.9666	0.9380	0.9115	0.8853	0.5277
HUF									
a	0.0176**	0.0683***	0.3024***	0.5536***	0.7323***	1.1942***	1.7361***		5.1160***
Se a	0.0069	0.0258	0.0828	0.1168	0.1344	0.1681	0.1893		0.4525
β	0.9971***	0.9882***	0.9480***	0.9047***	0.8739***	0.7941***	0.7013***		0.1203
Se β	0.0012	0.0044	0.0140	0.0198	0.0228	0.0284	0.0319		0.0765
t β=1	-2.5167**	-2.6832***	-3.7043***	-4.8135***	-5.5409***	-7.2452***	-9.3507***		-11.5007***
Wald	10.1459***	12.1797***	23.0334***	41.5123***	59.9831***	119.4579***	193.8326***		354.8720***
ADF	-63.3159***	-12.2289***	-9.3500***	-7.1371***	-6.0016***	-4.8148***	-3.9031***		-2.2326**
R2	0.9945	0.9777	0.9038	0.8273	0.7773	0.6580	0.5246		0.0118
IDR									
a	0.1712**	0.4717***	0.6101***	1.3826***	2.1991***	4.6864***	8.7655***	9.9434***	
Se a	0.0716	0.0926	0.1048	0.1585	0.1954	0.2419	0.3490	0.2010	
β	0.9826***	0.9513***	0.9365***	0.8559***	0.7708***	0.5121***	0.0894**	-0.0326	
Se β	0.0074	0.0096	0.0110	0.0166	0.0204	0.0252	0.0361	0.0209	
t β=1	-2.3447**	-5.0634***	-5.7964***	-8.7081***	-11.2399***	-19.3500***	-25.2281***	-49.4186***	
Wald	13.3941***	28.9506***	34.2424***	76.2729***	126.7461***	375.3967***	673.0654***	2446.1340***	
ADF	-7.1295***	-6.9303***	-9.5979***	-9.5036***	-7.5547***	-5.0157***	-3.9208***	-3.7297***	

R2	0.9676	0.9311	0.9360	0.8540	0.7652	0.4920	0.0246	0.0063	
INR									
a	0.0129***	0.0451***	0.2150***	0.4116***	0.5711***	1.0505***	1.3940***	1.6203***	
Se a	0.0047	0.0174	0.0570	0.0854	0.1038	0.1471	0.1691	0.1939	
β	0.9971***	0.9895***	0.9501***	0.9044***	0.8675***	0.7567***	0.6774***	0.6251***	
Se β	0.0011	0.0040	0.0132	0.0197	0.0240	0.0339	0.0390	0.0447	
t β=1	-2.7218***	-2.6150***	-3.7927***	-4.8472***	-5.5296***	-7.1684***	-8.2766***	-8.3900***	
Wald	12.4008***	7.6377**	15.4731***	25.1851***	32.5654***	53.5264***	71.4270***	74.2097***	
ADF	-63.3854***	-10.5760***	-8.5526***	-7.2807***	-5.6733***	-4.0366***	-3.3966***	-3.1142***	
R2	0.9954	0.9821	0.9153	0.8291	0.7581	0.5538	0.4104	0.3148	
MAD									
a	0.0044*	0.0012	0.0014	0.0021	0.0138	0.0686	0.0408	0.0676	0.5336***
Se a	0.0025	0.0092	0.0286	0.0436	0.0552	0.0782	0.0927	0.1120	0.1990
β	0.9983***	0.9992***	0.9981***	0.9963***	0.9905***	0.9661***	0.9727***	0.9587***	0.7696***
Se β	0.0009	0.0035	0.0107	0.0163	0.0206	0.0291	0.0344	0.0414	0.0726
t β=1	-1.8104*	-0.2208	-0.1818	-0.2247	-0.4616	-1.1633	-0.7930	-0.9954	-3.1726***
Wald	3.5376	4.8187*	11.5077***	21.0992***	30.9539***	62.9570***	103.1380***	139.6268***	330.0190***
ADF	-48.3936***	-9.7158***	-7.0109***	-5.5549***	-4.5705***	-2.9655***	-2.4621**	-2.3653**	-1.7275*
R2	0.9980	0.9919	0.9658	0.9308	0.8961	0.7947	0.7437	0.6673	0.3238
MXN									
a		0.0036	0.0171	0.0435	0.0665	0.1861***	0.4337***	0.6326***	3.3545***
Se a		0.0078	0.0240	0.0367	0.0458	0.0714	0.0971	0.1137	0.1977
β		0.9984***	0.9926***	0.9823***	0.9731***	0.9287***	0.8418***	0.7709***	-0.1080
Se β		0.0027	0.0083	0.0127	0.0158	0.0245	0.0330	0.0387	0.0640
t β=1		-0.5846	-0.8878	-1.3972	-1.7000*	-2.9071***	-4.7892***	-5.9217***	-17.3075***
Wald		4.4219	8.4813**	13.7360***	19.2268***	35.2678***	60.1744***	79.1471***	707.8225***
ADF		-11.4774***	-9.3793***	-7.2231***	-5.7745***	-4.2003***	-2.9886***	-2.7116***	-3.3765***
R2		0.9919	0.9655	0.9292	0.8958	0.7722	0.6005	0.4959	0.0135
MYR									
a	0.0017	-0.0017	-0.0085	-0.0093	-0.0052	0.0182	0.0142	-0.0137	
Se a	0.0015	0.0052	0.0155	0.0237	0.0310	0.0480	0.0538	0.0584	
β	0.9990***	1.0006***	1.0031***	1.0018***	0.9979***	0.9805***	0.9783***	0.9893***	
Se β	0.0008	0.0029	0.0087	0.0133	0.0174	0.0268	0.0301	0.0326	
t β=1	-1.2653	0.2002	0.3557	0.1350	-0.1183	-0.7262	-0.7226	-0.3275	
Wald	3.5850	2.4273	5.3138*	9.4155***	11.9938***	18.9760***	35.0469***	55.5840***	

ADF	-49.1022***	-10.3577***	-7.0012***	-6.3207***	-4.8895***	-3.1724***	-2.6585***	-2.7067***	
R2	0.9983	0.9940	0.9766	0.9516	0.9229	0.8368	0.7895	0.7703	
PHP									
a	0.0052*	0.0124	0.0975***	0.2242***	0.3694***	0.8629***	0.3936***	1.4683***	
Se a	0.0030	0.0113	0.0307	0.0474	0.0600	0.0894	0.1100	0.1143	
β	0.9988***	0.9970***	0.9771***	0.9476***	0.9140***	0.8001***	0.9041***	0.6602***	
Se β	0.0007	0.0026	0.0071	0.0109	0.0138	0.0205	0.0250	0.0261	
t β=1	-1.6967*	-1.1537	-3.2339***	-4.7973***	-6.2203***	-9.7376***	-3.8296***	-13.0205***	
Wald	3.9883	3.2962	11.6928***	24.6593***	40.5921***	97.8936***	63.9603***	182.3185***	
ADF	-63.2031***	-10.9126***	-9.2035***	-7.8828***	-6.5374***	-4.2199***	-3.5870***	-2.6074***	
R2	0.9980	0.9920	0.9735	0.9424	0.9078	0.7821	0.7504	0.6127	
PKR									
a		0.0569***	0.2462***	0.4757***	0.6825***	1.2837***			
Se a		0.0213	0.0619	0.0904	0.1139	0.1542			
β		0.9881***	0.9487***	0.9011***	0.8581***	0.7336***			
Se β		0.0044	0.0128	0.0187	0.0235	0.0318			
t β=1		-2.6924***	-4.0100***	-5.2929***	-6.0296***	-8.3787***			
Wald		8.0238**	17.4677***	29.6973***	38.4093***	73.9848***			
ADF		-9.7330***	-6.8612***	-5.8591***	-4.8202***	-2.9977***			
R2		0.9863	0.9463	0.8925	0.8323	0.6525			
PLZ									
a	0.0025	0.0083	0.0382*	0.0814***	0.1164***	0.2558***	0.4002***	0.4828***	1.0179***
Se a	0.0017	0.0062	0.0196	0.0300	0.0363	0.0515	0.0615	0.0665	0.0732
β	0.9985***	0.9947***	0.9757***	0.9485***	0.9264***	0.8401***	0.7509***	0.6992***	0.3503***
Se β	0.0010	0.0037	0.0116	0.0177	0.0214	0.0303	0.0361	0.0389	0.0435
t β=1	-1.5243	-1.4504	-2.1018**	-2.9118***	-3.4434***	-5.2867***	-6.9088***	-7.7270***	-14.9181***
Wald	2.3349	3.6276	7.6325**	13.7910***	19.4202***	41.5101***	68.9315***	88.0414***	382.4504***
ADF	-53.8742***	-10.1229***	-7.2155***	-6.1197***	-4.9510***	-3.7279***	-2.8344***	-2.2474**	-2.1550**
R2	0.9971	0.9886	0.9493	0.8935	0.8500	0.7088	0.5855	0.5190	0.2154
RUR									
a	0.0319***	0.0363	0.2424**	0.6912***	1.0512***	2.0945***	3.3872***	3.9642***	
Se a	0.0092	0.0350	0.1100	0.1704	0.1984	0.2191	0.2281	0.2103	
β	0.9918***	0.9904***	0.9367***	0.8208***	0.7278***	0.4591***	0.1279**	-0.0199	
Se β	0.0024	0.0090	0.0282	0.0437	0.0508	0.0560	0.0582	0.0536	
t β=1	-3.4792***	-1.0667	-2.2421**	-4.1039***	-5.3588***	-9.6601***	-14.9851***	-19.0389***	

Wald	12.1091***	5.5257*	13.5340***	30.7106***	51.6294***	154.4171***	324.6486***	533.3688***	
ADF	-48.3687***	-10.4403***	-7.2537***	-5.6264***	-4.9367***	-3.8699***	-3.4106***	-3.3941***	
R2	0.9867	0.9456	0.7820	0.5615	0.4331	0.1917	0.0178	0.0020	
THB									
a	0.0033	0.0078	0.0945**	0.2377***	0.4208***	1.0270***	0.4989***	1.7439***	
Se a	0.0033	0.0125	0.0413	0.0656	0.0852	0.1242	0.1146	0.1652	
β	0.9992***	0.9979***	0.9767***	0.9418***	0.8973***	0.7503***	0.8739***	0.5754***	
Se β	0.0008	0.0030	0.0101	0.0159	0.0207	0.0302	0.0277	0.0400	
t β=1	-1.0135	-0.6789	-2.3126**	-3.6486***	-4.9604***	-8.2814***	-4.5507***	-10.6097***	
Wald	1.7428	2.4669	5.7650*	13.6769***	24.8819***	68.6440***	54.3818***	114.3533***	
ADF	-63.5210***	-10.9584***	-8.4661***	-6.9245***	-5.2165***	-3.1524***	-3.0994***	-2.6833***	
R2	0.9975	0.9898	0.9487	0.8845	0.8104	0.5959	0.6964	0.3386	
TRL									
a	0.0696***	0.0651***	0.0406***	0.0368***	0.0340***	0.0268*	0.0879***	0.0483**	1.2051***
Se a	0.0099	0.0102	0.0092	0.0102	0.0111	0.0138	0.0211	0.0219	0.0523
β	0.9423***	0.9439***	0.9669***	0.9609***	0.9539***	0.9304***	0.8256***	0.8358***	-0.2368
Se β	0.0118	0.0122	0.0105	0.0115	0.0126	0.0156	0.0237	0.0240	0.0469
t β=1	-4.8779***	-4.6134***	-3.1568***	-3.3858***	-3.6655***	-4.4619***	-7.3502***	-6.8320***	-26.3600***
Wald	49.0789***	40.6833***	19.9985***	15.5540***	14.5776***	21.6986***	64.2348***	67.1548***	1720.8360***
ADF	-3.0097***	-3.1591***	-3.7257***	-3.5409***	-3.5376***	-3.1790***	-2.7230***	-2.6122***	-2.4153**
R2	0.9397	0.9366	0.9523	0.9424	0.9315	0.8955	0.7380	0.7505	0.0973
TWD									
a		0.0051	0.0506	0.1261**	0.2220***	0.5358***	0.4810***	1.2943***	1.2062***
Se a		0.0121	0.0384	0.0592	0.0758	0.1133	0.1333	0.1691	0.3263
β		0.9988***	0.9876***	0.9691***	0.9454***	0.8676***	0.8809***	0.6782***	0.6954***
Se β		0.0030	0.0097	0.0149	0.0191	0.0286	0.0336	0.0427	0.0819
t β=1		-0.4015	-1.2806	-2.0753**	-2.8616***	-4.6360***	-3.5486***	-7.5381***	-3.7174***
Wald		0.6482	3.5665	8.2297**	14.3874***	34.3084***	18.5868***	78.9091***	14.5585***
ADF		-12.1716***	-9.1553***	-7.7227***	-5.7153***	-4.1791***	-3.4531***	-2.4446**	-1.2641
R2		0.9896	0.9533	0.9021	0.8474	0.6865	0.6143	0.3858	0.2354
ZAR									
a	0.0069***	0.0243***	0.0786***	0.1756***	0.2642***	0.5696***	1.1043***	1.2201***	3.5557***
Se a	0.0024	0.0091	0.0246	0.0368	0.0439	0.0615	0.0808	0.0819	0.1291
β	0.9974***	0.9900***	0.9672***	0.9273***	0.8911***	0.7674***	0.5562***	0.5071***	-0.3788
Se β	0.0010	0.0037	0.0099	0.0148	0.0177	0.0246	0.0319	0.0325	0.0491

t β=1	-2.6951***	-2.7359***	-3.3074***	-4.9016***	-6.1651***	-9.4582***	-13.9156***	-15.1845***	-28.0809***
Wald	13.4654***	8.6082**	12.8668***	26.5008***	41.1012***	94.2197***	205.5230***	241.2177***	889.3404***
ADF	-63.3434***	-11.8659***	-9.3277***	-7.1947***	-6.2066***	-4.5103***	-3.2707***	-3.0013***	-2.8602***
R2	0.9963	0.9848	0.9491	0.8957	0.8523	0.6968	0.4128	0.3765	0.2041
Mean									
a	0.0144	0.0295	0.0802	0.1741	0.2689	0.5592	0.7799	0.9801	1.1893
Se a	0.0055	0.0130	0.0341	0.0508	0.0623	0.0836	0.0954	0.0990	0.1649
β	0.9955	0.9933	0.9808	0.9592	0.9374	0.8662	0.8165	0.7559	0.5234
se β	0.0016	0.0037	0.0102	0.0151	0.0185	0.0257	0.0297	0.0339	0.0585
t β=1	-0.3463	-0.2097	-0.2906	-0.4118	-0.5237	-0.8467	-0.9744	-1.3729	-1.8848
Wald	7.0893	6.0752	9.4119	17.8531	27.6801	67.5239	112.3093	203.6597	431.8630
R2	0.9935	0.9854	0.9521	0.9053	0.8634	0.7404	0.6490	0.5649	0.3281

We use the Dynamic Ordinary Least Squares (DOLS) estimator. For each economy we test for different time forward rates with different time to maturity. We report the values and standard errors of α and β, R squares of the equation, also the t statistics of testing β=1, the Wald statistics of joint test for α=1 and β=1, and the test statistics of unit root test (ADF) for the residuals of the equation. We calculate the mean of these statistics across the economies. Empty entries due to missing data in forward rates. Standard currency short codes are employed.

* Significance at 10%

** Significance at 5%

*** Significance at 1%

Table 3.6.5: Simple efficiency hypothesis DOLS test equation for USD exchange rates

	TN	1W	1M	2M	3M	6M	9M	1Y	2Y
AUD									
a	0.0002	-0.0006	-0.0019	-0.0030	-0.0041	-0.0034	-0.0138	0.0001	0.0026
Se a	0.0002	0.0008	0.0027	0.0042	0.0055	0.0087	0.0109	0.0138	0.0238
β	0.9994***	-0.9994	-0.9960	-0.9897	-0.9834	-0.9529	-0.9291	-0.8864	-0.4540
Se β	0.0006	0.0022	0.0073	0.0114	0.0146	0.0229	0.0277	0.0352	0.0861
t β=1	-0.9131	-897.5679***	-272.9289***	-174.7783***	-135.7746***	-85.2052***	-69.5424***	-53.5413***	-16.8871***
Wald	0.8506	2355964.0000***	227624.1000***	95431.5900***	58974.9400***	25174.5700***	17401.3100***	11770.2200***	2179.4760***
ADF	-63.2922***	-10.6455***	-8.5502***	-7.3102***	-5.9670***	-3.7955***	-3.2656***	-2.6861***	-1.8342*
R2	0.9985	0.9944	0.9732	0.9431	0.9116	0.8042	0.7220	0.6112	0.1064
CAD									
a	0.0000	0.0000	-0.0000	-0.0002	-0.0005	0.0002	-0.0015	-0.0002	0.0218***
Se a	0.0001	0.0005	0.0017	0.0024	0.0031	0.0049	0.0058	0.0071	0.0070
β	0.9995***	0.9983***	0.9944***	0.9893***	0.9837***	0.9599***	0.9292***	0.9201***	0.3022***
Se β	0.0005	0.0019	0.0059	0.0088	0.0111	0.0173	0.0207	0.0249	0.0501
t β=1	-0.8717	-0.8740	-0.9439	-1.2219	-1.4584	-2.3224**	-3.4153***	-3.2018***	-13.9199***
Wald	1.4763	1.9241	2.4714	4.6018	6.9700**	15.0402***	37.1537***	31.7623***	355.1551***
ADF	-63.3579***	-12.2387***	-8.7664***	-7.9206***	-6.2741***	-4.5006***	-3.3815***	-2.9961***	-2.3491**
R2	0.9989	0.9955	0.9818	0.9649	0.9461	0.8795	0.8227	0.7709	0.1332
CHF									
a	-0.0000	0.0001	0.0010	0.0012	0.0012	0.0017	0.0010	0.0037	-0.0485
Se a	0.0002	0.0006	0.0021	0.0031	0.0038	0.0054	0.0063	0.0077	0.0091
β	0.9995***	0.9993***	0.9956***	0.9919***	0.9893***	0.9800***	0.9630***	0.9565***	1.0110***
Se β	0.0005	0.0021	0.0068	0.0102	0.0125	0.0180	0.0214	0.0261	0.0699
t β=1	-0.9724	-0.3546	-0.6466	-0.7949	-0.8578	-1.1104	-1.7340*	-1.6660*	0.1578
Wald	3.3350	0.1371	0.4205	0.7328	1.0068	1.9695	6.2002**	4.5035	67.0813***
ADF	-63.4334***	-11.5813***	-9.4252***	-7.3522***	-6.1090***	-4.2106***	-3.4185***	-3.1936***	-2.2420**
R2	0.9988	0.9954	0.9768	0.9539	0.9346	0.8748	0.8241	0.7684	0.4705
XEU									

a	-0.0002	-0.0006	-0.0030	-0.0067	-0.0102	-0.0220	-0.0336	-0.0453	-0.2522
Se a	0.0002	0.0006	0.0020	0.0030	0.0037	0.0053	0.0064	0.0074	0.0202
β	0.9992***	0.9971***	0.9852***	0.9685***	0.9539***	0.9028***	0.8516***	0.7991***	0.1732***
Se β	0.0006	0.0024	0.0080	0.0123	0.0151	0.0217	0.0265	0.0305	0.0671
t β=1	-1.2842	-1.2081	-1.8497*	-2.5523**	-3.0509***	-4.4787***	-5.6017***	-6.5924***	-12.3173***
Wald	1.7737	1.4793	3.4895	6.7860**	9.9350***	21.7818***	34.0984***	47.0669***	156.1272***
ADF	-60.9739***	-9.7345***	-8.1417***	-6.7608***	-5.6733***	-4.0656***	-3.2415***	-2.7052***	-2.5299**
R2	0.9985	0.9938	0.9688	0.9335	0.9035	0.8088	0.7219	0.6385	0.0290

GBP

a	-0.0008	-0.0030	-0.0147	-0.0309	-0.0477	-0.1113	-0.1617	-0.2048	-0.3850
Se a	0.0005	0.0018	0.0057	0.0086	0.0107	0.0159	0.0186	0.0210	0.0401
β	0.9983***	0.9942***	0.9716***	0.9404***	0.9085***	0.7857***	0.6869***	0.6034***	0.2618***
Se β	0.0009	0.0035	0.0112	0.0168	0.0209	0.0312	0.0364	0.0413	0.0717
t β=1	-1.8079*	-1.6709*	-2.5505**	-3.5364***	-4.3710***	-6.8596***	-8.5993***	-9.5997***	-10.2887***
Wald	3.8127	2.8478	6.6347**	12.8364***	19.7888***	48.6597***	75.8467***	95.4305***	115.7673***
ADF	-63.2039***	-10.6395***	-9.2826***	-7.5414***	-6.0674***	-3.7492***	-2.9467***	-2.6929***	-1.4573
R2	0.9967	0.9864	0.9368	0.8717	0.8102	0.6009	0.4523	0.3466	0.0552

HKD

a	0.0195***	0.0057	0.2339***	0.9262***	1.6467***	2.2252***	2.2008***	2.1296***	2.3076***
Se a	0.0037	0.0159	0.0601	0.0883	0.0874	0.0474	0.0272	0.0212	0.0628
β	0.9905***	0.9972***	0.8860***	0.5484***	0.1971***	-0.0849	-0.0728	-0.0382	-0.1258
Se β	0.0018	0.0078	0.0293	0.0430	0.0426	0.0231	0.0133	0.0103	0.0307
t β=1	-5.3362***	-0.3560	-3.8902***	-10.4913***	-18.8427***	-46.9628***	-80.8370***	-100.5457***	-36.6238***
Wald	34.1133***	4.1821	16.2610***	111.0254***	355.4370***	2211.0640***	6568.4270***	10301.2500***	3967.7150***
ADF	-61.7586***	-10.6345***	-6.9164***	-5.2121***	-3.7443***	-3.7183***	-3.5937***	-3.7842***	-2.9231***
R2	0.9885	0.9491	0.6585	0.2715	0.0480	0.0312	0.0648	0.0328	0.0659

ILS

a	0.0027*	0.0096	0.0468**	0.1007***	0.1488***	0.3575***	0.5249***	0.6081***	0.8233***
Se a	0.0016	0.0063	0.0200	0.0296	0.0360	0.0513	0.0605	0.0644	0.0660
β	0.9980***	0.9927***	0.9645***	0.9238***	0.8876***	0.7332***	0.6095***	0.5466***	0.3735***
Se β	0.0012	0.0045	0.0144	0.0213	0.0259	0.0369	0.0434	0.0461	0.0465
t β=1	-1.7224*	-1.6232	-2.4646**	-3.5733***	-4.3429***	-7.2310***	-8.9953***	-9.8305***	-13.4624***
Wald	3.1941	4.2413	9.2282***	18.5341***	27.1968***	66.1177***	100.0541***	124.8742***	377.1897***
ADF	-48.4262***	-8.2404***	-6.2676***	-5.5124***	-4.5371***	-2.8211***	-2.1102**	-1.8282*	-2.4018**
R2	0.9967	0.9859	0.9358	0.8712	0.8150	0.5826	0.4186	0.3459	0.2150

JPY									
a	0.0060*	0.0099	0.0508	0.1122*	0.1856**	0.3198***	0.3698***	0.3588**	0.0211
Se a	0.0033	0.0122	0.0400	0.0607	0.0782	0.1163	0.1255	0.1656	0.3670
β	0.9987***	0.9979***	0.9894***	0.9765***	0.9610***	0.9326***	0.9209***	0.9249***	0.9898***
Se β	0.0007	0.0026	0.0086	0.0130	0.0168	0.0249	0.0269	0.0356	0.0801
t β=1	-1.9027*	-0.7909	-1.2334	-1.8056*	-2.3275**	-2.7021***	-2.9367***	-2.1117**	-0.1269
Wald	6.2311**	1.0819	2.8050	4.9999*	7.4580**	9.6791***	8.7723**	8.3460**	10.7409***
ADF	-63.4122***	-11.1278***	-8.7736***	-7.5653***	-6.1943***	-3.9077***	-3.6892***	-3.3205***	-1.5427
R2	0.9980	0.9922	0.9631	0.9251	0.8816	0.7684	0.7286	0.6257	0.3952
NOK									
a	0.0016	0.0074	0.0346**	0.0706***	0.1091***	0.2250***	0.3306***	0.4278***	1.7117***
Se a	0.0014	0.0052	0.0166	0.0254	0.0324	0.0470	0.0543	0.0638	0.1330
β	0.9992***	0.9959***	0.9812***	0.9616***	0.9406***	0.8777***	0.8179***	0.7678***	0.0364
Se β	0.0007	0.0027	0.0086	0.0132	0.0168	0.0244	0.0281	0.0329	0.0729
t β=1	-1.1669	-1.5182	-2.1720**	-2.9105***	-3.5328***	-5.0240***	-6.4878***	-7.0550***	-13.2146***
Wald	1.3620	3.3012	5.7605*	10.5914***	15.8417***	32.5308***	62.4742***	65.7625***	253.9507***
ADF	-63.3656***	-10.6310***	-8.3576***	-7.7251***	-6.1792***	-4.2572***	-3.3993***	-2.9773***	-2.6715***
R2	0.9978	0.9916	0.9618	0.9206	0.8766	0.7548	0.6623	0.5742	0.0011
NZD									
a	0.0004	-0.0000	0.0014	0.0031	0.0052	0.0233*	0.0258	0.0707***	0.3400***
Se a	0.0003	0.0013	0.0041	0.0062	0.0079	0.0128	0.0160	0.0204	0.0383
β	-0.9993	-0.9984	-0.9908	-0.9812	-0.9709	-0.9172	-0.8783	-0.7925	0.0342
Se β	0.0006	0.0024	0.0078	0.0118	0.0149	0.0239	0.0290	0.0368	0.0873
t β=1	-3085.0913***	-823.9144***	-255.5289***	-168.1346***	-132.0770***	-80.2918***	-64.7315***	-48.7425***	-11.0695***
Wald	59278934.0000***	4245493.0000***	424046.7000***	188104.9000***	119044.9000***	48346.7000***	33120.6400***	21836.1500***	10040.1000***
ADF	-63.3629***	-10.7456***	-8.6175***	-7.4615***	-6.1575***	-3.8468***	-3.1525***	-2.5216**	-1.6281*
R2	0.9983	0.9932	0.9693	0.9380	0.9057	0.7779	0.6795	0.5358	0.0007
SGD									
a	-0.0000	-0.0003	0.0009	0.0019	0.0023	0.0021	-0.0226	0.0097	0.0055
Se a	0.0002	0.0008	0.0028	0.0045	0.0056	0.0083	0.0088	0.0130	0.0190
β	0.9998***	1.0006***	0.9985***	0.9968***	0.9962***	0.9978***	1.0389***	0.9807***	0.8440***
Se β	0.0005	0.0018	0.0062	0.0098	0.0124	0.0182	0.0191	0.0286	0.0483
t β=1	-0.4360	0.3351	-0.2327	-0.3294	-0.3036	-0.1204	2.0316**	-0.6724	-3.2284***
Wald	3.6123	0.1306	0.1797	0.3075	0.3161	0.3318	10.1445***	0.6092	219.9871***

ADF	-63.3892***	-11.4305***	-9.0151***	-7.3836***	-5.7830***	-4.1001***	-3.8936***	-3.4688***	-1.7512*
R2	0.9990	0.9963	0.9805	0.9580	0.9364	0.8766	0.8715	0.7433	0.5654
AED									
a	0.4754***	1.0284***	1.2581***	1.2756***	1.2893***	1.3027***	1.3036***	1.3026***	1.3018***
Se a	0.0385	0.0196	0.0076	0.0044	0.0031	0.0018	0.0014	0.0011	0.0010
β	0.6346***	0.2095***	0.0330***	0.0195***	0.0090***	-0.0013	-0.0020	-0.0012	-0.0007
Se β	0.0296	0.0151	0.0058	0.0034	0.0024	0.0014	0.0011	0.0008	0.0008
t β=1	-12.3622***	-52.4170***	-165.6222***	-288.2381***	-418.7752***	-708.7453***	-953.4731***	-1186.6155***	-1255.0241***
Wald	153.1358***	2750.4200***	27512.0600***	83385.0900***	176027.2000***	505230.9000***	916039.1000***	1417493.0000***	1599344.0000***
ADF	-6.6452***	-12.4417***	-11.5721***	-11.1294***	-10.9818***	-10.6083***	-10.2697***	-10.4402***	-7.7957***
R2	0.2099	0.1656	0.0359	0.0351	0.0164	0.0015	0.0041	0.0025	0.0047
BRL									
a		0.0064**	0.0294***	0.0664***	0.1096***	0.2304***	0.3234***	0.3927***	0.4827***
Se a		0.0030	0.0093	0.0140	0.0178	0.0231	0.0266	0.0271	0.0292
β		0.9874***	0.9438***	0.8779***	0.8044***	0.6059***	0.4568***	0.3441***	0.1735***
Se β		0.0041	0.0128	0.0189	0.0237	0.0300	0.0337	0.0332	0.0316
t β=1		-3.0660***	-4.4102***	-6.4462***	-8.2358***	-13.1172***	-16.1062***	-19.7379***	-26.1626***
Wald		21.9924***	42.2320***	82.5915***	125.9337***	301.9986***	467.8309***	743.8782***	2127.7860***
ADF		-9.4384***	-6.7464***	-5.4788***	-4.6706***	-3.2117***	-2.8704***	-2.7446***	-2.1356**
R2		0.9883	0.9465	0.8853	0.8100	0.5885	0.4004	0.2875	0.1134
CLP									
a		0.0811**	0.3923***	0.9074***	1.5304***	3.2764***	4.7096***	5.2914***	6.2458***
Se a		0.0383	0.1276	0.1903	0.2420	0.3057	0.3430	0.3546	0.3959
β		0.9870***	0.9369***	0.8541***	0.7542***	0.4746***	0.2454***	0.1523***	-0.0008
Se β		0.0061	0.0204	0.0303	0.0386	0.0487	0.0546	0.0564	0.0627
t β=1		-2.1363**	-3.1016***	-4.8061***	-6.3704***	-10.7893***	-13.8266***	-15.0331***	-15.9662***
Wald		6.2527**	13.1162***	30.0891***	51.2253***	143.6522***	237.5381***	293.3593***	463.8525***
ADF		-10.1066***	-5.6097***	-5.8880***	-4.7435***	-3.1316***	-2.5146**	-2.3737**	-1.9073*
R2		0.9743	0.8745	0.7422	0.5915	0.2543	0.0695	0.0270	0.0009
CNY									
a		-0.0075	-0.0313	-0.0589	-0.0851	-0.1349	-0.1484	-0.1369	0.3482***
Se a		0.0012	0.0039	0.0061	0.0081	0.0155	0.0225	0.0309	0.0770
β		1.0037***	1.0154***	1.0290***	1.0421***	1.0673***	1.0747***	1.0695***	0.8161***

Se β		0.0006	0.0019	0.0030	0.0040	0.0078	0.0113	0.0155	0.0396
t β=1		6.0777***	7.9606***	9.5659***	10.4438***	8.6561***	6.6108***	4.4691***	-4.6461***
Wald		43.8905***	72.5992***	100.4552***	116.0342***	75.8147***	43.7264***	20.5384***	30.7524***
ADF		-10.4235***	-8.0068***	-6.7064***	-5.2608***	-3.6730***	-2.7273***	-2.5130**	-1.9749**
R2		0.9997	0.9987	0.9970	0.9951	0.9834	0.9671	0.9405	0.6445
COP									
a		0.0759**	0.3640***	0.8484***	1.3527***	2.6258***	3.5571***	3.7717***	4.2603***
Se a		0.0352	0.1177	0.1827	0.2285	0.2870	0.3192	0.3251	0.3731
β		0.9899***	0.9516***	0.8875***	0.8207***	0.6523***	0.5290***	0.4995***	0.4302***
Se β		0.0046	0.0154	0.0239	0.0299	0.0375	0.0416	0.0423	0.0481
t β=1		-2.1873**	-3.1396***	-4.7103***	-6.0023***	-9.2829***	-11.3266***	-11.8400***	-11.8464***
Wald		8.9073**	17.6623***	37.2044***	59.9288***	148.8816***	244.1677***	334.7014***	832.4887***
ADF		-8.3679***	-6.2087***	-5.4302***	-4.1512***	-2.9544***	-2.4973**	-2.0651**	-2.1197**
R2		0.9851	0.9259	0.8336	0.7401	0.5175	0.3715	0.3442	0.2549
CZK									
a	0.0010	0.0073	0.0335*	0.0663**	0.0967***	0.2015***	0.3222***	0.3601***	2.0216***
Se a	0.0014	0.0055	0.0187	0.0284	0.0352	0.0509	0.0582	0.0645	0.1372
β	0.9997***	0.9975***	0.9888***	0.9778***	0.9676***	0.9324***	0.8908***	0.8776***	0.3095***
Se β	0.0004	0.0017	0.0058	0.0088	0.0108	0.0156	0.0179	0.0198	0.0455
t β=1	-0.7251	-1.4427	-1.9354*	-2.5282**	-2.9962***	-4.3191***	-6.0884***	-6.1912***	-15.1837***
Wald	1.0062	3.8154	6.1622**	10.9698***	16.1529***	33.8701***	71.9526***	81.0751***	327.2825***
ADF	-63.3742***	-11.0885***	-8.7101***	-7.1189***	-5.8263***	-4.0921***	-3.2166***	-3.3838***	-2.2208**
R2	0.9992	0.9968	0.9830	0.9646	0.9478	0.8938	0.8508	0.8295	0.1637
HUF									
a	0.0101**	0.0414**	0.2033***	0.4160***	0.6068***	1.2138***	1.7099***	1.9418***	5.0803***
Se a	0.0051	0.0193	0.0641	0.0959	0.1165	0.1627	0.1809	0.1912	0.3696
β	0.9982***	0.9921***	0.9614***	0.9212***	0.8851***	0.7708***	0.6776***	0.6336***	0.0406
Se β	0.0009	0.0036	0.0119	0.0178	0.0216	0.0301	0.0333	0.0352	0.0689
t β=1	-1.9214*	-2.2016**	-3.2427***	-4.4364***	-5.3250***	-7.6266***	-9.6717***	-10.4211***	-13.9253***
Wald	7.7287**	8.6447**	16.8402***	31.0321***	45.3446***	91.0115***	148.1126***	186.5563***	277.5701***
ADF	-63.3576***	-10.9480***	-8.6569***	-6.9541***	-5.6386***	-3.9672***	-3.0528***	-2.6521***	-1.9783**
R2	0.9964	0.9855	0.9312	0.8613	0.8013	0.6220	0.4887	0.4333	0.0025
IDR									
a	0.4226**	0.8555***	0.7900***	1.6003***	2.4547***	4.8877***	10.4787***	9.8093***	
Se a	0.1691	0.1798	0.1180	0.1645	0.1968	0.2268	0.2668	0.1509	

β	0.9520***	0.9045***	0.9110***	0.8217***	0.7275***	0.4608***	-0.1470	-0.0747	
Se β	0.0185	0.0197	0.0130	0.0181	0.0216	0.0248	0.0290	0.0165	
t β=1	-2.5903***	-4.8514***	-6.8543***	-9.8581***	-12.6057***	-21.7032***	-39.6135***	-65.3078***	
Wald	45.6380***	63.5941***	67.6382***	110.4044***	171.6101***	485.7306***	1928.9880***	4323.5080***	
ADF	-4.0340***	-3.8675***	-7.5478***	-8.8539***	-7.4053***	-5.4496***	-4.1612***	-6.0581***	
R2	0.8573	0.8082	0.9115	0.8203	0.7222	0.4470	0.0730	0.0464	
INR									
a	0.0034	0.0366***	0.1775***	0.3409***	0.4947***	0.9505***	1.5614***	2.2112***	
Se a	0.0029	0.0112	0.0407	0.0639	0.0802	0.1150	0.1427	0.1728	
β	0.9992***	0.9903***	0.9532***	0.9101***	0.8696***	0.7500***	0.5903***	0.4208***	
Se β	0.0008	0.0029	0.0107	0.0167	0.0210	0.0300	0.0372	0.0450	
t β=1	-1.0841	-3.3211***	-4.3961***	-5.3865***	-6.2233***	-8.3343***	-11.0149***	-12.8772***	
Wald	21.2704***	14.7290***	22.9026***	34.4084***	45.8338***	80.2332***	136.0205***	182.8634***	
ADF	-63.3789***	-10.5997***	-8.6572***	-6.5802***	-5.2424***	-3.2306***	-2.5721***	-1.8761*	
R2	0.9979	0.9906	0.9435	0.8734	0.8061	0.6111	0.3733	0.1753	
MAD									
a	0.0099**	0.0330**	0.1853***	0.3863***	0.5461***	1.1443***	1.5604***	1.6445***	1.7938***
Se a	0.0041	0.0152	0.0498	0.0736	0.0869	0.1109	0.1246	0.1295	0.1198
β	0.9954***	0.9842***	0.9116***	0.8159***	0.7397***	0.4571***	0.2613***	0.2213***	0.1457***
Se β	0.0019	0.0071	0.0234	0.0345	0.0407	0.0518	0.0580	0.0601	0.0547
t β=1	-2.3802**	-2.2186**	-3.7811***	-5.3338***	-6.3923***	-10.4830***	-12.7377***	-12.9671***	-15.6143***
Wald	6.0146**	7.2211**	19.2436***	38.4340***	57.4768***	148.9745***	227.1727***	266.3173***	740.0526***
ADF	-48.4303***	-8.8030***	-6.5705***	-5.1764***	-4.2784***	-3.1131***	-2.4046**	-2.2129**	-2.6251***
R2	0.9915	0.9666	0.8337	0.6714	0.5558	0.2183	0.0699	0.0486	0.0318
MXN									
a		0.0037	0.0108	0.0358	0.0654	0.2082***	0.5332***	0.6181***	2.0179***
Se a		0.0069	0.0204	0.0326	0.0424	0.0675	0.0921	0.1026	0.1568
β		0.9980***	0.9936***	0.9813***	0.9672***	0.9030***	0.7664***	0.7270***	0.1868***
Se β		0.0029	0.0086	0.0137	0.0177	0.0280	0.0378	0.0421	0.0618
t β=1		-0.6766	-0.7499	-1.3664	-1.8495*	-3.4617***	-6.1830***	-6.4924***	-13.1672***
Wald		7.3553**	13.5948***	21.6141***	30.0650***	57.6047***	106.0083***	130.2463***	227.7640***
ADF		-10.0662***	-7.8843***	-7.3882***	-5.5646***	-3.9484***	-2.8111***	-2.7080***	-2.0555**
R2		0.9906	0.9636	0.9190	0.8717	0.7116	0.4880	0.4254	0.0375
MYR									
a	0.0779***	0.0780***	0.1512***	0.2244***	0.2450***	0.3914***	0.4559***	0.5787***	

Se a	0.0058	0.0068	0.0146	0.0196	0.0226	0.0281	0.0308	0.0313	
β	0.9335***	0.9330***	0.8701***	0.8071***	0.7883***	0.6624***	0.6060***	0.5020***	
Se β	0.0047	0.0055	0.0117	0.0158	0.0181	0.0223	0.0243	0.0245	
t β=1	-14.2600***	-12.1780***	-11.0595***	-12.2312***	-11.6804***	-15.1353***	-16.1816***	-20.2894***	
Wald	299.1827***	234.7452***	200.1251***	247.6626***	243.9968***	410.1590***	494.6606***	738.1952***	
ADF	-2.5877***	-3.4884***	-4.3715***	-4.4656***	-3.6725***	-2.6538***	-2.1244**	-1.9600**	
R2	0.9919	0.9868	0.9491	0.9047	0.8753	0.7732	0.6875	0.6047	
PHP									
a	0.0049**	0.0237**	0.1276***	0.2815***	0.4459***	1.0021***	0.7878***	1.8843***	
Se a	0.0025	0.0101	0.0247	0.0389	0.0491	0.0697	0.0992	0.0930	
β	0.9988***	0.9937***	0.9661***	0.9256***	0.8823***	0.7369***	0.7891***	0.5073***	
Se β	0.0006	0.0026	0.0064	0.0101	0.0128	0.0181	0.0255	0.0240	
t β=1	-1.9002*	-2.4133**	-5.2527***	-7.3445***	-9.2056***	-14.5394***	-8.2722***	-20.5557***	
Wald	8.6885**	10.6728***	31.1335***	59.0133***	91.5757***	224.9889***	180.7107***	462.8611***	
ADF	-63.1727***	-11.8347***	-9.9143***	-9.4833***	-6.5686***	-4.3248***	-3.2379***	-2.2709**	
R2	0.9981	0.9915	0.9773	0.9477	0.9150	0.7961	0.6889	0.5257	
PKR									
a		0.0132***	0.0570***	0.1069***	0.1587***	0.3314***			
Se a		0.0048	0.0163	0.0251	0.0341	0.0560			
β		0.9969***	0.9865***	0.9747***	0.9625***	0.9219***			
Se β		0.0011	0.0038	0.0058	0.0079	0.0130			
t β=1		-2.7834***	-3.5731***	-4.3264***	-4.7196***	-6.0039***			
Wald		9.6376***	14.9201***	21.0044***	24.5935***	39.3763***			
ADF		-8.0733***	-5.4001***	-4.2824***	-3.8224***	-2.0794**			
R2		0.9992	0.9956	0.9902	0.9821	0.9462			
PLZ									
a	0.0025*	0.0118**	0.0566***	0.1191***	0.1744***	0.3686***	0.5216***	0.5847***	1.0741***
Se a	0.0013	0.0049	0.0157	0.0240	0.0293	0.0414	0.0466	0.0476	0.0647
β	0.9979***	0.9890***	0.9475***	0.8902***	0.8394***	0.6642***	0.5257***	0.4661***	0.0014
Se β	0.0011	0.0042	0.0134	0.0205	0.0249	0.0351	0.0393	0.0400	0.0572
t β=1	-1.9118*	-2.6066***	-3.9187***	-5.3520***	-6.4373***	-9.5652***	-12.0678***	-13.3330***	-17.4725***
Wald	3.7106	8.7586**	19.2452***	35.2182***	51.0370***	108.7986***	174.1055***	218.8773***	344.4714***
ADF	-53.8558***	-10.1983***	-7.5789***	-6.0095***	-4.8301***	-3.3834***	-2.6348***	-2.2199**	-1.9169*
R2	0.9963	0.9847	0.9291	0.8460	0.7740	0.5321	0.3688	0.3120	0.0005
RUR									

a	0.0045	0.0463***	0.2256***	0.4901***	0.7383***	1.5363***	2.1260***	2.3863***	
Se a	0.0043	0.0166	0.0537	0.0839	0.1015	0.1333	0.1489	0.1515	
β	0.9987***	0.9860***	0.9317***	0.8521***	0.7774***	0.5385***	0.3626***	0.2852***	
Se β	0.0013	0.0049	0.0160	0.0250	0.0302	0.0396	0.0441	0.0448	
t β=1	-1.0392	-2.8429***	-4.2613***	-5.9173***	-7.3706***	-11.6623***	-14.4521***	-15.9602***	
Wald	1.8505	11.2864***	23.2380***	42.3669***	64.7589***	154.0644***	232.6006***	285.6671***	
ADF	-48.3005***	-8.7326***	-7.4437***	-6.3823***	-4.6368***	-2.3713**	-1.8195*	-1.7689*	
R2	0.9961	0.9826	0.9159	0.8089	0.7148	0.3993	0.2004	0.1336	
THB									
a	0.0025	0.0119	0.1181***	0.2905***	0.4816***	1.0758***	0.7072***	1.8364***	
Se a	0.0026	0.0100	0.0352	0.0580	0.0755	0.1053	0.0946	0.1368	
β	0.9993***	0.9965***	0.9668***	0.9188***	0.8656***	0.7011***	0.7978***	0.4896***	
Se β	0.0007	0.0028	0.0098	0.0161	0.0209	0.0291	0.0260	0.0377	
t β=1	-0.9589	-1.2594	-3.3968***	-5.0518***	-6.4295***	-10.2704***	-7.7686***	-13.5469***	
Wald	1.0586	5.5116*	12.6442***	26.7320***	42.6717***	106.9875***	125.8429***	191.6119***	
ADF	-63.5264***	-9.9956***	-8.3668***	-9.4511***	-6.9757***	-3.1277***	-2.7988***	-2.8587***	
R2	0.9981	0.9918	0.9509	0.8780	0.7974	0.5808	0.6854	0.2957	
TRL									
a	0.0402***	0.0363***	0.0225***	0.0127*	0.0030	-0.0262	-0.0368	-0.0738	0.3669***
Se a	0.0074	0.0075	0.0074	0.0077	0.0080	0.0091	0.0121	0.0135	0.0468
β	0.9515***	0.9531***	0.9771***	0.9757***	0.9732***	0.9625***	0.8929***	0.8934***	0.0825
Se β	0.0125	0.0128	0.0105	0.0111	0.0118	0.0142	0.0227	0.0225	0.0823
t β=1	-3.8828***	-3.6507***	-2.1823**	-2.1784**	-2.2601**	-2.6489***	-4.7143***	-4.7432***	-11.1436***
Wald	40.0129***	32.3926***	14.0924***	7.2939**	5.1756*	17.9966***	57.0941***	81.5738***	413.8129***
ADF	-3.0821***	-3.1522***	-3.2426***	-3.5833***	-3.6456***	-3.1567***	-2.7964***	-2.5468**	-1.4218
R2	0.9344	0.9311	0.9531	0.9476	0.9411	0.9177	0.7822	0.7974	0.0048
TWD									
a		0.0275**	0.1682***	0.3835***	0.6123***	1.3107***	1.4290***	2.4252***	3.5165***
Se a		0.0120	0.0380	0.0614	0.0784	0.1106	0.1274	0.1339	0.3336
β		0.9921***	0.9518***	0.8900***	0.8243***	0.6237***	0.5891***	0.3031***	-0.0206
Se β		0.0034	0.0110	0.0177	0.0226	0.0319	0.0367	0.0387	0.0972
t β=1		-2.2866**	-4.4022***	-6.2101***	-7.7638***	-11.7888***	-11.1891***	-18.0217***	-10.4982***
Wald		5.8945*	22.0961***	43.1529***	66.7286***	151.7965***	127.6913***	352.9854***	130.4140***
ADF		-12.2326***	-8.8644***	-6.3397***	-4.9222***	-3.4073***	-3.0692***	-1.9943**	-1.1065
R2		0.9869	0.9376	0.8485	0.7529	0.4777	0.3748	0.1345	0.0004

ZAR									
a	0.0045**	0.0173**	0.0581***	0.1341***	0.2151***	0.4792***	0.9100***	1.0367***	2.1000***
Se a	0.0019	0.0070	0.0193	0.0298	0.0375	0.0534	0.0684	0.0713	0.1046
β	0.9979***	0.9909***	0.9690***	0.9293***	0.8874***	0.7523***	0.5400***	0.4726***	-0.0329
Se β	0.0009	0.0035	0.0098	0.0150	0.0188	0.0267	0.0336	0.0352	0.0503
t β=1	-2.1866**	-2.6040***	-3.1744***	-4.7116***	-5.9758***	-9.2840***	-13.7018***	-15.0016***	-20.5492***
Wald	12.0638***	8.1035**	12.4129***	25.4196***	39.7175***	92.9580***	201.7596***	239.5810***	456.9730***
ADF	-63.3193***	-10.8290***	-8.3772***	-6.8519***	-5.7902***	-4.1140***	-2.5396**	-2.6175***	-2.2925**
R2	0.9965	0.9861	0.9509	0.8939	0.8346	0.6534	0.3752	0.3106	0.0020

Mean									
a	0.0454	0.0792	0.1532	0.2936	0.4378	0.8192	1.2011	1.3741	1.4649
Se a	0.0108	0.0149	0.0310	0.0465	0.0570	0.0741	0.0849	0.0878	0.1248
β	0.8933	0.8339	0.8047	0.7608	0.7178	0.6081	0.5128	0.4524	0.2324
se β	0.0034	0.0046	0.0108	0.0161	0.0195	0.0257	0.0300	0.0327	0.0588
t β=1	-26.7803	-10.6060	-4.4898	-4.3279	-4.8268	-6.5029	-8.5970	-10.3947	-13.2866
Wald	2469983.1301	213056.1339	21931.3551	11874.0988	11478.7371	18839.8143	32622.3401	49030.4457	67644.1879
R2	0.9556	0.9537	0.9101	0.8458	0.7876	0.6350	0.5096	0.4223	0.1375

We use the Dynamic Ordinary Least Squares (DOLS) estimator. For each economy we test for different time forward rates with different time to maturity. We report the values and standard errors of α and β, R squares of the equation, also the t statistics of testing β=1, the Wald statistics of joint test for α=1 and β=1, and the test statistics of unit root test (ADF) for the residuals of the equation. We calculate the mean of these statistics across the economies. Empty entries are due to missing data in forward rates. Standard currency short codes are employed.

* Significance at 10%

** Significance at 5%

*** Significance at 1%

Table 3.6.6: Simple efficiency hypothesis DOLS test equation for EURO exchange rates

	TN	1W	1M	2M	3M	6M	9M	1Y	2Y
AUD									
a	0.0008	0.0010	-0.3284	0.0069	0.0096	0.0135	0.0153	0.0350	0.1173*
Se a	0.0005	0.0018	0.0325	0.0080	0.0100	0.0151	0.0203	0.0261	0.0608
β	0.9983***	0.9957***	1.5663***	0.9683***	0.9550***	0.9253***	0.9008***	0.8427***	0.5536***
Se β	0.0010	0.0038	0.0635	0.0164	0.0203	0.0302	0.0398	0.0500	0.1091
t β=1	-1.6768*	-1.1337	8.9145***	-1.9326*	-2.2176**	-2.4768**	-2.4941**	-3.1461***	-4.0912***
Wald	2.8165	6.6741**	207.8279***	24.3767***	34.7051***	61.4760***	88.2298***	114.4186***	244.9043***
ADF	-60.9149***	-10.8920***	-2.8317***	-7.3295***	-6.4875***	-4.7627***	-3.7982***	-3.1970***	-1.3948
R2	0.9960	0.9843	0.5886	0.8865	0.8366	0.6956	0.5628	0.4218	0.1004
CAD									
a	0.0015***	0.0054***	0.0245***	0.0454***	0.0665***	0.1245***	0.1681***	0.2377***	0.2792***
Se a	0.0005	0.0020	0.0061	0.0087	0.0105	0.0149	0.0178	0.0204	0.0321
β	0.9960***	0.9848***	0.9312***	0.8726***	0.8142***	0.6546***	0.5340***	0.3504***	0.1955**
Se β	0.0013	0.0050	0.0155	0.0221	0.0269	0.0377	0.0447	0.0509	0.0785
t β=1	-3.0235***	-3.0259***	-4.4290***	-5.7563***	-6.9136***	-9.1545***	-10.4335***	-12.7722***	-10.2464***
Wald	9.4781***	10.2840***	21.9197***	37.0156***	53.2636***	93.9949***	127.1436***	188.8119***	191.2157***
ADF	-60.9166***	-11.2828***	-8.3951***	-7.4445***	-6.0755***	-4.2018***	-3.4535***	-2.7397***	-1.7954*
R2	0.9933	0.9726	0.8813	0.7785	0.6822	0.4241	0.2650	0.1106	0.0256
CHF									
a	0.0001	0.0001	0.0007	-0.0001	-0.0006	-0.0066	-0.0080	-0.0090	-0.1164
Se a	0.0003	0.0010	0.0030	0.0044	0.0053	0.0077	0.0103	0.0131	0.0371
β	0.9995***	0.9997***	0.9977***	0.9989***	0.9994***	1.0114***	1.0110***	1.0087***	1.1972***
Se β	0.0006	0.0025	0.0076	0.0109	0.0132	0.0191	0.0257	0.0327	0.0926
t β=1	-0.8113	-0.1154	-0.3110	-0.1041	-0.0447	0.5990	0.4271	0.2677	2.1292**
Wald	5.0470*	0.0761	0.1831	0.3058	0.4455	1.9917	3.0830	4.6251*	44.9951***
ADF	-61.0142***	-14.1031***	-11.2936***	-11.4041***	-6.3654***	-5.3944***	-3.7738***	-2.9532***	-1.3619
R2	0.9984	0.9933	0.9724	0.9502	0.9298	0.8725	0.7951	0.7097	0.4205
GBP									

a	-0.0002	-0.0005	-0.0015	-0.0026	-0.0040	-0.0106	-0.0168	-0.0265	-0.0997
Se a	0.0002	0.0008	0.0026	0.0038	0.0047	0.0067	0.0081	0.0095	0.0162
β	0.9992***	0.9986***	0.9953***	0.9909***	0.9858***	0.9638***	0.9435***	0.9103***	0.4929***
Se β	0.0006	0.0024	0.0073	0.0109	0.0134	0.0192	0.0232	0.0276	0.0587
t β=1	-1.2606	-0.5860	-0.6420	-0.8326	-1.0528	-1.8869*	-2.4311**	-3.2491***	-8.6327***
Wald	3.1637	0.3484	0.4156	0.7486	1.2353	3.7850	6.1660**	11.0539***	100.3507***
ADF	-60.9390***	-10.2689***	-8.7212***	-7.0512***	-6.0199***	-4.2481***	-3.5329***	-3.4569***	-1.7806*
R2	0.9985	0.9940	0.9741	0.9486	0.9261	0.8600	0.8045	0.7352	0.2319

HKD

a	0.0018	0.0059	0.0310*	0.0673**	0.0999***	0.2139***	0.3294***	0.4516***	1.9979***
Se a	0.0015	0.0054	0.0179	0.0277	0.0341	0.0495	0.0608	0.0705	0.1585
β	0.9992***	0.9974***	0.9864***	0.9706***	0.9565***	0.9068***	0.8562***	0.8025***	0.1524**
Se β	0.0006	0.0024	0.0080	0.0124	0.0153	0.0221	0.0272	0.0316	0.0678
t β=1	-1.2569	-1.0753	-1.6977*	-2.3760**	-2.8499***	-4.2108***	-5.2826***	-6.2549***	-12.4981***
Wald	1.6007	1.2575	3.1419	6.3355**	9.4363***	20.6592***	32.0758***	44.2092***	173.3323***
ADF	-60.9761***	-9.6195***	-8.0535***	-6.7950***	-5.6947***	-4.0619***	-3.2521***	-2.6875***	-2.4703**
R2	0.9985	0.9939	0.9690	0.9332	0.9022	0.8042	0.7132	0.6238	0.0223

ILS

a	0.0070**	0.0248**	0.1104***	0.2297***	0.2734***	0.4898***	0.6163***	0.7555***	0.5047***
Se a	0.0035	0.0127	0.0378	0.0545	0.0596	0.0723	0.0779	0.0834	0.0702
β	0.9958***	0.9848***	0.9327***	0.8603***	0.8333***	0.7016***	0.6236***	0.5378***	0.6728***
Se β	0.0021	0.0076	0.0226	0.0326	0.0356	0.0431	0.0463	0.0495	0.0410
t β=1	-2.0312**	-2.0041**	-2.9727***	-4.2833***	-4.6766***	-6.9197***	-8.1228***	-9.3458***	-7.9787***
Wald	4.1979	5.2773*	11.0769***	22.1285***	28.3430***	63.6764***	98.1864***	146.4662***	481.8779***
ADF	-48.4682***	-8.1458***	-7.0807***	-6.2409***	-5.2002***	-3.6641***	-3.2505***	-2.8598***	-3.7194***
R2	0.9896	0.9606	0.8460	0.7123	0.6681	0.4791	0.3944	0.3047	0.5260

JPY

a	0.0071*	0.0266*	0.1236**	0.2644***	0.4071***	0.8116***	1.0932***	1.3894***	1.7492***
Se a	0.0043	0.0157	0.0498	0.0762	0.0953	0.1385	0.1659	0.1863	0.4628
β	0.9985***	0.9946***	0.9747***	0.9459***	0.9166***	0.8332***	0.7753***	0.7147***	0.6380***
Se β	0.0009	0.0032	0.0103	0.0158	0.0197	0.0287	0.0344	0.0387	0.0949
t β=1	-1.6941*	-1.6733*	-2.4488**	-3.4299***	-4.2239***	-5.8039***	-6.5273***	-7.3753***	-3.8163***
Wald	3.7771	3.3279	7.0955**	13.6887***	20.5245***	37.1732***	47.2411***	62.3747***	17.3433***
ADF	-60.8622***	-10.1917***	-8.0847***	-6.9016***	-5.7600***	-3.5942***	-2.8930***	-2.9067***	-1.5334
R2	0.9971	0.9885	0.9481	0.8906	0.8348	0.6737	0.5603	0.4672	0.1639

NOK									
a	0.0095***	0.0318***	0.1436***	0.2869***	0.4201***	0.7417***	1.1887***	1.7143***	2.3645***
Se a	0.0031	0.0116	0.0360	0.0530	0.0647	0.0887	0.1090	0.1223	0.1767
β	0.9954***	0.9845***	0.9301***	0.8605***	0.7958***	0.6400***	0.4253***	0.1742***	-0.1338
Se β	0.0015	0.0056	0.0173	0.0254	0.0310	0.0424	0.0519	0.0581	0.0834
t β=1	-3.0795***	-2.7851***	-4.0433***	-5.4989***	-6.5935***	-8.4955***	-11.0633***	-14.2014***	-13.5926***
Wald	9.5609***	11.0101***	22.9251***	42.9400***	62.7306***	112.5208***	184.6351***	290.1468***	292.2365***
ADF	-60.9515***	-10.5833***	-8.1238***	-6.8547***	-5.6270***	-4.1756***	-3.1966***	-2.6424***	-1.8045*
R2	0.9918	0.9670	0.8565	0.7235	0.6083	0.3584	0.1479	0.0252	0.0108
NZD									
a	0.0017**	0.0050	0.0201**	0.0356***	0.0514***	0.0926***	0.1365***	0.2197***	0.6105***
Se a	0.0008	0.0031	0.0094	0.0134	0.0165	0.0239	0.0307	0.0377	0.0688
β	0.9974***	0.9908***	0.9628***	0.9337***	0.9044***	0.8283***	0.7497***	0.6169***	0.0249
Se β	0.0013	0.0047	0.0141	0.0201	0.0246	0.0352	0.0446	0.0539	0.0943
t β=1	-2.0982**	-1.9439*	-2.6291***	-3.3013***	-3.8865***	-4.8764***	-5.6110***	-7.1087***	-10.3360***
Wald	4.4432	8.3190**	16.8478***	29.4825***	42.4898***	77.8069***	117.6515***	167.4326***	270.5818***
ADF	-60.9523***	-10.9854***	-8.5563***	-7.5471***	-6.3188***	-4.4443***	-3.6979***	-2.9332***	-1.0798
R2	0.9940	0.9756	0.9040	0.8284	0.7580	0.5734	0.4147	0.2519	0.0006
SGD									
a	0.0005	0.0022	0.0109*	0.0235***	0.0342***	0.0673***	0.1098***	0.1713***	-0.1717
Se a	0.0005	0.0018	0.0058	0.0088	0.0107	0.0155	0.0198	0.0240	0.0535
β	0.9991***	0.9964***	0.9821***	0.9616***	0.9443***	0.8911***	0.8229***	0.7246***	1.1856***
Se β	0.0008	0.0029	0.0092	0.0141	0.0171	0.0247	0.0316	0.0382	0.0784
t β=1	-1.1101	-1.2265	-1.9434*	-2.7283***	-3.2597***	-4.4033***	-5.6100***	-7.2054***	2.3657**
Wald	2.5334	1.5336	3.8175	7.4631**	10.6302***	19.3904***	31.4917***	52.0003***	104.9884***
ADF	-60.9549***	-10.4253***	-8.7254***	-6.7571***	-5.8299***	-4.1744***	-3.0619***	-2.5497**	-1.9708**
R2	0.9976	0.9909	0.9587	0.9136	0.8777	0.7605	0.6312	0.4810	0.4932
USD									
a	0.0002	0.0006	0.0030	0.0067**	0.0102***	0.0220***	0.0336***	0.0453***	0.2522***
Se a	0.0002	0.0006	0.0020	0.0030	0.0037	0.0053	0.0064	0.0074	0.0202
β	0.9992***	0.9971***	0.9852***	0.9685***	0.9539***	0.9027***	0.8516***	0.7991***	0.1732***
Se β	0.0006	0.0024	0.0080	0.0123	0.0151	0.0217	0.0265	0.0305	0.0671
t β=1	-1.2852	-1.2083	-1.8497*	-2.5523**	-3.0509***	-4.4788***	-5.6017***	-6.5924***	-12.3173***
Wald	1.7762	1.4800	3.4896	6.7862**	9.9350***	21.7821***	34.0987***	47.0672***	156.1280***
ADF	-60.9741***	-9.7344***	-8.1418***	-6.7607***	-5.6732***	-4.0656***	-3.2414***	-2.7052***	-2.5298**

R2	0.9985	0.9938	0.9688	0.9335	0.9035	0.8088	0.7219	0.6385	0.0290
AED									
a	0.0013	0.0040	0.1422***	0.0450**	0.0667***	0.1412***	0.2139***	0.2893***	1.3195***
Se a	0.0010	0.0036	0.0172	0.0185	0.0227	0.0325	0.0395	0.0455	0.1184
β	0.9991***	0.9973***	0.9088***	0.9704***	0.9563***	0.9079***	0.8605***	0.8112***	0.1786**
Se β	0.0006	0.0024	0.0116	0.0124	0.0152	0.0219	0.0266	0.0306	0.0742
t β=1	-1.3383	-1.0977	-7.8817***	-2.3896**	-2.8645***	-4.2094***	-5.2488***	-6.1767***	-11.0680***
Wald	1.8764	1.2262	77.5990***	6.0278**	8.9152**	19.6660***	30.6388***	42.2670***	128.3273***
ADF	-60.9695***	-9.6858***	-5.0485***	-6.7604***	-5.6623***	-4.0404***	-3.2393***	-2.7389***	-2.4658**
R2	0.9985	0.9938	0.9331	0.9331	0.9025	0.8084	0.7248	0.6438	0.0247
BRL									
a		0.0126**	0.0599***	0.1210***	0.1818***	0.3467***	0.4931***	0.6525***	0.7936***
Se a		0.0051	0.0161	0.0224	0.0257	0.0304	0.0341	0.0341	0.0355
β		0.9848***	0.9297***	0.8592***	0.7899***	0.6056***	0.4471***	0.2812***	0.1242***
Se β		0.0051	0.0160	0.0221	0.0252	0.0290	0.0320	0.0312	0.0295
t β=1		-2.9875***	-4.3899***	-6.3828***	-8.3441***	-13.5817***	-17.2808***	-23.0486***	-29.7275***
Wald		21.8475***	41.2970***	85.7479***	145.2730***	386.6125***	644.8500***	1144.2860***	3121.8350***
ADF		-9.9075***	-7.8375***	-5.5200***	-5.1820***	-3.9521***	-3.7896***	-3.4897***	-2.6097***
R2		0.9826	0.9169	0.8457	0.7848	0.6031	0.4137	0.2358	0.0705
CLP									
a		0.0776*	0.3423**	0.6907***	1.0320***	1.9203***	3.3857***	4.5865***	7.7631***
Se a		0.0447	0.1431	0.2068	0.2491	0.3188	0.4052	0.4532	0.5042
β		0.9881***	0.9473***	0.8937***	0.8412***	0.7046***	0.4804***	0.2971***	-0.1845
Se β		0.0068	0.0218	0.0315	0.0380	0.0486	0.0616	0.0689	0.0763
t β=1		-1.7500*	-2.4145**	-3.3707***	-4.1818***	-6.0853***	-8.4301***	-10.2087***	-15.5274***
Wald		4.5077	8.7118**	17.1719***	27.1784***	63.6162***	113.4856***	166.8526***	385.2427***
ADF		-11.3432***	-6.6495***	-6.0582***	-5.0762***	-3.7950***	-2.7148***	-2.2203**	-1.7327*
R2		0.9681	0.8602	0.7431	0.6470	0.4250	0.1836	0.0671	0.0243
CNY									
a		0.0150	0.0900***	0.2038***	0.3070***	0.6133***	0.9205***	1.2012***	-0.4120
Se a		0.0096	0.0324	0.0502	0.0619	0.0918	0.1136	0.1323	0.2067
β		0.9935***	0.9607***	0.9111***	0.8662***	0.7321***	0.5971***	0.4733***	1.1838***
Se β		0.0043	0.0145	0.0224	0.0276	0.0410	0.0509	0.0593	0.0923
t β=1		-1.5294	-2.7149***	-3.9695***	-4.8406***	-6.5298***	-7.9180***	-8.8753***	1.9910**
Wald		3.1394	9.3743***	20.2905***	31.2550***	58.0407***	87.0225***	112.4583***	3.9761

ADF		-9.3746***	-7.2439***	-5.6912***	-4.6606***	-3.1892***	-2.6170***	-2.0032**	-2.8287***
R2		0.9851	0.9212	0.8292	0.7488	0.5023	0.3109	0.1759	0.4095
COP									
a		0.1075**	0.4509***	0.9130***	1.3814***	2.5079***	3.4726***	4.0141***	3.9975***
Se a		0.0471	0.1470	0.2113	0.2541	0.3136	0.3595	0.3880	0.4413
β		0.9863***	0.9425***	0.8835***	0.8238***	0.6801***	0.5570***	0.4875***	0.4848***
Se β		0.0059	0.0185	0.0266	0.0320	0.0394	0.0451	0.0486	0.0548
t β=1		-2.3098**	-3.1034***	-4.3735***	-5.5055***	-8.1120***	-9.8161***	-10.5465***	-9.3980***
Wald		8.7977**	16.6636***	34.0334***	55.4686***	136.3496***	231.0650***	334.6561***	759.8717***
ADF		-8.9864***	-6.5849***	-5.4050***	-4.4105***	-3.3511***	-2.7105***	-2.4045**	-2.2465**
R2		0.9752	0.8934	0.7986	0.7124	0.5108	0.3566	0.2743	0.2485
CZK									
a	0.0012	0.0106*	0.0497***	0.1098***	0.1719***	0.3515***	0.5018***	0.6364***	1.7744***
Se a	0.0016	0.0061	0.0186	0.0269	0.0329	0.0458	0.0546	0.0587	0.1029
β	0.9996***	0.9967***	0.9847***	0.9662***	0.9471***	0.8917***	0.8452***	0.8035***	0.4483***
Se β	0.0005	0.0018	0.0055	0.0080	0.0097	0.0136	0.0161	0.0173	0.0311
t β=1	-0.8016	-1.7894*	-2.7876***	-4.2531***	-5.4369***	-7.9883***	-9.5963***	-11.3554***	-17.7332***
Wald	1.6781	5.9642*	15.1870***	34.9774***	56.3335***	123.2096***	186.7944***	272.1440***	688.9584***
ADF	-60.8706***	-10.6509***	-8.9189***	-7.4425***	-6.4631***	-4.2915***	-3.4436***	-3.1733***	-2.4691**
R2	0.9991	0.9964	0.9850	0.9705	0.9562	0.9132	0.8728	0.8462	0.4672
HUF									
a	0.0201**	0.0637**	0.2773***	0.6743***	1.1255***	2.4408***	3.3675***	3.5322***	4.5256***
Se a	0.0080	0.0309	0.0940	0.1437	0.1830	0.2491	0.2788	0.2908	0.3090
β	0.9964***	0.9884***	0.9495***	0.8776***	0.7961***	0.5592***	0.3928***	0.3628***	0.1901***
Se β	0.0014	0.0055	0.0169	0.0258	0.0328	0.0446	0.0498	0.0518	0.0546
t β=1	-2.4970**	-2.0937**	-2.9954***	-4.7481***	-6.2144***	-9.8919***	-12.2010***	-12.2954***	-14.8291***
Wald	16.1089***	12.4623***	25.3598***	50.1105***	76.2381***	176.1627***	280.6366***	353.1667***	413.2941***
ADF	-60.9104***	-9.6375***	-7.9135***	-7.0721***	-5.4918***	-3.6201***	-2.9939***	-2.6789***	-2.2772**
R2	0.9918	0.9666	0.8664	0.7248	0.5815	0.2800	0.1353	0.1111	0.0494
IDR									
a	0.1070**	0.1198**	0.2076**	0.3674***	0.5007***	1.0590***	1.7782***	2.9899***	
Se a	0.0485	0.0545	0.0971	0.1415	0.1752	0.2399	0.2847	0.3270	
β	0.9887***	0.9872***	0.9775***	0.9600***	0.9453***	0.8846***	0.8072***	0.6771***	
Se β	0.0052	0.0059	0.0104	0.0152	0.0188	0.0257	0.0305	0.0350	
t β=1	-2.1655**	-2.1788**	-2.1566**	-2.6324***	-2.9093***	-4.4871***	-6.3223***	-9.2321***	

Wald	8.8837**	5.6913*	5.5041*	9.9883***	14.7819***	32.5981***	53.9326***	103.7001***	
ADF	-7.1413***	-7.5980***	-8.8059***	-6.6438***	-5.0898***	-4.6407***	-3.6716***	-3.6140***	
R2	0.9861	0.9800	0.9488	0.9013	0.8564	0.7422	0.6373	0.4901	
INR									
a	0.0018	0.0069	0.0343	0.0670	0.0918*	0.1506*	0.2169**	0.3366***	
Se a	0.0025	0.0092	0.0299	0.0455	0.0558	0.0785	0.0984	0.1225	
β	0.9996***	0.9982***	0.9910***	0.9826***	0.9763***	0.9614***	0.9448***	0.9151***	
Se β	0.0006	0.0023	0.0075	0.0113	0.0139	0.0195	0.0244	0.0304	
t β=1	-0.6253	-0.8057	-1.2057	-1.5327	-1.7084*	-1.9779**	-2.2593**	-2.7928***	
Wald	6.9489**	2.3647	3.3581	4.4612	5.1383*	6.0147**	6.9673**	9.0665**	
ADF	-60.9586***	-10.1116***	-8.4147***	-6.8415***	-5.8874***	-4.4404***	-3.7823***	-3.3177***	
R2	0.9985	0.9944	0.9734	0.9448	0.9206	0.8555	0.7890	0.6990	
MAD									
a	0.0148***	0.0579***	0.2948***	0.6276***	0.9368***	1.9825***	2.5258***	2.6144***	2.3973***
Se a	0.0057	0.0190	0.0593	0.0862	0.1002	0.1072	0.0944	0.0813	0.0529
β	0.9939***	0.9758***	0.8769***	0.7383***	0.6098***	0.1773***	-0.0460	-0.0820	0.0074
Se β	0.0024	0.0079	0.0246	0.0356	0.0414	0.0441	0.0387	0.0332	0.0213
t β=1	-2.5699**	-3.0783***	-5.0110***	-7.3446***	-9.4289***	-18.6488***	-27.0040***	-32.5585***	-46.6365***
Wald	16.2778***	42.8355***	92.7061***	173.6387***	276.4440***	836.6790***	1793.8830***	3010.2920***	10076.0400***
ADF	-48.2318***	-9.0650***	-6.2372***	-4.7963***	-3.9491***	-2.6480***	-2.4497**	-2.3430**	-2.7748***
R2	0.9874	0.9597	0.8090	0.6123	0.4532	0.0624	0.0067	0.0227	0.0007
MXN									
a		-0.0013	-0.0039	-0.0029	0.0037	0.0358	0.0876	0.2180***	1.9182***
Se a		0.0049	0.0160	0.0253	0.0327	0.0498	0.0635	0.0816	0.1475
β		1.0002***	1.0000***	0.9984***	0.9947***	0.9793***	0.9567***	0.9047***	0.3096***
Se β		0.0019	0.0061	0.0097	0.0125	0.0190	0.0241	0.0308	0.0521
t β=1		0.0866	-0.0011	-0.1694	-0.4237	-1.0878	-1.7979*	-3.0901***	-13.2636***
Wald		3.2487	5.8466*	7.8586**	9.6716***	15.0741***	21.7298***	28.6992***	213.2642***
ADF		-10.0226***	-7.9311***	-6.6085***	-5.8799***	-4.2288***	-3.2840***	-2.9361***	-2.6134***
R2		0.9962	0.9821	0.9603	0.9366	0.8667	0.7979	0.6882	0.1303
MYR									
a	0.0042*	0.0080	0.0434	0.0985**	0.1487***	0.3798***	0.6182***	0.7851***	
Se a	0.0025	0.0085	0.0265	0.0405	0.0504	0.0800	0.0978	0.1136	
β	0.9972***	0.9943***	0.9699***	0.9323***	0.8982***	0.7433***	0.5843***	0.4723***	

Se β	0.0017	0.0056	0.0175	0.0267	0.0332	0.0525	0.0641	0.0742	
t β=1	-1.6849*	-1.0042	-1.7202*	-2.5325**	-3.0668***	-4.8853***	-6.4908***	-7.1128***	
Wald	3.0268	2.5633	5.5082*	10.4653***	14.6981***	32.0777***	56.7750***	74.6807***	
ADF	-49.0692***	-9.5013***	-7.6098***	-5.6100***	-4.6212***	-3.2710***	-2.4364**	-2.0203**	
R2	0.9934	0.9784	0.9068	0.8110	0.7285	0.4373	0.2305	0.1292	
PHP									
a	0.0047*	0.0093	0.0487	0.1112**	0.1748***	0.4057***	0.5949***	0.7937***	
Se a	0.0026	0.0092	0.0300	0.0460	0.0567	0.0815	0.0958	0.1097	
β	0.9989***	0.9975***	0.9873***	0.9714***	0.9552***	0.8969***	0.8492***	0.7994***	
Se β	0.0006	0.0023	0.0074	0.0113	0.0140	0.0200	0.0235	0.0268	
t β=1	-1.7247*	-1.0780	-1.7138*	-2.5258**	-3.2090***	-5.1432***	-6.4189***	-7.4850***	
Wald	5.5515*	3.3051	6.6845**	11.9771***	17.9235***	40.3593***	64.3070***	89.2442***	
ADF	-60.8013***	-9.8764***	-8.7234***	-6.9593***	-6.0768***	-4.3653***	-3.5298***	-3.3854***	
R2	0.9984	0.9944	0.9734	0.9434	0.9162	0.8301	0.7661	0.6945	
PKR									
a		0.0247**	0.1092***	0.2019***	0.2874***	0.5927***		6.0263***	
Se a		0.0114	0.0354	0.0505	0.0624	0.0898		1.5245	
β		0.9945***	0.9760***	0.9558***	0.9372***	0.8706***		-0.2483	
Se β		0.0025	0.0077	0.0110	0.0136	0.0195		0.3132	
t β=1		-2.1855**	-3.1035***	-4.0097***	-4.6145***	-6.6243***		-3.9862***	
Wald		5.0046*	9.7459***	16.0958***	21.3032***	43.9597***		79.3537***	
ADF		-9.4872***	-6.9398***	-5.4671***	-4.6888***	-3.0803***		-1.4249	
R2		0.9957	0.9810	0.9644	0.9465	0.8749		0.0149	
PLZ									
a	0.0045**	0.0187**	0.0867***	0.2036***	0.3253***	0.6812***	0.9390***	1.1445***	1.4500***
Se a	0.0019	0.0073	0.0225	0.0357	0.0449	0.0625	0.0700	0.0739	0.0747
β	0.9969***	0.9864***	0.9370***	0.8528***	0.7656***	0.5109***	0.3269***	0.1817***	-0.0502
Se β	0.0013	0.0052	0.0161	0.0254	0.0319	0.0442	0.0493	0.0520	0.0526
t β=1	-2.2797**	-2.6079***	-3.9189***	-5.7887***	-7.3511***	-11.0545***	-13.6409***	-15.7466***	-19.9827***
Wald	7.6310**	7.5420**	16.8431***	35.4291***	56.3820***	127.8748***	196.9743***	262.4516***	467.1539***
ADF	-53.8414***	-9.3502***	-6.5397***	-6.3399***	-4.8265***	-3.0376***	-2.0880**	-2.1199**	-1.9770**
R2	0.9942	0.9762	0.8993	0.7668	0.6367	0.3021	0.1295	0.0416	0.0039
RUR									
a	0.0046	0.0512***	0.2021***	0.4370***	0.6566***	1.2272***	1.6560***	2.0473***	
Se a	0.0045	0.0171	0.0472	0.0739	0.0914	0.1145	0.1265	0.1366	

β	0.9988***	0.9857***	0.9437***	0.8786***	0.8178***	0.6601***	0.5419***	0.4344***	
Se β	0.0012	0.0047	0.0130	0.0203	0.0251	0.0313	0.0345	0.0372	
t β=1	-1.0022	-3.0413***	-4.3441***	-5.9855***	-7.2698***	-10.8545***	-13.2726***	-15.2172***	
Wald	2.5171	12.4284***	25.1819***	44.1288***	63.7985***	139.6678***	209.7260***	276.3863***	
ADF	-48.3589***	-11.7656***	-6.1591***	-6.1224***	-4.0021***	-3.0726***	-2.1077**	-1.6903*	
R2	0.9963	0.9844	0.9439	0.8697	0.7987	0.6104	0.4737	0.3408	
THB									
a	0.0063	0.0181	0.0912**	0.2070***	0.3102***	0.6362***	0.9542***	1.3436***	
Se a	0.0040	0.0142	0.0442	0.0676	0.0824	0.1149	0.1381	0.1608	
β	0.9983***	0.9951***	0.9754***	0.9445***	0.9170***	0.8305***	0.7463***	0.6434***	
Se β	0.0011	0.0037	0.0117	0.0178	0.0217	0.0303	0.0363	0.0423	
t β=1	-1.5713	-1.3049	-2.1038**	-3.1118***	-3.8184***	-5.5986***	-6.9815***	-8.4401***	
Wald	2.4728	3.0657	6.7023**	12.5978***	18.2343***	36.3779***	55.5734***	80.5983***	
ADF	-60.9045***	-10.3257***	-8.8749***	-6.9627***	-5.7272***	-4.1856***	-3.3793***	-2.9098***	
R2	0.9957	0.9849	0.9346	0.8642	0.8067	0.6475	0.5144	0.3731	
TRL									
a	0.0917***	0.0893***	0.0891***	0.0907***	0.0941***	0.1101***	0.1438***	0.1913***	0.4514***
Se a	0.0091	0.0094	0.0101	0.0109	0.0118	0.0142	0.0172	0.0201	0.0631
β	0.8484***	0.8478***	0.8382***	0.8244***	0.8072***	0.7480***	0.6614***	0.5612***	0.3104***
Se β	0.0138	0.0142	0.0152	0.0163	0.0176	0.0207	0.0245	0.0276	0.0735
t β=1	-10.9851***	-10.7430***	-10.6692***	-10.7666***	-10.9666***	-12.1485***	-13.8193***	-15.8741***	-9.3814***
Wald	141.8986***	132.0047***	123.8029***	120.9568***	122.3279***	147.9221***	195.7208***	264.3150***	448.9671***
ADF	-4.1680***	-4.2251***	-4.2673***	-3.8473***	-3.8601***	-3.3802***	-3.2383***	-3.0794***	-2.2259**
R2	0.8794	0.8742	0.8588	0.8399	0.8164	0.7447	0.6339	0.5049	0.0706
TWD									
a		0.0035	0.0211	0.0569	0.0915	0.2033**	0.3805***	0.6557***	3.9316***
Se a		0.0089	0.0286	0.0451	0.0567	0.0819	0.1038	0.1279	0.3390
β		0.9991***	0.9945***	0.9850***	0.9759***	0.9465***	0.8991***	0.8247***	-0.0490
Se β		0.0024	0.0078	0.0123	0.0155	0.0224	0.0285	0.0351	0.0910
t β=1		-0.3703	-0.7027	-1.2128	-1.5496	-2.3863**	-3.5474***	-4.9936***	-11.5253***
Wald		0.4884	1.1823	3.0830	5.1003*	12.0419***	22.6147***	37.6373***	157.5237***
ADF		-10.9070***	-8.4924***	-6.9876***	-5.9034***	-4.2671***	-3.2109***	-2.7847***	-1.6619*
R2		0.9936	0.9707	0.9354	0.9027	0.8130	0.7146	0.5864	0.0017
ZAR									
a	0.0049**	0.0117*	0.0465**	0.0961***	0.1436***	0.3421***	0.5174***	0.7778***	2.2209***

Se a	0.0021	0.0067	0.0213	0.0320	0.0392	0.0574	0.0669	0.0784	0.1077
β	0.9980***	0.9944***	0.9775***	0.9539***	0.9314***	0.8393***	0.7585***	0.6408***	0.0481
Se β	0.0009	0.0030	0.0096	0.0145	0.0177	0.0258	0.0299	0.0348	0.0453
t β=1	-2.1199**	-1.8328*	-2.3282**	-3.1829***	-3.8726***	-6.2324***	-8.0776***	-10.3137***	-20.9961***
Wald	13.7107***	4.2618	7.6104**	13.5070***	19.6278***	46.4935***	77.6863***	122.2675***	459.3925***
ADF	-58.3115***	-10.6499***	-8.6817***	-6.5754***	-5.4553***	-4.0519***	-3.4906***	-2.6416***	-2.6208***
R2	0.9975	0.9902	0.9551	0.9084	0.8666	0.7215	0.6173	0.4653	0.0089
Mean									
a	0.0124	0.0262	0.0910	0.2027	0.3032	0.6028	0.8811	1.2845	1.6508
Se a	0.0046	0.0124	0.0368	0.0530	0.0647	0.0868	0.1023	0.1600	0.1525
β	0.9913	0.9876	0.9778	0.9249	0.8907	0.7867	0.6901	0.5717	0.3397
se β	0.0018	0.0044	0.0143	0.0184	0.0223	0.0302	0.0362	0.0497	0.0673
t β=1	-0.4312	-0.3504	-0.4595	-0.6551	-0.7900	-1.1566	-1.4781	-1.7169	-2.5268
Wald	11.5407	10.7206	25.9229	29.1554	42.5752	96.6147	170.0129	257.8429	808.4084
R2	0.9904	0.9802	0.9155	0.8602	0.8015	0.6407	0.5106	0.3927	0.1473

We use the Dynamic Ordinary Least Squares (DOLS) estimator. For each economy we test for different time forward rates with different time to maturity. We report the values and standard errors of α and β, R squares of the equation, also the t statistics of testing β=1, the Wald statistics of joint test for α=1 and β=1, and the test statistics of unit root test (ADF) for the residuals of the equation. We calculate the mean of these statistics across the economies. Empty entries due to missing data in forward rates. Standard currency short codes are employed.

* Significance at 10%

** Significance at 5%

*** Significance at 1%

Table 3.7 Number of rejections of unbiasedness hypothesis using Sterling, USD and Euro sample

Panel A (FMOLS)

	TN	1W	1M	2M	3M	6M	9M	1Y	2Y
Sterling									
a=0	1	3	9	15	17	20	21	20	17
t β=1	1	3	9	15	17	22	22	22	17
a=0 & β=1	2	7	13	24	25	26	27	27	22
USD									
a=0	5	7	19	20	21	22	21	22	18
t β=1	6	11	22	25	27	29	29	28	22
a=0 & β=1	7	16	23	26	28	29	29	28	24
Euro									
a=0	2	2	15	25	25	26	26	28	19
t β=1	2	3	18	25	26	27	28	30	24
a=0 & β=1	5	7	20	25	27	28	28	30	23

Panel B (DOLS)

	TN	1W	1M	2M	3M	6M	9M	1Y	2Y
Sterling									
a=0	7	6	13	16	17	21	21	20	17
t β=1	7	7	14	16	17	22	22	21	17
a=0 & β=1	8	8	15	24	25	26	28	27	22
USD									
a=0	9	16	20	20	21	22	21	22	18
t β=1	8	19	24	26	27	29	29	28	22
a=0 & β=1	12	19	25	27	28	29	30	28	24
Euro									
a=0	10	12	20	25	25	26	26	28	19
t β=1	10	12	21	25	26	28	28	30	24
a=0 & β=1	9	11	21	27	27	29	29	30	23

Numbers in each row of the table represents of the number of economies that are rejected for the hypothesis α=0, β=1, and the joint test α=0 and β=1 respectively. Most periods contain all 31 economies data coverage, except only 24 economies for TN, and 30 economies for 9M. For 2Y forward rates, Sterling covers 22 economies, while both USD and Euro have 24 economies. For 1Y forward rates, Sterling has 29 economies and USD has 30 economies data coverage. Empty entries in table 3.7.1 to 3.7.6 indicate the economies with missing data.

Table 3.8 ADF test for Sterling Spot returns

	TN	1W	1M	2M	3M	6M	9M	1Y	2Y
AUD									
ADF trend	-14.8155***	-13.4997***	-10.5008***	-9.1444***	-7.8592***	-5.9920***	-5.0162***	-4.7033***	-3.4576**
ADF const	-14.7499***	-13.43443***	-10.44149***	-9.100410***	-7.784599***	-5.867230***	-4.912309***	-4.609350***	-3.199108**
ADF 1st.diff	-23.5029***	-23.8387***	-30.8015***	-76.7234***	-75.4813***	-76.4891***	-75.2612***	-75.5105***	-55.0392***
CAD									
ADF trend	-14.7150***	-13.1674***	-10.4929***	-9.9215***	-8.2489***	-5.7565***	-4.8683***	-4.7032***	-3.8068**
ADF const	-14.6676***	-13.11752***	-10.44810***	-9.884589***	-8.179004***	-5.691917***	-4.831383***	-4.656649***	-3.464863***
ADF 1st.diff	-23.9796***	-25.4640***	-33.2714***	-74.0890***	-73.9469***	-73.6107***	-75.3781***	-73.6983***	-73.0464***
CHF									
ADF trend	-16.3141***	-13.1364***	-11.0393***	-9.3792***	-7.5917***	-5.2303***	-4.1537***	-3.6042**	-2.2100
ADF const	-16.2930***	-13.10970***	-11.01190***	-9.083858***	-7.551550***	-5.170244***	-4.090084***	-3.553535***	-2.2422
ADF 1st.diff	-24.5045***	-23.9748***	-26.0055***	-75.8460***	-74.2133***	-74.4549***	-74.7751***	-73.3416***	-71.9921***
XEU									
ADF trend	-14.7603***	-12.9669***	-10.9239***	-9.2621***	-7.5540***	-5.2553***	-4.3310***	-3.6686**	-2.5008
ADF const	-14.7458***	-12.95275***	-10.91216***	-9.255727***	-7.522632***	-5.229275***	-4.307906***	-3.657348***	-2.5240
ADF 1st.diff	-24.6787***	-24.2564***	-28.2011***	-77.1730***	-76.0566***	-77.4971***	-78.0444***	-76.4917***	-75.2927***
HKD									
ADF trend	-12.7882***	-11.5548***	-10.0523***	-8.9363***	-7.1319***	-4.7354***	-4.1429***	-3.9357**	-2.7511
ADF const	-12.7888***	-11.55557***	-10.05229***	-8.936335***	-7.128852***	-4.735627***	-4.143733***	-3.928708***	-2.746136*
ADF 1st.diff	-25.2118***	-25.3234***	-26.9292***	-72.9708***	-73.7593***	-72.8128***	-73.7363***	-72.8512***	-71.4248***
ILS									
ADF trend	-14.0143***	-12.5030***	-10.7630***	-9.7743***	-8.0100***	-5.6281***	-4.8444***	-4.4355***	-2.8250
ADF const	-13.8248***	-12.31188***	-10.57867***	-9.609225***	-7.774694***	-5.369819***	-4.583359***	-4.197059***	-2.707664*
ADF 1st.diff	-23.2346***	-24.3530***	-28.1692***	-81.0725***	-79.2904***	-81.0178***	-81.0397***	-79.0538***	-46.9744***
JPY									

ADF trend	-16.4818***	-11.6920***	-9.8839***	-8.7137***	-6.9981***	-4.6327***	-3.8889**	-3.3994*	-1.9906
ADF const	-16.4827***	-11.69167***	-9.882237***	-8.712427***	-6.994374***	-4.622631***	-3.875080***	-3.391420**	-1.9970
ADF 1st.diff	-24.6640***	-24.8792***	-30.4966***	-45.9643***	-73.6126***	-73.3201***	-46.2350***	-72.2785***	-44.7984***
NOK									
ADF trend	-15.1376***	-14.0105***	-11.2742***	-9.8757***	-8.6127***	-6.3884***	-5.2421***	-4.5271***	-3.2498*
ADF const	-15.0929***	-13.96762***	-11.23739***	-9.848812***	-8.546919***	-6.300586***	-5.151889***	-4.451576***	-3.181975**
ADF 1st.diff	-23.2849***	-24.7416***	-30.5538***	-47.9632***	-47.7049***	-76.4028***	-76.3925***	-56.0608***	-74.2186***
NZD									
ADF trend	-14.3284***	-13.1519***	-10.6125***	-9.3400***	-7.8861***	-5.6712***	-4.7030***	-4.1250***	-2.8688
ADF const	-14.2884***	-13.11028***	-10.57186***	-9.308396***	-7.827340***	-5.614141***	-4.656309***	-4.100352***	-2.850836*
ADF 1st.diff	-23.8785***	-25.1254***	-32.3308***	-76.2748***	-56.3209***	-75.1860***	-74.7389***	-74.7602***	-55.1576***
SGD									
ADF trend	-14.5053***	-12.2151***	-10.0237***	-9.0534***	-6.9901***	-5.0487***	-4.3323***	-3.5416**	-2.2997
ADF const	-14.4998***	-12.21006***	-10.01916***	-9.048578***	-6.978205***	-5.042590***	-4.336781***	-3.545799***	-2.2875
ADF 1st.diff	-24.1478***	-24.8525***	-30.0393***	-76.0857***	-48.1766***	-75.5912***	-47.6788***	-46.8784***	-46.2899***
USD									
ADF trend	-16.5028***	-11.6300***	-10.0031***	-8.8956***	-7.1630***	-4.7777***	-4.1900***	-3.9762***	-2.7960
ADF const	-16.5029***	-11.63044***	-10.00306***	-8.895504***	-7.159610***	-4.777994***	-4.191098***	-3.969537***	-2.790572*
ADF 1st.diff	-25.3551***	-25.3050***	-30.4363***	-72.9433***	-73.1209***	-72.2418***	-73.6145***	-72.3628***	-70.6101***
AED									
ADF trend	-13.4737***	-11.6987***	-9.7403***	-8.6187***	-6.9531***	-4.6531***	-4.1984***	-3.9289**	-2.7461
ADF const	-13.4743***	-11.69906***	-9.740682***	-8.618808***	-6.949232***	-4.653114***	-4.199886***	-3.921934***	-2.740561*
ADF 1st.diff	-24.0120***	-25.2683***	-29.9914***	-75.8812***	-75.4908***	-75.8618***	-75.6729***	-74.9129***	-74.3039***
BRL									
ADF trend	-8.8277***	-8.0284***	-7.7092***	-6.5533***	-5.4137***	-2.3082	-1.7287	-1.3279	-0.3174
ADF const	-7.1830***	-7.036046***	-6.646214***	-5.509062***	-4.669719***	-2.1234	-1.8304	-1.8906	-1.7933
ADF 1st.diff	-25.6663***	-28.5730***	-16.6351***	-17.3474***	-12.6101***	-58.8813***	-29.4055***	-83.1264***	-80.5981***
CLP									
ADF trend	-13.6258***	-12.0949***	-10.0314***	-8.8645***	-7.4688***	-5.5131***	-5.0636***	-5.0928***	-3.7061**
ADF const	-12.8148***	-11.99215***	-9.934827***	-8.779919***	-7.347847***	-5.377156***	-4.892254***	-4.931015***	-3.497110***
ADF 1st.diff	-25.2164***	-24.5843***	-29.4145***	-77.8783***	-74.6850***	-75.3777***	-76.5773***	-76.4416***	-75.2744***
CNY									

ADF trend	-13.2997***	-12.1465***	-10.1482***	-8.8799***	-7.2685***	-4.9522***	-4.1821***	-3.8150**	-2.9022
ADF const	-13.1829***	-12.02999***	-10.04064***	-8.783905***	-7.130525***	-4.798006***	-4.068414***	-3.739187***	-2.655454*
ADF 1st.diff	-23.7405***	-25.2796***	-30.1306***	-76.4751***	-76.6917***	-76.0504***	-75.8370***	-75.5226***	-73.6660***
COP									
ADF trend	-15.2016***	-13.4725***	-10.8865***	-9.0154***	-7.8684***	-5.8794***	-5.2194***	-4.8165***	-3.1006
ADF const	-14.9423***	-13.20587***	-10.63807***	-8.818548***	-7.566024***	-5.462824***	-4.811848***	-4.388221***	-2.635102*
ADF 1st.diff	-22.0822***	-23.1668***	-28.8200***	-75.3612***	-75.1276***	-75.1012***	-74.4754***	-74.2924***	-72.7497***
CZK									
ADF trend	-14.4888***	-12.8263***	-10.7313***	-9.6402***	-7.0036***	-5.1757***	-4.1297***	-4.6716***	-4.1050***
ADF const	-14.3576***	-12.68749***	-10.62176***	-9.567685***	-6.841151***	-5.076151***	-4.032510***	-4.869611***	-4.524123***
ADF 1st.diff	-25.6950***	-24.8519***	-29.9325***	-76.5323***	-38.5931***	-76.5394***	-75.8204***	-55.9344***	-73.8303***
HUF									
ADF trend	-14.6219***	-13.0456***	-11.0374***	-9.7681***	-7.9258***	-5.8008***	-4.7602***	-3.9448**	-2.3010
ADF const	-14.4345***	-12.84948***	-10.86640***	-9.620103***	-7.682210***	-5.485644***	-4.391465***	-3.602378***	-2.1926
ADF 1st.diff	-23.1980***	-24.4068***	-30.0997***	-75.0987***	-76.1971***	-75.1539***	-75.3719***	-74.5107***	-72.8795***
IDR									
ADF trend	-11.0887***	-10.9068***	-10.9029***	-12.6332***	-9.2698***	-5.4180***	-4.9666***	-4.1938***	-2.7373
ADF const	-11.0657***	-10.88386***	-10.87012***	-12.57610***	-9.216917***	-5.379627***	-4.932274***	-4.151123***	-2.658757*
ADF 1st.diff	-23.5797***	-23.2409***	-14.9451***	-11.6033***	-11.8216***	-11.1712***	-9.7814***	-10.3547***	-10.2708***
INR									
ADF trend	-13.6882***	-12.6244***	-9.8627***	-8.7552***	-7.2290***	-5.1850***	-4.7740***	-4.3971***	-3.5819**
ADF const	-13.5800***	-12.50241***	-9.759654***	-8.669158***	-7.077726***	-5.030163***	-4.612288***	-4.249962***	-3.739776***
ADF 1st.diff	-23.6084***	-24.0898***	-30.8596***	-78.3719***	-77.1337***	-76.0484***	-76.4679***	-77.1487***	-74.9161***
MAD									
ADF trend	-15.4325***	-12.7469***	-10.9894***	-8.9981***	-7.9042***	-5.2412***	-4.2593***	-3.7180**	-2.5776
ADF const	-15.3941***	-12.70959***	-10.95310***	-8.945182***	-7.813016***	-5.234721***	-4.256718***	-3.739094***	-2.640944*
ADF 1st.diff	-25.5457***	-24.2944***	-23.1617***	-24.7289***	-16.1970***	-23.9517***	-24.4136***	-19.9647***	-23.6937***
MXN									
ADF trend	-14.8063***	-14.0717***	-11.3140***	-11.2425***	-8.3102***	-5.6838***	-4.1070***	-3.2538*	-2.1561
ADF const	-14.7104***	-13.98087***	-11.19256***	-11.10088***	-8.174387***	-5.563733***	-4.015216***	-3.162940**	-2.0157
ADF 1st.diff	-21.5467***	-22.0723***	-22.1525***	-14.6876***	-13.9063***	-14.0496***	-14.6804***	-15.0882***	-14.2646***
MYR									

ADF trend	-10.3633***	-8.8465***	-7.0737***	-6.5589***	-5.1752***	-3.4035*	-2.8721	-3.0870	-2.1827
ADF const	-10.3583***	-8.851510***	-7.076823***	-6.558051***	-5.170754***	-3.403904**	-2.872675**	-3.110260**	-2.2226
ADF 1st.diff	-22.0448***	-16.6679***	-16.7209***	-50.7481***	-49.3587***	-49.8238***	-50.4205***	-49.0293***	-46.1867***
PHP									
ADF trend	-12.4452***	-11.3026***	-9.6956***	-8.7062***	-6.8224***	-4.5567***	-4.1381***	-4.0244***	-2.4876
ADF const	-12.3641***	-11.22489***	-9.614213***	-8.632818***	-6.727717***	-4.468319***	-4.124221***	-4.039902***	-2.4430
ADF 1st.diff	-24.9022***	-24.8883***	-28.4521***	-76.6794***	-56.4122***	-75.6505***	-76.5133***	-41.8776***	-74.2684***
PKR									
ADF trend	-13.7382***	-12.3773***	-11.0300***	-9.7078***	-7.7591***	-5.5648***	-4.9737***	-4.9758***	-3.8241**
ADF const	-13.7233***	-12.36153***	-11.01378***	-9.678136***	-7.724153***	-5.540323***	-4.961337***	-4.948674***	-3.759700***
ADF 1st.diff	-25.8026***	-24.7213***	-27.4606***	-24.4285***	-23.5324***	-23.4420***	-23.2098***	-23.6490***	-23.0867***
PLZ									
ADF trend	-16.1871***	-12.4152***	-11.8585***	-11.6537***	-9.1558***	-6.5481***	-5.7171***	-5.0801***	-3.3533*
ADF const	-16.1395***	-12.13520***	-11.62420***	-11.51079***	-8.935432***	-6.273668***	-5.402483***	-4.814203***	-3.117258**
ADF 1st.diff	-25.4842***	-24.7770***	-26.0980***	-76.8030***	-76.1372***	-76.5868***	-76.0092***	-76.2308***	-74.6826***
RUR									
ADF trend	-11.8709***	-11.0840***	-9.6944***	-9.3775***	-7.0149***	-4.7785***	-4.1133***	-2.8383	-2.5643
ADF const	-11.2394***	-10.45589***	-9.108887***	-8.678399***	-6.495297***	-4.346200***	-3.733253***	-2.642889*	-2.771028*
ADF 1st.diff	-21.4196***	-20.4451***	-21.1695***	-13.3026***	-13.6223***	-13.1943***	-11.7455***	-13.2278***	-13.8733***
THB									
ADF trend	-12.7958***	-11.2513***	-9.4654***	-8.1361***	-6.1439***	-4.1536***	-3.7451**	-3.0451	-2.2298
ADF const	-12.7554***	-11.21124***	-9.429684***	-8.095941***	-6.091243***	-4.105633***	-3.708675***	-3.019472**	-2.1255
ADF 1st.diff	-25.5552***	-24.5477***	-29.1761***	-56.2372***	-47.8014***	-46.7898***	-71.9608***	-46.8577***	-34.6296***
TRL									
ADF trend	-11.3432***	-11.1143***	-9.2743***	-8.5167***	-7.4689***	-4.9778***	-3.9658***	-3.4876**	-2.4205
ADF const	-10.4682***	-10.19940***	-8.451763***	-7.712154***	-6.457694***	-3.929878***	-2.860545*	-2.2621	-1.1169
ADF 1st.diff	-23.7857***	-18.4439***	-24.8071***	-31.7079***	-17.1911***	-17.2886***	-17.2591***	-17.1808***	-17.3647***
TWD									
ADF trend	-12.9328***	-11.8735***	-9.8592***	-8.9451***	-7.2132***	-4.9334***	-4.4380***	-3.9963***	-2.5187
ADF const	-12.9138***	-11.85541***	-9.842620***	-8.929309***	-7.185847***	-4.925837***	-4.456569***	-4.022706***	-2.5200
ADF 1st.diff	-25.1261***	-24.8979***	-29.5602***	-78.3755***	-77.1423***	-77.1868***	-78.0886***	-76.8504***	-75.9598***
ZAR									

ADF trend	-16.0222***	-14.1257***	-10.7450***	-8.9777***	-7.5905***	-5.4427***	-4.5151***	-3.5859**	-2.4317
ADF const	-15.9989***	-14.09083***	-10.71668***	-8.954198***	-7.560765***	-5.404963***	-4.495669***	-3.587699***	-2.4442
ADF 1st.diff	-23.4011***	-22.5252***	-28.5498***	-75.3114***	-73.9195***	-73.5293***	-73.9564***	-74.0944***	-72.2560***

ADF test statistics for spot return and ΔS_{t+n} is the log difference of spot rate difference n period ahead.

* Significance at 10%
** Significance at 5%
*** Significance at 1%

Table 3.9: ADF test for Sterling forward premium

	TN	1W	1M	2M	3M	6M	9M	1Y	2Y
AUD									
ADF trend	-63.7860***	-4.8533***	-4.6371***	-3.4400**	-2.6128	-2.7051	-2.0989	-2.6577	
ADF const	-10.2572***	-2.4517	-1.5997	-1.0142	-1.0351	-1.0409	-2.0397	-1.0205	
ADF 1st.diff	-22.7297***	-25.0106***	-27.8858***	-30.3521***	-35.4093***	-47.0015***	-43.7303***	-46.6501***	
CAD									
ADF trend	-62.3662***	-6.7473***	-2.2239	-2.0687	-1.9007	-1.9717	-2.3934	-2.5812	
ADF const	-62.1679***	-5.268489***	-1.8388	-1.8010	-1.7091	-1.7369	-2.2410	-2.2262	
ADF 1st.diff	-25.1819***	-24.2129***	-20.7520***	-19.2074***	-18.7839***	-16.0282***	-76.6823***	-83.5831***	
CHF									
ADF trend	-9.3106***	-3.8850**	-3.0140	-2.8165	-2.3792	-1.9018	-1.6415	-1.8431	-2.4481
ADF const	-5.9582***	-2.588166*	-1.5814	-1.2743	-0.9310	-0.6994	-1.2562	-0.7035	-1.4596
ADF 1st.diff	-21.3108***	-23.9936***	-34.6089***	-43.1258***	-49.1152***	-50.9499***	-51.4043***	-58.5336***	-58.0898***
XEU									
ADF trend	-14.7831***	-4.0961***	-2.2297	-1.9251	-1.9156	-1.7582	-1.7187	-1.8839	-1.8574
ADF const	-7.7195***	-2.806973*	-1.4839	-1.2605	-1.2929	-1.3075	-1.4566	-1.4500	-1.8085
ADF 1st.diff	-22.9965***	-25.3850***	-18.5600***	-15.9631***	-14.7189***	-45.7056***	-68.8774***	-75.4889***	-38.6731***
HKD									
ADF trend	-6.6484***	-6.8691***	-5.7316***	-4.5690***	-3.9064**	-3.3720*	-2.5834	-2.3701	-2.3027
ADF const	-6.5784***	-6.890477***	-5.680424***	-4.511394***	-3.846675***	-3.295726**	-2.811655*	-2.2858	-2.3801
ADF 1st.diff	-21.9778***	-31.1564***	-25.0111***	-22.4291***	-32.4762***	-16.9597***	-29.8598***	-30.5027***	-48.1126***
ILS									
ADF trend	-3.1857*	-3.0144	-3.5936**	-3.2758*	-2.8245	-2.4709	-2.2268	-2.3537	-3.3643*
ADF const	-1.9035	-1.9465	-2.5441	-2.4197	-2.1207	-1.9052	-1.7906	-1.9145	-3.118113**
ADF 1st.diff	-14.7169***	-25.3674***	-31.5572***	-16.1486***	-43.8093***	-41.3726***	-33.2356***	-41.5014***	-56.6756***
JPY									
ADF trend	-4.0893***	-2.7994	-2.6676	-1.9071	-1.8293	-2.1430	-1.4793	-2.1097	-1.6960

ADF const	-2.3060	-1.5150	-0.8243	-0.4377	-0.7848	-0.7231	-0.6767	-0.0141	-0.3934
ADF 1st.diff	-21.1100***	-27.8227***	-21.9925***	-16.4629***	-13.3980***	-11.2811***	-26.1745***	-64.2969***	-55.2168***
NOK									
ADF trend	-14.2859***	-2.9496	-2.5457	-2.1146	-1.8920	-1.6585	-1.6798	-1.5814	-1.8630
ADF const	-14.2849***	-2.995105**	-2.5480	-2.1284	-1.9377	-1.7545	-1.8449	-1.6994	-1.5651
ADF 1st.diff	-22.7384***	-26.0121***	-22.9290***	-27.0910***	-29.5461***	-34.7902***	-73.5924***	-41.8432***	-32.7109***
NZD									
ADF trend	-62.7464***	-6.1557***	-3.0087	-4.7706***	-4.4220***	-3.5077**	-2.6616	-3.7147**	-3.3385*
ADF const	-62.0875***	-4.168224***	-2.0849	-2.965508**	-2.674852*	-1.9852	-1.8684	-1.9838	-3.281305**
ADF 1st.diff	-25.2678***	-25.8152***	-20.3743***	-38.0529***	-38.7315***	-44.5762***	-42.9502***	-58.8789***	-68.8228***
SGD									
ADF trend	-24.3049***	-6.6096***	-5.1005***	-3.7658**	-3.3431*	-3.0512	-3.3278*	-2.5781	-1.5298
ADF const	-23.1071***	-3.525157***	-4.735845***	-3.376647**	-2.938847**	-2.625330*	-2.5567	-2.1859	-1.3707
ADF 1st.diff	-26.3912***	-21.4524***	-24.6457***	-25.0176***	-24.2692***	-30.4509***	-11.8009***	-24.7441***	-40.6447***
USD									
ADF trend	-2.9513	-2.9568	-2.7288	-1.9771	-1.7754	-1.4368	-1.6253	-1.4961	-2.5928
ADF const	-2.8869**	-2.843501*	-2.573271*	-1.8255	-1.6276	-1.2959	-1.5883	-1.3840	-2.859375*
ADF 1st.diff	-18.5650***	-33.5959***	-34.7846***	-41.4359***	-44.1848***	-46.1754***	-19.2732***	-72.3335***	-49.7905***
AED									
ADF trend	-6.6735***	-4.0331***	-3.3899*	-3.3496*	-3.4475**	-2.1716	-1.7228	-1.8273	-1.7742
ADF const	-6.6460***	-3.984545***	-3.278878**	-3.210493**	-3.264514**	-2.0225	-1.6897	-1.7829	-1.9658
ADF 1st.diff	-21.3580***	-33.1635***	-33.7800***	-47.5872***	-56.4038***	-50.0554***	-24.5310***	-77.3206***	-27.9471***
BRL									
ADF trend		-4.0682***	-3.0922	-5.5461***	-5.7257***	-6.1210***	-6.5768***	-6.3865***	-6.6591***
ADF const		-3.444797***	-2.4005	-3.993142***	-4.141506***	-4.138095***	-4.834997***	-4.298152***	-4.660160***
ADF 1st.diff		-21.6082***	-18.2705***	-28.6980***	-39.1562***	-26.5914***	-26.7242***	-25.8676***	-52.8164***
CLP									
ADF trend		-4.2551***	-2.3894	-3.2635*	-2.8422	-2.3565	-2.1838	-2.1270	-2.4779
ADF const		-2.906288**	-1.6286	-2.1974	-1.9065	-1.5776	-1.4620	-1.4385	-1.4598
ADF 1st.diff		-28.3728***	-19.5985***	-49.6452***	-49.8600***	-50.2875***	-50.1054***	-49.8117***	-51.7012***
CNY									
ADF trend		-7.2645***	-4.8277***	-4.2050***	-3.8183**	-3.0839	-2.7156	-2.4332	-2.1328

ADF const		-6.490417***	-4.121785***	-3.541666***	-3.170583**	-2.4287	-2.0212	-1.7054	-1.6030
ADF 1st.diff		-33.2871***	-19.8242***	-57.7730***	-54.5900***	-54.7770***	-55.0153***	-52.6203***	-54.2209***
COP									
ADF trend		-4.3776***	-4.1910***	-3.4062*	-2.9001	-2.4202	-2.1647	-2.0108	-2.0924
ADF const		-4.328730***	-4.147325***	-3.382981**	-2.890682**	-2.4226	-2.1592	-1.9970	-2.0943
ADF 1st.diff		-30.3295***	-34.2455***	-32.5620***	-32.3604***	-36.0452***	-34.9731***	-34.8572***	-52.2186***
CZK									
ADF trend	-12.5168***	-3.2137*	-4.9714***	-2.8271	-2.1817	-1.4231	-3.0028	-1.6411	-1.9084
ADF const	-11.9989***	-3.413569**	-4.456604***	-2.777640*	-2.3737	-1.7191	-3.815740***	-1.8264	-1.6633
ADF 1st.diff	-22.1762***	-26.7525***	-19.5027***	-19.6165***	-18.5038***	-15.2849***	-17.2808***	-16.1197***	-50.4445***
HUF									
ADF trend	-6.0907***	-3.2122*	-2.7061	-2.7751	-2.5519	-2.6612	-2.7224		-1.8563
ADF const	-5.7510***	-3.166466**	-2.820735*	-2.953877**	-2.776299*	-2.832670*	-2.708812*		-1.8169
ADF 1st.diff	-21.9545***	-23.7186***	-27.5844***	-29.5643***	-27.8143***	-33.4458***	-73.1699***		-38.2580***
IDR									
ADF trend	-6.3243***	-6.3543***	-6.4015***	-5.8959***	-5.1276***	-4.3526***	-3.5632**	-3.4283**	
ADF const	-6.2730***	-6.319180***	-6.392153***	-5.804607***	-4.944278***	-4.074383***	-3.273483**	-3.171592**	
ADF 1st.diff	-25.9686***	-25.9996***	-27.3507***	-28.0988***	-33.8872***	-50.7778***	-27.5117***	-76.3130***	
INR									
ADF trend	-7.5144***	-4.7104***	-5.2866***	-3.9665***	-3.1100	-2.9017	-2.5868	-2.2434	
ADF const	-7.0019***	-4.445219***	-5.037838***	-3.806198***	-3.000970**	-2.855169*	-2.569832*	-2.2383	
ADF 1st.diff	-20.9792***	-24.5826***	-44.6359***	-44.4908***	-20.4736***	-51.2183***	-50.5389***	-31.7508***	
MAD									
ADF trend	-5.7596***	-3.0266	-2.7186	-2.3295	-1.8530	-1.7008	-1.5029	-1.6575	-2.0213
ADF const	-4.7461***	-2.579493*	-2.2645	-2.0626	-1.6682	-1.3932	-1.3319	-1.3894	-1.4422
ADF 1st.diff	-19.4380***	-29.1411***	-17.6547***	-19.2189***	-53.0404***	-53.6352***	-57.2366***	-63.7924***	-28.8155***
MXN									
ADF trend		-3.5637**	-4.4230***	-3.1679*	-3.0979	-2.4183	-2.3082	-2.1506	-2.3067
ADF const		-2.902346**	-4.030346***	-2.653921*	-2.5142	-2.0891	-1.9371	-1.9457	-2.2836
ADF 1st.diff		-37.1214***	-51.0125***	-20.3199***	-19.4242***	-27.7426***	-19.1475***	-27.9906***	-51.8678***
MYR									
ADF trend	-3.7246**	-3.4335**	-3.4097*	-3.2956*	-3.2338*	-3.0772	-3.0582	-3.0541	

ADF const	-0.9510	-0.7457	-0.9547	-0.9577	-0.9793	-0.9950	-1.0354	-1.0521	
ADF 1st.diff	-15.9273***	-22.8119***	-20.2449***	-23.5121***	-22.0814***	-30.9417***	-48.6297***	-49.4611***	
PHP									
ADF trend	-60.5902***	-9.9213***	-6.3989***	-5.1614***	-4.8162***	-4.0446***	-4.1256***	-3.6536**	
ADF const	-41.5250***	-7.972960***	-5.028956***	-3.821170***	-3.472630***	-2.788471*	-3.190486**	-2.2356	
ADF 1st.diff	-24.7216***	-31.5093***	-39.1490***	-34.9243***	-36.9333***	-45.9719***	-41.6049***	-54.9557***	
PKR									
ADF trend		-6.1244***	-4.1727***	-3.2717*	-2.9620	-2.4883			
ADF const		-3.877175***	-2.849971*	-2.5135	-2.5138	-2.5231			
ADF 1st.diff		-27.8075***	-33.5322***	-35.3653***	-40.8500***	-42.2779***			
PLZ									
ADF trend	-4.8653***	-3.0359	-2.5580	-2.8996	-2.9608	-2.9335	-2.8381	-2.7601	-2.7199
ADF const	-4.7908***	-2.777964*	-2.1786	-2.3907	-2.4955	-2.4952	-2.3833	-2.3173	-1.8945
ADF 1st.diff	-22.2182***	-24.2017***	-26.3573***	-23.5515***	-25.3098***	-61.0720***	-59.3961***	-57.5653***	-54.2014***
RUR									
ADF trend	-3.0960	-5.8248***	-3.4965**	-4.1763***	-4.3044***	-3.4760**	-4.0433***	-3.6281**	
ADF const	-2.8896**	-5.706413***	-3.385449**	-3.611620***	-4.031138***	-3.193129**	-2.979960**	-3.180973**	
ADF 1st.diff	-18.0454***	-14.6854***	-15.6227***	-9.0839***	-7.3827***	-8.3175***	-8.3007***	-10.8147***	
THB									
ADF trend	-18.9605***	-6.7578***	-5.7890***	-4.9272***	-4.5402***	-4.1525***	-2.5588	-3.0409	
ADF const	-18.9093***	-6.729318***	-5.609194***	-4.772174***	-4.394945***	-4.022600***	-2.617053*	-2.979984**	
ADF 1st.diff	-21.1512***	-22.0453***	-19.5776***	-19.3416***	-18.1882***	-28.1536***	-18.1417***	-31.1167***	
TRL									
ADF trend	-3.1673*	-3.1798*	-3.2807*	-3.3289*	-3.3171*	-3.3018*	-3.2113*	-3.2473*	-2.6527
ADF const	-3.0681**	-3.103014**	-3.264333**	-3.333783**	-3.316116**	-3.213901**	-3.098178**	-2.966685**	-1.7941
ADF 1st.diff	-47.5914***	-47.2659***	-47.7778***	-63.3164***	-63.8674***	-65.1895***	-64.2193***	-67.4769***	-65.4668***
TWD									
ADF trend		-7.5896***	-5.6526***	-4.4105***	-4.8524***	-3.4580**	-2.7600	-2.5346	-3.0340
ADF const		-7.422738***	-5.475469***	-4.258708***	-4.660207***	-3.332919**	-2.691289*	-2.5043	-1.3271
ADF 1st.diff		-26.3145***	-27.3859***	-25.7783***	-36.6697***	-40.1566***	-37.8720***	-38.1430***	-39.1597***
ZAR									
ADF trend	-4.2958***	-2.9880	-3.1477*	-2.4075	-2.4524	-2.2645	-1.8807	-2.5943	-1.8808

ADF const	-4.0553***	-2.903138**	-3.205336**	-2.3781	-2.616457*	-2.4545	-1.8877	-2.709999*	-1.5130
ADF 1st.diff	-21.0319***	-26.9997***	-31.0076***	-11.7556***	-37.7175***	-36.0491***	-32.5520***	-50.5139***	-23.6466***

ADF test statistics for forward premium.

*   Significance at 10%
**   Significance at 5%
*** Significance at 1%

Table 3.10.1 Fama FMOLS regression for Sterling exchange rate

	TN	1W	1M	2M	3M	6M	9M	1Y	2Y
AUD									
a	-0.0002	-0.0004	-0.0002	0.0003	0.0012	0.0021	-0.0126	-0.0013	
Se a	0.0002	0.0003	0.0006	0.0008	0.0026	0.0034	0.0044	0.0050	
β	1.0508	-1.0515	-1.6545*	-2.0174**	-2.2273**	-2.1630**	-1.2392	-1.9245*	
Se β	0.7083	0.6183	0.2971	0.2097	0.5004	0.3334	0.2872	0.2512	
t β=1	0.0717	-3.3176***	-8.9359***	-14.3885***	-6.4497***	-9.4873***	-7.7956***	-11.6402***	
Wald	1.4241	22.3743***	114.0311***	276.9711***	53.0950***	114.2394***	138.8877***	186.2623***	
R2	0.0005	0.0007	0.0073	0.0216	0.0394	0.0852	0.0419	0.1223	
CAD									
a	-0.0002	-0.0006	-0.0023	-0.0042	-0.0059	-0.0101	-0.0109	-0.0195	
Se a	0.0001	0.0002	0.0005	0.0007	0.0008	0.0012	0.0015	0.0016	
β	-0.4318	-0.2499	-0.5816	-0.4491	-0.3574	0.0069	1.2563***	0.1918	
Se β	0.5549	0.6830	0.3754	0.2683	0.2196	0.1654	0.1527	0.1177	
t β=1	-2.5803***	-1.8300*	-4.2138***	-5.4014***	-6.1825***	-6.0051***	1.6779*	-6.8650***	
Wald	9.5701***	6.1009**	23.6414***	40.6827***	54.8349***	69.7879***	141.1809***	149.1537***	
R2	0.0002	0.0000	0.0006	0.0007	0.0006	0.0000	0.0173	0.0007	
CHF									
a	-0.0003	-0.0013	-0.0059	-0.0107	-0.0150	-0.0287	-0.0444	-0.0689	-0.1607
Se a	0.0002	0.0004	0.0022	0.0032	0.0041	0.0063	0.0079	0.0091	0.0076
β	0.0650	-1.1917	-1.4871	-1.2408	-1.1170	-1.0433	-1.0220	-1.4191	-0.9738
Se β	0.7030	0.6009	0.7795	0.5820	0.5000	0.3828	0.3396	0.2839	0.1498
t β=1	-1.3301	-3.6470***	-3.1905***	-3.8502***	-4.2336***	-5.3379***	-5.9544***	-8.5199***	-13.1735***
Wald	8.5352**	13.4157***	10.2160***	14.8642***	17.9859***	28.6249***	35.8415***	72.6816***	675.8280***
R2	0.0000	0.0010	0.0069	0.0090	0.0109	0.0168	0.0219	0.0568	0.0221
XEU									
a	-0.0001	-0.0006	-0.0022	-0.0036	-0.0052	-0.0090	-0.0127	-0.0173	-0.0100
Se a	0.0001	0.0003	0.0015	0.0022	0.0027	0.0039	0.0048	0.0057	0.0039

β	0.3396	-1.1199	-1.2702	-0.8764	-0.8093	-0.6454	-0.3200	-0.5456	1.9368***
Se β	0.8737	0.7363	1.0144	0.7623	0.6277	0.4514	0.3784	0.3263	0.1391
t β=1	-0.7558	-2.8792***	-2.2378**	-2.4614**	-2.8822***	-3.6454***	-3.4881***	-4.7368***	6.7327***
Wald	2.5571	8.2931**	5.2058*	6.3486**	8.7289**	14.3706***	12.1997***	24.2944***	205.4509***
R2	0.0000	0.0006	0.0030	0.0025	0.0034	0.0044	0.0016	0.0064	0.0939
HKD									
a	0.0000	0.0003	-0.0000	0.0001	0.0006	0.0023*	0.0022	0.0006	0.0517***
Se a	0.0001	0.0002	0.0004	0.0007	0.0008	0.0012	0.0015	0.0016	0.0043
β	-1.6753*	1.8336***	0.4769*	0.4795**	0.5360***	0.7299***	0.6806***	0.3644***	3.7425***
Se β	0.9552	0.5852	0.2560	0.1988	0.1660	0.1241	0.1037	0.0841	0.1404
t β=1	-2.8008***	1.4245	-2.0433**	-2.6179***	-2.7953***	-2.1753**	-3.0811***	-7.5549***	19.5299***
Wald	8.3914**	2.3416	5.3584*	10.2639***	14.2738***	16.0407***	19.5846***	71.2064***	403.7265***
R2	0.0008	0.0024	0.0008	0.0014	0.0025	0.0083	0.0111	0.0047	0.2754
ILS									
a	-0.0004	-0.0009	-0.0033	-0.0060	-0.0083	-0.0126	-0.0192	-0.0280	-0.0998
Se a	0.0003	0.0006	0.0006	0.0008	0.0009	0.0033	0.0035	0.0041	0.0023
β	-3.4612***	3.3437	3.4577***	4.4289***	5.1381***	7.6894***	8.2673***	8.1053***	6.0725***
Se β	4.0628	2.6310	0.6172	0.4603	0.3782	0.7436	0.5881	0.5445	0.1758
t β=1	-1.0981	0.8908	3.9821***	7.4499***	10.9428***	8.9954***	12.3580***	13.0493***	28.8515***
Wald	2.9662	3.0328	51.7399***	123.9849***	225.8479***	108.1764***	200.5929***	237.8188***	2233.6660***
R2	-0.0004	0.0027	0.0133	0.0386	0.0746	0.2584	0.4020	0.4355	0.3896
JPY									
a	0.0000	0.0004	0.0016	0.0033	0.0059	0.0048	0.0009	-0.0206	-0.0499
Se a	0.0003	0.0012	0.0032	0.0050	0.0066	0.0103	0.0040	0.0150	0.0344
β	-1.2813	1.1045	0.9484	0.9625	1.0588*	0.7647*	0.8089***	0.0798	0.9524**
Se β	1.2073	1.3710	0.8530	0.6691	0.5901	0.4596	0.1207	0.3322	0.4680
t β=1	-1.8897*	0.0763	-0.0605	-0.0560	0.0996	-0.5120	-1.5831	-2.7700***	-0.1017
Wald	6.3961**	0.2903	1.2950	2.1960	2.9534	4.2991	16.1616***	14.9140***	10.9374***
R2	0.0003	0.0002	0.0020	0.0044	0.0071	0.0066	0.0115	0.0001	0.0174
NOK									
a	-0.0001	-0.0003	-0.0009	-0.0019	-0.0029	-0.0064	-0.0138	-0.0142	-0.0704
Se a	0.0001	0.0002	0.0004	0.0005	0.0018	0.0024	0.0028	0.0032	0.0047
β	-0.3020	-1.3557	-1.1868	-1.1854	-1.2033	-0.9299	-0.2981	-0.5730	-0.0068
Se β	0.5566	0.4788	0.2011	0.1488	0.3682	0.2490	0.2145	0.1829	0.1685
t β=1	-2.3394**	-4.9199***	-10.8728***	-14.6892***	-5.9834***	-7.7514***	-6.0521***	-8.6001***	-5.9732***

Wald	6.3002**	27.6812***	125.2120***	232.5153***	38.7258***	67.3542***	65.7394***	90.8536***	242.5624***
R2	0.0001	0.0020	0.0082	0.0149	0.0211	0.0295	0.0038	0.0219	-0.0000
NZD									
a	-0.0002	-0.0005	-0.0004	-0.0009	-0.0004	0.0066***	-0.0046	0.0296***	0.0209**
Se a	0.0002	0.0003	0.0022	0.0011	0.0013	0.0019	0.0070	0.0027	0.0092
β	0.2277	0.0308	-0.6415	-0.5556	-0.7451	-1.6114	-1.2283	-2.7589***	-2.1325**
Se β	0.6101	0.7174	1.1693	0.3086	0.2553	0.1911	0.4710	0.1430	0.1887
t β=1	-1.2657	-1.3510	-1.4039	-5.0411***	-6.8351***	-13.6633***	-4.7313***	-26.2872***	-16.5976***
Wald	2.0998	10.9109***	5.5347*	87.9349***	139.6124***	358.0121***	91.5369***	1063.3300***	3267.4380***
R2	0.0000	0.0000	0.0004	0.0008	0.0020	0.0170	0.0158	0.0852	0.0639
SGD									
a	-0.0001	-0.0002	-0.0011	-0.0014	-0.0009	0.0026	-0.0028	-0.0099	-0.0572
Se a	0.0001	0.0003	0.0005	0.0008	0.0010	0.0047	0.0056	0.0076	0.0103
β	-0.4609	0.4797	-0.0253	0.1475	0.3533**	0.7684**	0.8338***	0.1191	1.5625***
Se β	0.4804	0.4489	0.2103	0.1718	0.1502	0.3751	0.3016	0.3085	0.2417
t β=1	-3.0411***	-1.1589	-4.8750***	-4.9610***	-4.3050***	-0.6174	-0.5510	-2.8555***	2.3271**
Wald	13.3652***	1.3523	26.5215***	32.8897***	33.6162***	3.7560	0.3118	12.4887***	168.1167***
R2	0.0002	0.0003	0.0000	0.0002	0.0013	0.0084	0.0180	0.0003	0.1486
USD									
a	0.0000	0.0000	-0.0007	-0.0004	0.0004	0.0044	0.0057	0.0027	0.0257***
Se a	0.0001	0.0003	0.0005	0.0022	0.0028	0.0042	0.0054	0.0060	0.0035
β	-1.6236	0.6289	-0.2280	0.1765	0.4726	1.1113*	1.0879**	0.5185	4.3208***
Se β	1.8271	0.9134	0.4025	0.8854	0.7418	0.5746	0.4960	0.4225	0.1592
t β=1	-1.4360	-0.4062	-3.0508***	-0.9301	-0.7109	0.1937	0.1773	-1.1396	20.8634***
Wald	2.4885	0.2832	10.0711***	1.1796	1.1661	1.5499	1.5355	3.9671	501.9754***
R2	0.0002	0.0001	0.0001	0.0001	0.0010	0.0088	0.0125	0.0040	0.2828
AED									
a	-0.0000	-0.0000	-0.0008	-0.0005	0.0005	0.0091**	0.0173***	0.0204***	0.0196***
Se a	0.0001	0.0002	0.0005	0.0007	0.0008	0.0038	0.0048	0.0053	0.0029
β	-0.7189	0.5441	-0.3137	0.1501	0.5232***	1.9898***	2.5645***	2.2918***	3.5698***
Se β	0.9105	0.6665	0.3011	0.2294	0.1894	0.4442	0.3788	0.3225	0.1005
t β=1	-1.8878*	-0.6840	-4.3633***	-3.7052***	-2.5171**	2.2286**	4.1304***	4.0055***	25.5785***
Wald	4.0003	0.6085	19.9630***	16.8355***	12.9900***	6.7571**	19.0723***	19.4306***	725.1168***
R2	0.0002	0.0002	0.0003	0.0001	0.0018	0.0432	0.1023	0.1104	0.4032

BRL									
a		-0.0019	-0.0009	0.0026	0.0037	0.0085*	-0.0007	0.0054	-0.1209
Se a		0.0008	0.0063	0.0030	0.0037	0.0051	0.0078	0.0087	0.0119
β		0.4313	-0.5695	-0.9386	-0.9426	-0.9628	-0.7535	-0.8059	-0.0082
Se β		0.4099	0.8441	0.2115	0.1727	0.1238	0.1328	0.1059	0.0718
t β=1		-1.3876	-1.8594*	-9.1658***	-11.2457***	-15.8485***	-13.1996***	-17.0465***	-14.0335***
Wald		52.4752***	29.4231***	526.1270***	846.4889***	1783.3200***	2067.2840***	2655.6570***	6773.8350***
R2		0.0005	0.0016	0.0085	0.0128	0.0264	0.0146	0.0267	0.0000
CLP									
a		-0.0010	-0.0034	-0.0072	-0.0118	-0.0268	-0.0404	-0.0536	-0.0938
Se a		0.0004	0.0020	0.0028	0.0035	0.0043	0.0047	0.0049	0.0069
β		0.3851	-0.4808	-0.1917	0.2136	1.3284***	1.6679***	1.7300***	0.8804***
Se β		0.7213	0.8458	0.6426	0.5490	0.3878	0.3189	0.2675	0.2309
t β=1		-0.8525	-1.7509*	-1.8545*	-1.4322	0.8468	2.0946**	2.7287***	-0.5180
Wald		9.8521***	8.5703**	14.1537***	18.4091***	39.6265***	73.2314***	119.4503***	248.7017***
R2		0.0001	0.0014	0.0003	0.0004	0.0380	0.0882	0.1329	0.0572
CNY									
a		-0.0005	-0.0022	-0.0023	-0.0008	0.0174***	0.0456***	0.0586***	0.0075
Se a		0.0003	0.0006	0.0009	0.0012	0.0057	0.0069	0.0080	0.0125
β		-0.1668	-0.2877	0.1578	0.4688***	1.5586***	2.2574***	2.1756***	1.5321***
Se β		0.2921	0.1530	0.1173	0.1002	0.2361	0.1922	0.1680	0.1390
t β=1		-3.9943***	-8.4145***	-7.1819***	-5.2990***	2.3658**	6.5415***	6.9985***	3.8292***
Wald		16.0221***	72.4568***	57.3657***	39.6862***	9.4064***	49.6961***	58.0171***	31.5739***
R2		0.0001	0.0012	0.0006	0.0076	0.1112	0.2971	0.3532	0.3364
COP									
a		-0.0014	-0.0037	-0.0053	-0.0083	-0.0060	0.0023	0.0039	-0.0659
Se a		0.0005	0.0010	0.0015	0.0019	0.0077	0.0090	0.0104	0.0158
β		0.3436	-0.5994	-1.0609	-0.9949	-1.6107	-2.0736**	-2.0292**	-0.6615
Se β		0.6672	0.2908	0.2496	0.2236	0.4623	0.3600	0.3030	0.2095
t β=1		-0.9837	-5.5005***	-8.2557***	-8.9211***	-5.6468***	-8.5388***	-9.9987***	-7.9322***
Wald		17.0499***	102.0348***	231.5964***	370.6206***	137.3840***	282.4710***	426.6175***	899.4010***
R2		0.0001	0.0018	0.0078	0.0086	0.0378	0.1002	0.1345	0.0395
CZK									
a	-0.0003	-0.0007	-0.0023	-0.0046	-0.0067	-0.0139	-0.0267	-0.0310	-0.0320

Se a	0.0001	0.0002	0.0004	0.0006	0.0007	0.0031	0.0012	0.0044	0.0090
β	0.3741	0.1897	0.9978***	1.2382***	1.1249***	1.1402***	0.6366***	1.0989***	3.2691***
Se β	0.4729	0.4051	0.1434	0.1087	0.0928	0.2130	0.0673	0.1601	0.2797
t β=1	-1.3235	-2.0003**	-0.0157	2.1910**	1.3456	0.6582	-5.4030***	0.6175	8.1118***
Wald	6.1056**	13.8536***	25.9569***	59.2706***	84.9360***	20.2946***	468.6072***	50.8774***	207.5140***
R2	0.0002	0.0001	0.0113	0.0300	0.0339	0.0621	0.0228	0.1028	0.3628
HUF									
a	0.0001	-0.0002	-0.0012	-0.0047	-0.0088	-0.0200	-0.0322		-0.1202
Se a	0.0002	0.0005	0.0011	0.0014	0.0017	0.0021	0.0026		0.0158
β	0.2640	0.2686	0.3373	0.5813***	0.7343***	0.8570***	0.9515***		1.4456***
Se β	0.7096	0.4373	0.2080	0.1457	0.1148	0.0781	0.0665		0.1897
t β=1	-1.0372	-1.6727*	-3.1865***	-2.8737***	-2.3146**	-1.8326*	-0.7286		2.3485**
Wald	3.2868	15.9440***	80.8534***	163.5326***	257.3583***	566.6244***	773.4079***		152.1639***
R2	0.0000	0.0001	0.0007	0.0040	0.0102	0.0300	0.0505		0.1909
IDR									
a	0.0005	0.0012*	0.0054***	0.0100***	0.0175***	0.0496***	0.0408***	0.1169***	
Se a	0.0004	0.0006	0.0013	0.0020	0.0026	0.0040	0.0032	0.0067	
β	0.0324**	0.0553**	0.2799***	0.3151***	0.1250*	-0.3273	-0.7696	-0.7155	
Se β	0.0161	0.0256	0.0502	0.0658	0.0703	0.0671	0.0379	0.0638	
t β=1	-60.2071***	-36.8643***	-14.3458***	-10.4026***	-12.4398***	-19.7913***	-46.7523***	-26.8887***	
Wald	3709.8640***	1381.3700***	212.3405***	112.7531***	158.4090***	397.9278***	2373.5170***	730.0586***	
R2	0.0010	0.0012	0.0073	0.0054	0.0008	0.0058	0.0971	0.0305	
INR									
a	0.0003**	0.0008***	0.0032***	0.0037***	0.0037***	0.0070*	0.0103**	0.0096**	
Se a	0.0001	0.0003	0.0006	0.0008	0.0010	0.0040	0.0046	0.0047	
β	1.1634**	-0.7486	-0.7210	-0.2172	0.0623	0.1458	0.1444	0.2986**	
Se β	0.4910	0.2896	0.1598	0.1201	0.0989	0.2190	0.1736	0.1384	
t β=1	0.3328	-6.0370***	-10.7723***	-10.1343***	-9.4824***	-3.9012***	-4.9274***	-5.0693***	
Wald	4.7658*	37.8007***	122.9273***	115.9464***	106.5734***	17.0619***	26.5699***	29.0058***	
R2	0.0014	0.0017	0.0051	0.0008	0.0001	0.0011	0.0017	0.0103	
MAD									
a	-0.0003	-0.0008	-0.0033	-0.0067	-0.0105	-0.0248	-0.0407	-0.0553	-0.1283
Se a	0.0002	0.0003	0.0015	0.0022	0.0028	0.0037	0.0043	0.0050	0.0079
β	-2.2298**	0.9080**	0.6840	0.7219*	0.8054**	1.2328***	1.4675***	1.4793***	1.6281***
Se β	1.4243	0.4081	0.4932	0.3703	0.3136	0.2161	0.1658	0.1446	0.1197

t β=1	-2.2676**	-0.2255	-0.6407	-0.7510	-0.6206	1.0773	2.8191***	3.3151***	5.2486***
Wald	6.1503**	15.7658***	11.7680***	21.5331***	30.9043***	63.1837***	113.4339***	155.8425***	370.7623***
R2	0.0010	0.0021	0.0061	0.0134	0.0237	0.0991	0.2172	0.2757	0.4347
MXN									
a		0.0010**	0.0046***	0.0088***	0.0128***	0.0263***	0.0394***	0.0479***	-0.0563
Se a		0.0004	0.0008	0.0011	0.0013	0.0056	0.0070	0.0083	0.0159
β		-0.4822	-0.4984	-0.4320	-0.3984	-0.3844	-0.4568	-0.2953	0.8525***
Se β		0.2202	0.0971	0.0689	0.0555	0.1253	0.1105	0.0964	0.2117
t β=1		-6.7316***	-15.4324***	-20.7960***	-25.2020***	-11.0486***	-13.1880***	-13.4362***	-0.6965
Wald		55.7595***	300.7180***	548.3618***	809.4778***	155.7233***	220.0655***	239.6551***	182.5810***
R2		0.0012	0.0062	0.0093	0.0122	0.0225	0.0420	0.0228	0.0606
MYR									
a	-0.0003	-0.0008	-0.0031	-0.0061	-0.0088	-0.0164	-0.0252	-0.0331	
Se a	0.0002	0.0003	0.0014	0.0020	0.0026	0.0040	0.0044	0.0047	
β	0.1342	0.3224	0.8639	1.0128*	1.1671**	1.1070***	0.8364***	0.9159***	
Se β	1.7419	0.6688	0.7669	0.5922	0.5217	0.4170	0.3221	0.2687	
t β=1	-0.4971	-1.0132	-0.1775	0.0216	0.3204	0.2565	-0.5080	-0.3130	
Wald	3.1137	9.1839**	5.2835*	9.3549***	12.0542***	18.7502***	34.7820***	55.3525***	
R2	0.0000	0.0001	0.0039	0.0101	0.0178	0.0269	0.0235	0.0396	
PHP									
a	-0.0001	-0.0001	-0.0040	-0.0095	-0.0127	-0.0176	-0.0367	-0.0302	
Se a	0.0002	0.0003	0.0007	0.0011	0.0014	0.0023	0.0022	0.0031	
β	-0.8502	0.2060	1.8015***	2.1109***	1.9961***	1.5726***	1.3453***	1.3301***	
Se β	0.3702	0.3396	0.1737	0.1350	0.1185	0.0962	0.0621	0.0662	
t β=1	-4.9973***	-2.3384**	4.6135***	8.2284***	8.4088***	5.9517***	5.5621***	4.9886***	
Wald	25.5693***	10.6800***	30.0534***	81.2000***	86.3960***	59.4110***	452.9469***	111.9661***	
R2	0.0013	0.0001	0.0249	0.0550	0.0636	0.0609	0.1089	0.0918	
PKR									
a		-0.0000	0.0017*	0.0063*	0.0121**	0.0272***			
Se a		0.0005	0.0009	0.0038	0.0050	0.0073			
β		0.6980**	0.2745*	0.0027	-0.1699	-0.2440			
Se β		0.3379	0.1542	0.3319	0.2945	0.2160			
t β=1		-0.8938	-4.7057***	-3.0043***	-3.9722***	-5.7582***			
Wald		2.0424	30.4426***	10.5201***	17.6182***	36.1963***			
R2		0.0018	0.0014	0.0000	0.0012	0.0037			

PLZ									
a	-0.0001	-0.0012	-0.0059	-0.0114	-0.0165	-0.0295	-0.0422	-0.0604	-0.1092
Se a	0.0002	0.0004	0.0008	0.0012	0.0014	0.0020	0.0025	0.0026	0.0089
β	-0.0399	2.4033***	2.8511***	2.9207***	2.9544***	2.8200***	2.7985***	3.4154***	3.0336***
Se β	1.0529	0.7655	0.3785	0.2841	0.2321	0.1794	0.1592	0.1382	0.2840
t β=1	-0.9876	1.8331*	4.8910***	6.7611***	8.4193***	10.1424***	11.2994***	17.4753***	7.1594***
Wald	1.0364	8.4000**	48.4769***	89.8757***	135.1660***	215.3050***	296.8191***	539.0758***	151.5476***
R2	0.0000	0.0034	0.0193	0.0356	0.0539	0.0815	0.1019	0.1865	0.3155
RUR									
a	-0.0001	-0.0011	-0.0047	-0.0083	-0.0124	-0.0168	-0.0173	-0.0147	
Se a	0.0002	0.0003	0.0006	0.0008	0.0010	0.0013	0.0016	0.0017	
β	-1.6139	1.1100***	1.1736***	1.0636***	1.0826***	0.7168***	0.4603***	0.2205***	
Se β	1.0189	0.1012	0.0671	0.0557	0.0467	0.0362	0.0332	0.0286	
t β=1	-2.5654**	1.0865	2.5862***	1.1410	1.7690*	-7.8167***	-16.2461***	-27.2867***	
Wald	6.6277**	13.8070***	67.5754***	107.2190***	175.0159***	422.4335***	742.2736***	1507.9430***	
R2	0.0011	0.0488	0.1161	0.1362	0.1903	0.1494	0.0813	0.0275	
THB									
a	-0.0002	-0.0005	-0.0015	-0.0020	-0.0017	-0.0006	-0.0152	-0.0022	
Se a	0.0002	0.0003	0.0006	0.0009	0.0011	0.0016	0.0012	0.0022	
β	0.3765	0.1845	1.3446***	1.2513***	1.0198***	0.8796***	-0.6670	0.2880***	
Se β	0.5607	0.2598	0.1217	0.1077	0.1011	0.0899	0.0531	0.0698	
t β=1	-1.1119	-3.1396***	2.8304***	2.3333**	0.1957	-1.3388	-31.4012***	-10.2032***	
Wald	2.3701	16.8496***	11.3346***	8.5881**	2.4532	2.2965	1340.7840***	117.2952***	
R2	0.0001	0.0001	0.0281	0.0311	0.0238	0.0227	0.0394	0.0042	
TRL									
a	0.0011***	0.0026***	0.0127***	0.0251***	0.0361***	0.0565***	0.0681***	0.0842***	0.2833***
Se a	0.0003	0.0004	0.0008	0.0012	0.0015	0.0024	0.0032	0.0042	0.0199
β	-0.0009	-0.0033	-0.0007	0.0338***	0.0729***	0.2175***	0.1988***	0.3006***	-1.3071
Se β	0.0018	0.0027	0.0051	0.0074	0.0087	0.0105	0.0115	0.0112	0.0973
t β=1	-551.0027***	-376.4646***	-196.5120***	-131.3946***	-106.4461***	-74.2257***	-69.9020***	-62.3124***	-23.7144***
Wald	321927.9000***	148416.0000***	39612.6200***	17467.0400***	11370.6400***	5549.5780***	5070.0250***	4242.3310***	1451.6440***
R2	0.0001	0.0004	0.0000	0.0050	0.0165	0.0937	0.0726	0.1521	0.4191
TWD									
a		0.0001	0.0007	0.0017**	0.0030***	0.0092***	0.0066	0.0212***	-0.0025

Se a		0.0002	0.0004	0.0007	0.0009	0.0013	0.0051	0.0065	0.0167
β		0.6575***	0.5086***	0.5152***	0.5761***	0.8440***	0.9007***	1.0558***	1.0716***
Se β		0.2119	0.1427	0.1196	0.1057	0.0864	0.2307	0.2325	0.2713
t β=1		-1.6167	-3.4434***	-4.0546***	-4.0099***	-1.8059*	-0.4304	0.2402	0.2639
Wald		3.8076	25.9796***	50.5339***	71.9151***	120.8768***	5.4413*	19.4335***	0.7621
R2		0.0024	0.0030	0.0044	0.0071	0.0227	0.0360	0.0470	0.0615
ZAR									
a	0.0004	0.0021***	0.0127***	0.0305***	0.0499***	0.0983***	0.1545***	0.1803***	0.4495***
Se a	0.0003	0.0008	0.0017	0.0072	0.0087	0.0128	0.0161	0.0199	0.0310
β	0.3991	-1.1568	-1.9008*	-2.4130**	-2.7241***	-2.7681***	-3.1969***	-2.6196***	-4.6658***
Se β	0.7621	0.6024	0.2882	0.6562	0.5382	0.4126	0.3672	0.3369	0.3270
t β=1	-0.7885	-3.5806***	-10.0654***	-5.2010***	-6.9201***	-9.1328***	-11.4292***	-10.7451***	-17.3279***
Wald	6.1178**	14.8313***	115.3860***	29.2928***	50.8116***	88.1123***	140.3556***	124.2564***	352.6393***
R2	0.0001	0.0009	0.0102	0.0288	0.0556	0.0949	0.1601	0.1279	0.4553
Mean									
a	-0.0000	-0.0002	-0.0004	-0.0002	0.0003	0.0030	-0.0002	0.0042	-0.0145
Se a	0.0002	0.0004	0.0012	0.0017	0.0023	0.0041	0.0047	0.0060	0.0116
β	-0.4276	0.2775	0.1146	0.2159	0.2837	0.4771	0.5713	0.4239	1.1870
se β	0.9197	0.5683	0.3826	0.2995	0.2724	0.2635	0.2232	0.2041	0.1983
t β=1	-5.5012	-2.6922	-1.7565	-1.4197	-1.2149	-1.0117	-1.2733	-1.3501	0.2982
Wald	13573.7917	4845.4251	1332.6771	662.9333	491.8956	338.5961	509.1452	452.7323	875.3611
R2	0.0003	0.0024	0.0094	0.0155	0.0228	0.0476	0.0738	0.0901	0.2014

We use OLS or FMOLS estimator according to the stationarity of the forward premium. For example, referring to Table 3.10, for AUD, OLS is applied for TN, 1W, 1M and 2M, and FMOLS is applied for 3M, 6M, 9M, and 1Y. For each economy we test for different time forward rates with different time to maturity. We report the values and standard errors of α and β, R squares of the equation, also the t statistics of testing β=1, the Wald statistics of joint test for α=1 and β=1, and the test statistics of unit root test (ADF) for the residuals of the equation. We calculate the mean of these statistics across the economies. We append the total number of rejections of the market efficiency hypothesis out of the 31 economies at the end of the table.

* Significance at 10%

** Significance at 5%

*** Significance at 1%

Table 3.10.2 Fama DOLS regression for Sterling exchange rate

	TN	1W	1M	2M	3M	6M	9M	1Y	2Y
AUD									
a	-0.0002	-0.0004	-0.0002	0.0003	0.0011	0.0017	-0.0133	-0.0019	
Se a	0.0002	0.0003	0.0006	0.0008	0.0026	0.0035	0.0042	0.0050	
β	1.0508	-1.0515	-1.6545*	-2.0174**	-2.1888**	-2.1369**	-1.2046	-1.9100*	
Se β	0.7083	0.6183	0.2971	0.2097	0.5034	0.3359	0.2739	0.2525	
t β=1	0.0717	-3.3176***	-8.9359***	-14.3885***	-6.3351***	-9.3376***	-8.0495***	-11.5251***	
Wald	1.4241	22.3743***	114.0311***	276.9711***	51.6078***	111.9233***	152.8805***	184.5695***	
R2	0.0005	0.0007	0.0073	0.0216	0.0402	0.0877	0.0430	0.1246	
CAD									
a	-0.0002	-0.0006	-0.0023	-0.0042	-0.0059	-0.0101	-0.0109	-0.0195	
Se a	0.0001	0.0002	0.0005	0.0007	0.0008	0.0012	0.0015	0.0016	
β	-0.4318	-0.2499	-0.5816	-0.4491	-0.3574	0.0069	1.2563***	0.1918	
Se β	0.5549	0.6830	0.3754	0.2683	0.2196	0.1654	0.1527	0.1177	
t β=1	-2.5803***	-1.8300*	-4.2138***	-5.4014***	-6.1825***	-6.0051***	1.6779*	-6.8650***	
Wald	9.5701***	6.1009**	23.6414***	40.6827***	54.8349***	69.7879***	141.1809***	149.1537***	
R2	0.0002	0.0000	0.0006	0.0007	0.0006	0.0000	0.0173	0.0007	
CHF									
a	-0.0003	-0.0013	-0.0061	-0.0106	-0.0151	-0.0288	-0.0442	-0.0688	-0.1607
Se a	0.0002	0.0004	0.0023	0.0033	0.0042	0.0063	0.0075	0.0091	0.0076
β	0.0650	-1.1917	-1.5437	-1.2179	-1.1149	-1.0339	-1.0095	-1.4091	-0.9738
Se β	0.7030	0.6009	0.7967	0.5868	0.5032	0.3838	0.3230	0.2845	0.1498
t β=1	-1.3301	-3.6470***	-3.1929***	-3.7797***	-4.2032***	-5.2997***	-6.2214***	-8.4677***	-13.1735***
Wald	8.5352**	13.4157***	10.2280***	14.3074***	17.6988***	28.1789***	39.1737***	71.7628***	675.8280***
R2	0.0000	0.0010	0.0075	0.0109	0.0126	0.0178	0.0221	0.0581	0.0221
XEU									
a	-0.0001	-0.0006	-0.0023	-0.0036	-0.0051	-0.0089	-0.0126	-0.0172	-0.0100
Se a	0.0001	0.0003	0.0015	0.0023	0.0028	0.0039	0.0045	0.0057	0.0039
β	0.3396	-1.1199	-1.2907	-0.8211	-0.7743	-0.6217	-0.2996	-0.5276	1.9368***

Se β	0.8737	0.7363	1.0347	0.7703	0.6311	0.4526	0.3604	0.3271	0.1391
t β=1	-0.7558	-2.8792***	-2.2138**	-2.3640**	-2.8115***	-3.5832***	-3.6064***	-4.6695***	6.7327***
Wald	2.5571	8.2931**	5.0869*	5.8282*	8.2733**	13.8317***	13.0269***	23.5235***	205.4509***
R2	0.0000	0.0006	0.0039	0.0045	0.0045	0.0057	0.0033	0.0081	0.0939
HKD									
a	0.0000	0.0003	-0.0000	0.0001	0.0006	0.0023*	0.0022	0.0006	0.0517***
Se a	0.0001	0.0002	0.0004	0.0007	0.0008	0.0012	0.0015	0.0016	0.0043
β	-1.6753*	1.8336***	0.4769*	0.4795**	0.5360***	0.7299***	0.6806***	0.3644***	3.7425***
Se β	0.9552	0.5852	0.2560	0.1988	0.1660	0.1241	0.1037	0.0841	0.1404
t β=1	-2.8008***	1.4245	-2.0433**	-2.6179***	-2.7953***	-2.1753**	-3.0811***	-7.5549***	19.5299***
Wald	8.3914**	2.3416	5.3584*	10.2639***	14.2738***	16.0407***	19.5846***	71.2064***	403.7265***
R2	0.0008	0.0024	0.0008	0.0014	0.0025	0.0083	0.0111	0.0047	0.2754
ILS									
a	-0.0004	-0.0009	-0.0033	-0.0060	-0.0083	-0.0127	-0.0192	-0.0282	-0.0998
Se a	0.0003	0.0006	0.0006	0.0008	0.0009	0.0033	0.0035	0.0041	0.0023
β	-1.1766	3.4862	3.4577***	4.4289***	5.1381***	7.6313***	8.2036***	8.0336***	6.0725***
Se β	5.1047	2.6731	0.6172	0.4603	0.3782	0.7494	0.5914	0.5481	0.1758
t β=1	-0.4264	0.9301	3.9821***	7.4499***	10.9428***	8.8491***	12.1809***	12.8322***	28.8515***
Wald	2.0088	3.1303	51.7399***	123.9849***	225.8479***	105.6173***	196.3538***	232.2703***	2233.6660***
R2	0.0013	0.0028	0.0133	0.0386	0.0746	0.2645	0.4055	0.4410	0.3896
JPY									
a	0.0000	0.0003	0.0016	0.0033	0.0058	0.0048	0.0009	-0.0209	-0.0498
Se a	0.0003	0.0012	0.0033	0.0050	0.0066	0.0103	0.0040	0.0150	0.0345
β	-1.2813	0.9394	0.9375	0.9778	1.0650*	0.7685*	0.8089***	0.0832	0.9591**
Se β	1.2073	1.3950	0.8754	0.6749	0.5930	0.4603	0.1207	0.3328	0.4688
t β=1	-1.8897*	-0.0434	-0.0714	-0.0330	0.1096	-0.5029	-1.5831	-2.7551***	-0.0872
Wald	6.3961**	0.2568	1.2692	2.0886	2.7805	4.2328	16.1616***	14.4550***	11.0489***
R2	0.0003	0.0027	0.0026	0.0051	0.0078	0.0066	0.0115	0.0011	0.0177
NOK									
a	-0.0001	-0.0003	-0.0009	-0.0019	-0.0029	-0.0065	-0.0141	-0.0144	-0.0704
Se a	0.0001	0.0002	0.0004	0.0005	0.0019	0.0024	0.0027	0.0033	0.0047
β	-0.3020	-1.3557	-1.1868	-1.1854	-1.1787	-0.9115	-0.2736	-0.5581	-0.0018
Se β	0.5566	0.4788	0.2011	0.1488	0.3727	0.2504	0.2053	0.1839	0.1690
t β=1	-2.3394**	-4.9199***	-10.8728***	-14.6892***	-5.8458***	-7.6337***	-6.2046***	-8.4735***	-5.9294***
Wald	6.3002**	27.6812***	125.2120***	232.5153***	37.1417***	65.7775***	71.7525***	89.2374***	240.7445***

R2	0.0001	0.0020	0.0082	0.0149	0.0220	0.0306	0.0101	0.0242	0.0002
NZD									
a	-0.0002	-0.0005	-0.0004	-0.0009	-0.0004	0.0066***	-0.0049	0.0296***	0.0209**
Se a	0.0002	0.0003	0.0023	0.0011	0.0013	0.0019	0.0066	0.0027	0.0092
β	0.2277	0.0308	-0.6145	-0.5556	-0.7451	-1.6114	-1.1960	-2.7589***	-2.1325**
Se β	0.6101	0.7174	1.2690	0.3086	0.2553	0.1911	0.4489	0.1430	0.1887
t β=1	-1.2657	-1.3510	-1.2722	-5.0411***	-6.8351***	-13.6633***	-4.8921***	-26.2872***	-16.5976***
Wald	2.0998	10.9109***	5.1599*	87.9349***	139.6124***	358.0121***	100.0968***	1063.3300***	3267.4380***
R2	0.0000	0.0000	0.0005	0.0008	0.0020	0.0170	0.0166	0.0852	0.0639
SGD									
a	-0.0001	-0.0002	-0.0011	-0.0014	-0.0009	0.0023	-0.0032	-0.0099	-0.0568
Se a	0.0001	0.0003	0.0005	0.0008	0.0010	0.0048	0.0053	0.0076	0.0104
β	-0.4609	0.4797	-0.0253	0.1475	0.3533**	0.7374*	0.8153***	0.1146	1.5620***
Se β	0.4804	0.4489	0.2103	0.1718	0.1502	0.3781	0.2878	0.3100	0.2427
t β=1	-3.0411***	-1.1589	-4.8750***	-4.9610***	-4.3050***	-0.6945	-0.6418	-2.8565***	2.3156**
Wald	13.3652***	1.3523	26.5215***	32.8897***	33.6162***	3.8485	0.4235	12.4995***	165.1241***
R2	0.0002	0.0003	0.0000	0.0002	0.0013	0.0093	0.0182	0.0005	0.1519
USD									
a	0.0000	0.0000	-0.0007	-0.0004	0.0005	0.0045	0.0058	0.0028	0.0257***
Se a	0.0001	0.0003	0.0005	0.0022	0.0028	0.0042	0.0052	0.0060	0.0035
β	-1.6236	0.6289	-0.2280	0.1931	0.4997	1.1273*	1.1036**	0.5320	4.3208***
Se β	1.8271	0.9134	0.4025	0.8931	0.7461	0.5778	0.4716	0.4230	0.1592
t β=1	-1.4360	-0.4062	-3.0508***	-0.9035	-0.6706	0.2204	0.2197	-1.1064	20.8634***
Wald	2.4885	0.2832	10.0711***	1.1274	1.0985	1.5008	1.6789	3.8943	501.9754***
R2	0.0002	0.0001	0.0001	0.0010	0.0021	0.0121	0.0131	0.0041	0.2828
AED									
a	-0.0000	-0.0000	-0.0008	-0.0005	0.0005	0.0091**	0.0172***	0.0205***	0.0196***
Se a	0.0001	0.0002	0.0005	0.0007	0.0008	0.0039	0.0046	0.0053	0.0029
β	-0.7189	0.5441	-0.3137	0.1501	0.5232***	1.9976***	2.5661***	2.2955***	3.5698***
Se β	0.9105	0.6665	0.3011	0.2294	0.1894	0.4506	0.3621	0.3232	0.1005
t β=1	-1.8878*	-0.6840	-4.3633***	-3.7052***	-2.5171**	2.2140**	4.3257***	4.0079***	25.5785***
Wald	4.0003	0.6085	19.9630***	16.8355***	12.9900***	6.5862**	20.8205***	19.4258***	725.1168***
R2	0.0002	0.0002	0.0003	0.0001	0.0018	0.0509	0.1074	0.1108	0.4032
BRL									

a		-0.0019	-0.0003	0.0026	0.0037	0.0085*	-0.0007	0.0054	-0.1209
Se a		0.0008	0.0064	0.0030	0.0037	0.0051	0.0078	0.0087	0.0119
β		0.4313	-0.6607	-0.9386	-0.9426	-0.9628	-0.7535	-0.8059	-0.0082
Se β		0.4099	0.8628	0.2115	0.1727	0.1238	0.1328	0.1059	0.0718
t β=1		-1.3876	-1.9246*	-9.1658***	-11.2457***	-15.8485***	-13.1996***	-17.0465***	-14.0335***
Wald		52.4752***	29.3114***	526.1270***	846.4889***	1783.3200***	2067.2840***	2655.6570***	6773.8350***
R2		0.0005	0.0025	0.0085	0.0128	0.0264	0.0146	0.0267	0.0000
CLP									
a		-0.0010	-0.0033	-0.0073	-0.0119	-0.0271	-0.0409	-0.0537	-0.0940
Se a		0.0004	0.0020	0.0029	0.0035	0.0043	0.0048	0.0049	0.0069
β		0.3851	-0.5798	-0.1945	0.2014	1.3285***	1.6778***	1.7334***	0.8769***
Se β		0.7213	0.8521	0.6455	0.5514	0.3898	0.3205	0.2683	0.2319
t β=1		-0.8525	-1.8539*	-1.8504*	-1.4482	0.8427	2.1144**	2.7331***	-0.5307
Wald		9.8521***	8.8469**	14.2042***	18.6900***	40.3113***	74.3733***	119.5913***	248.2320***
R2		0.0001	0.0016	0.0005	0.0006	0.0404	0.0917	0.1336	0.0570
CNY									
a		-0.0005	-0.0022	-0.0023	-0.0008	0.0170***	0.0451***	0.0582***	0.0071
Se a		0.0003	0.0006	0.0009	0.0012	0.0058	0.0070	0.0081	0.0126
β		-0.1668	-0.2877	0.1578	0.4688***	1.5421***	2.2415***	2.1665***	1.5276***
Se β		0.2921	0.1530	0.1173	0.1002	0.2399	0.1942	0.1687	0.1394
t β=1		-3.9943***	-8.4145***	-7.1819***	-5.2990***	2.2600**	6.3940***	6.9160***	3.7838***
Wald		16.0221***	72.4568***	57.3657***	39.6862***	8.6553**	47.5301***	56.7520***	31.2621***
R2		0.0001	0.0012	0.0006	0.0076	0.1229	0.3036	0.3547	0.3379
COP									
a		-0.0014	-0.0037	-0.0053	-0.0083	-0.0064	0.0017	0.0030	-0.0656
Se a		0.0005	0.0010	0.0015	0.0019	0.0077	0.0091	0.0104	0.0159
β		0.3436	-0.5994	-1.0609	-0.9949	-1.5852	-2.0441**	-1.9972**	-0.6603
Se β		0.6672	0.2908	0.2496	0.2236	0.4658	0.3622	0.3053	0.2112
t β=1		-0.9837	-5.5005***	-8.2557***	-8.9211***	-5.5497***	-8.4039***	-9.8176***	-7.8610***
Wald		17.0499***	102.0348***	231.5964***	370.6206***	135.9723***	279.7039***	420.2850***	885.8912***
R2		0.0001	0.0018	0.0078	0.0086	0.0384	0.1021	0.1375	0.0471
CZK									
a	-0.0003	-0.0007	-0.0023	-0.0046	-0.0067	-0.0139	-0.0267	-0.0308	-0.0323
Se a	0.0001	0.0002	0.0004	0.0006	0.0007	0.0031	0.0012	0.0044	0.0091
β	0.3741	0.1897	0.9978***	1.2382***	1.1249***	1.1354***	0.6366***	1.0992***	3.2613***

Se β	0.4729	0.4051	0.1434	0.1087	0.0928	0.2137	0.0673	0.1609	0.2806
t β=1	-1.3235	-2.0003**	-0.0157	2.1910**	1.3456	0.6338	-5.4030***	0.6163	8.0582***
Wald	6.1056**	13.8536***	25.9569***	59.2706***	84.9360***	20.0461***	468.6072***	49.8341***	206.6151***
R2	0.0002	0.0001	0.0113	0.0300	0.0339	0.0634	0.0228	0.1053	0.3643
HUF									
a	0.0001	-0.0002	-0.0012	-0.0047	-0.0088	-0.0200	-0.0322		-0.1193
Se a	0.0002	0.0005	0.0011	0.0014	0.0017	0.0021	0.0026		0.0158
β	0.2640	0.2686	0.3373	0.5813***	0.7343***	0.8570***	0.9515***		1.4335***
Se β	0.7096	0.4373	0.2080	0.1457	0.1148	0.0781	0.0665		0.1904
t β=1	-1.0372	-1.6727*	-3.1865***	-2.8737***	-2.3146**	-1.8326*	-0.7286		2.2766**
Wald	3.2868	15.9440***	80.8534***	163.5326***	257.3583***	566.6244***	773.4079***		151.3909***
R2	0.0000	0.0001	0.0007	0.0040	0.0102	0.0300	0.0505		0.1942
IDR									
a	0.0005	0.0012*	0.0054***	0.0100***	0.0175***	0.0496***	0.0408***	0.1169***	
Se a	0.0004	0.0006	0.0013	0.0020	0.0026	0.0040	0.0032	0.0067	
β	0.0324**	0.0553**	0.2799***	0.3151***	0.1250*	-0.3273	-0.7696	-0.7155	
Se β	0.0161	0.0256	0.0502	0.0658	0.0703	0.0671	0.0379	0.0638	
t β=1	-60.2071***	-36.8643***	-14.3458***	-10.4026***	-12.4398***	-19.7913***	-46.7523***	-26.8887***	
Wald	3709.8640***	1381.3700***	212.3405***	112.7531***	158.4090***	397.9278***	2373.5170***	730.0586***	
R2	0.0010	0.0012	0.0073	0.0054	0.0008	0.0058	0.0971	0.0305	
INR									
a	0.0003**	0.0008***	0.0032***	0.0037***	0.0037***	0.0068*	0.0101**	0.0095**	
Se a	0.0001	0.0003	0.0006	0.0008	0.0010	0.0041	0.0044	0.0047	
β	1.1634**	-0.7486	-0.7210	-0.2172	0.0623	0.1509	0.1474	0.2995**	
Se β	0.4910	0.2896	0.1598	0.1201	0.0989	0.2200	0.1657	0.1390	
t β=1	0.3328	-6.0370***	-10.7723***	-10.1343***	-9.4824***	-3.8588***	-5.1459***	-5.0406***	
Wald	4.7658*	37.8007***	122.9273***	115.9464***	106.5734***	16.7895***	29.1159***	28.8552***	
R2	0.0014	0.0017	0.0051	0.0008	0.0001	0.0022	0.0030	0.0126	
MAD									
a	-0.0003	-0.0008	-0.0033	-0.0068	-0.0106	-0.0249	-0.0408	-0.0553	-0.1280
Se a	0.0002	0.0003	0.0015	0.0022	0.0028	0.0038	0.0043	0.0051	0.0079
β	-2.2298**	0.9080**	0.6897	0.7311**	0.8065**	1.2332***	1.4664***	1.4772***	1.6215***
Se β	1.4243	0.4081	0.4958	0.3719	0.3146	0.2173	0.1664	0.1452	0.1200
t β=1	-2.2676**	-0.2255	-0.6259	-0.7230	-0.6150	1.0730	2.8024***	3.2862***	5.1806***
Wald	6.1503**	15.7658***	11.8171***	21.5738***	30.9769***	63.1701***	113.3185***	155.3714***	369.6178***

R2	0.0010	0.0021	0.0090	0.0161	0.0246	0.1075	0.2208	0.2806	0.4363
MXN									
a		0.0010**	0.0046***	0.0088***	0.0128***	0.0265***	0.0395***	0.0481***	-0.0561
Se a		0.0004	0.0008	0.0011	0.0013	0.0056	0.0066	0.0084	0.0161
β		-0.4822	-0.4984	-0.4320	-0.3984	-0.3921	-0.4594	-0.2970	0.8479***
Se β		0.2202	0.0971	0.0689	0.0555	0.1256	0.1051	0.0966	0.2134
t β=1		-6.7316***	-15.4324***	-20.7960***	-25.2020***	-11.0806***	-13.8850***	-13.4274***	-0.7126
Wald		55.7595***	300.7180***	548.3618***	809.4778***	156.4913***	243.8828***	239.0948***	181.3605***
R2		0.0012	0.0062	0.0093	0.0122	0.0225	0.0426	0.0234	0.0682
MYR									
a	-0.0003	-0.0008	-0.0031	-0.0062	-0.0088	-0.0163	-0.0251	-0.0332	
Se a	0.0002	0.0003	0.0014	0.0020	0.0026	0.0040	0.0044	0.0047	
β	0.1342	0.3224	0.8788	1.0281*	1.1787**	1.1179***	0.8409***	0.9128***	
Se β	1.7419	0.6688	0.7693	0.5943	0.5231	0.4182	0.3229	0.2694	
t β=1	-0.4971	-1.0132	-0.1575	0.0472	0.3417	0.2820	-0.4928	-0.3236	
Wald	3.1137	9.1839**	5.3281*	9.4957***	12.1549***	18.6474***	34.6757***	55.5569***	
R2	0.0000	0.0001	0.0069	0.0128	0.0200	0.0269	0.0236	0.0411	
PHP									
a	-0.0001	-0.0001	-0.0040	-0.0095	-0.0127	-0.0176	-0.0367	-0.0302	
Se a	0.0002	0.0003	0.0007	0.0011	0.0014	0.0023	0.0022	0.0031	
β	-0.8502	0.2060	1.8015***	2.1109***	1.9961***	1.5726***	1.3453***	1.3301***	
Se β	0.3702	0.3396	0.1737	0.1350	0.1185	0.0962	0.0621	0.0662	
t β=1	-4.9973***	-2.3384**	4.6135***	8.2284***	8.4088***	5.9517***	5.5621***	4.9886***	
Wald	25.5693***	10.6800***	30.0534***	81.2000***	86.3960***	59.4110***	452.9469***	111.9661***	
R2	0.0013	0.0001	0.0249	0.0550	0.0636	0.0609	0.1089	0.0918	
PKR									
a		-0.0000	0.0017*	0.0063	0.0121**	0.0266***			
Se a		0.0005	0.0009	0.0039	0.0050	0.0073			
β		0.6980**	0.2745*	0.0166	-0.1697	-0.2288			
Se β		0.3379	0.1542	0.3339	0.2958	0.2172			
t β=1		-0.8938	-4.7057***	-2.9453***	-3.9544***	-5.6566***			
Wald		2.0424	30.4426***	10.1161***	17.4313***	35.2489***			
R2		0.0018	0.0014	0.0004	0.0020	0.0053			
PLZ									

a	-0.0001	-0.0012	-0.0059	-0.0114	-0.0165	-0.0295	-0.0422	-0.0604	-0.1085
Se a	0.0002	0.0004	0.0008	0.0012	0.0014	0.0020	0.0025	0.0026	0.0089
β	-0.0399	2.4033***	2.8511***	2.9207***	2.9544***	2.8200***	2.7985***	3.4154***	3.0019***
Se β	1.0529	0.7655	0.3785	0.2841	0.2321	0.1794	0.1592	0.1382	0.2849
t β=1	-0.9876	1.8331*	4.8910***	6.7611***	8.4193***	10.1424***	11.2994***	17.4753***	7.0256***
Wald	1.0364	8.4000**	48.4769***	89.8757***	135.1660***	215.3050***	296.8191***	539.0758***	149.4522***
R2	0.0000	0.0034	0.0193	0.0356	0.0539	0.0815	0.1019	0.1865	0.3181
RUR									
a	-0.0001	-0.0011	-0.0047	-0.0083	-0.0124	-0.0168	-0.0173	-0.0147	
Se a	0.0002	0.0003	0.0006	0.0008	0.0010	0.0013	0.0016	0.0017	
β	-1.6139	1.1100***	1.1736***	1.0636***	1.0826***	0.7168***	0.4603***	0.2205***	
Se β	1.0189	0.1012	0.0671	0.0557	0.0467	0.0362	0.0332	0.0286	
t β=1	-2.5654**	1.0865	2.5862***	1.1410	1.7690*	-7.8167***	-16.2461***	-27.2867***	
Wald	6.6277**	13.8070***	67.5754***	107.2190***	175.0159***	422.4335***	742.2736***	1507.9430***	
R2	0.0011	0.0488	0.1161	0.1362	0.1903	0.1494	0.0813	0.0275	
THB									
a	-0.0002	-0.0005	-0.0015	-0.0020	-0.0017	-0.0006	-0.0152	-0.0022	
Se a	0.0002	0.0003	0.0006	0.0009	0.0011	0.0016	0.0012	0.0022	
β	0.3765	0.1845	1.3446***	1.2513***	1.0198***	0.8796***	-0.6670	0.2880***	
Se β	0.5607	0.2598	0.1217	0.1077	0.1011	0.0899	0.0531	0.0698	
t β=1	-1.1119	-3.1396***	2.8304***	2.3333**	0.1957	-1.3388	-31.4012***	-10.2032***	
Wald	2.3701	16.8496***	11.3346***	8.5881**	2.4532	2.2965	1340.7840***	117.2952***	
R2	0.0001	0.0001	0.0281	0.0311	0.0238	0.0227	0.0394	0.0042	
TRL									
a	0.0011***	0.0026***	0.0127***	0.0251***	0.0361***	0.0565***	0.0681***	0.0842***	0.2827***
Se a	0.0003	0.0004	0.0008	0.0012	0.0015	0.0024	0.0032	0.0042	0.0201
β	-0.0009	-0.0033	-0.0007	0.0338***	0.0729***	0.2175***	0.1988***	0.3006***	-1.3015
Se β	0.0018	0.0027	0.0051	0.0074	0.0087	0.0105	0.0115	0.0112	0.0983
t β=1	-551.0027***	-376.4646***	-196.5120***	-131.3946***	-106.4461***	-74.2257***	-69.9020***	-62.3124***	-23.4095***
Wald	321927.9000***	148416.0000***	39612.6200***	17467.0400***	11370.6400***	5549.5780***	5070.0250***	4242.3310***	1419.3710***
R2	0.0001	0.0004	0.0000	0.0050	0.0165	0.0937	0.0726	0.1521	0.4254
TWD									
a		0.0001	0.0007	0.0017**	0.0030***	0.0092***	0.0064	0.0210***	-0.0026
Se a		0.0002	0.0004	0.0007	0.0009	0.0013	0.0048	0.0065	0.0168
β		0.6575***	0.5086***	0.5152***	0.5761***	0.8440***	0.8915***	1.0443***	1.0697***

Se β		0.2119	0.1427	0.1196	0.1057	0.0864	0.2202	0.2334	0.2729
t β=1		-1.6167	-3.4434***	-4.0546***	-4.0099***	-1.8059*	-0.4928	0.1898	0.2554
Wald		3.8076	25.9796***	50.5339***	71.9151***	120.8768***	6.0316**	19.3317***	0.7599
R2		0.0024	0.0030	0.0044	0.0071	0.0227	0.0364	0.0472	0.0617
ZAR									
a	0.0004	0.0021***	0.0127***	0.0307***	0.0505***	0.0984***	0.1545***	0.1800***	0.4472***
Se a	0.0003	0.0008	0.0017	0.0073	0.0087	0.0128	0.0153	0.0199	0.0311
β	0.3991	-1.1568	-1.9008*	-2.4491**	-2.7717***	-2.7689***	-3.1966***	-2.6126***	-4.6412***
Se β	0.7621	0.6024	0.2882	0.6630	0.5418	0.4141	0.3495	0.3379	0.3280
t β=1	-0.7885	-3.5806***	-10.0654***	-5.2020***	-6.9611***	-9.1015***	-12.0082***	-10.6915***	-17.1965***
Wald	6.1178**	14.8313***	115.3860***	29.3915***	51.4870***	87.4542***	154.9896***	122.9549***	347.9468***
R2	0.0001	0.0009	0.0102	0.0296	0.0563	0.0953	0.1612	0.1292	0.4575
Mean									
a	-0.0000	-0.0002	-0.0004	-0.0002	0.0003	0.0029	-0.0003	0.0041	-0.0145
Se a	0.0002	0.0004	0.0012	0.0017	0.0023	0.0041	0.0046	0.0060	0.0116
β	-0.3324	0.2768	0.1072	0.2194	0.2865	0.4785	0.5739	0.4245	1.1857
se β	0.9631	0.5704	0.3887	0.3009	0.2734	0.2648	0.2177	0.2048	0.1990
t β=1	-5.4955	-2.6927	-1.7564	-1.4178	-1.2127	-1.0100	-1.2888	-1.3482	0.2996
Wald	13573.7518	4845.4272	1332.6691	662.8910	491.7952	338.2548	511.4140	451.9752	872.5388
R2	0.0004	0.0025	0.0097	0.0159	0.0231	0.0493	0.0751	0.0913	0.2031

We use OLS or DOLS estimator according to the stationarity of the forward premium. For example, referring to Table 3.10, for AUD, OLS is applied for TN, 1W, 1M and 2M, and DOLS is applied for 3M, 6M, 9M, and 1Y. For each economy we test for different time forward rates with different time to maturity. We report the values and standard errors of α and β, R squares of the equation, also the t statistics of testing β=1, the Wald statistics of joint test for α=1 and β=1, and the test statistics of unit root test (ADF) for the residuals of the equation. We calculate the mean of these statistics across the economies. We append the total number of rejections of the market efficiency hypothesis out of the 31 economies at the end of the table.

* Significance at 10%

** Significance at 5%

*** Significance at 1%

Table 3.11 Number of rejections in the Fama equation using Sterling, USD and Euro sample

Panel A (FMOLS)

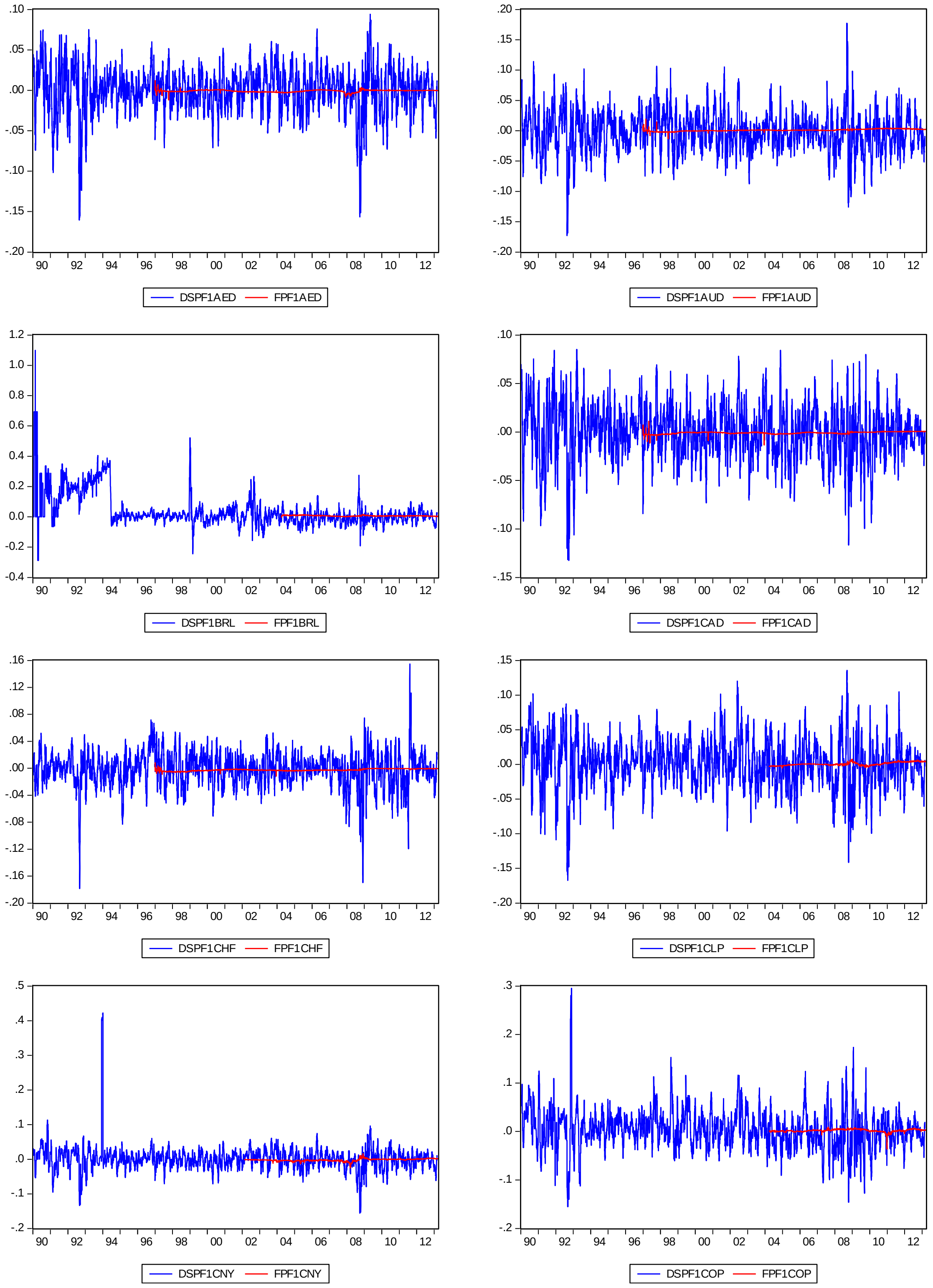
		1W	1M	2M	3M	6M	9M	1Y	2Y
Sterling									
a=0	2	4	5	6	7	9	7	9	6
t β=1	9	13	24	25	23	21	23	25	18
a=0 & β=1	13	23	26	29	28	27	27	28	21
USD									
a=0	2	3	8	7	8	8	7	10	8
t β=1	9	23	24	24	25	26	28	26	22
a=0 & β=1	8	27	28	30	30	30	29	29	24
Euro									
a=0	2	5	7	11	12	13	15	15	9
t β=1	11	23	26	26	27	28	26	27	19
a=0 & β=1	10	24	25	28	30	30	30	31	23

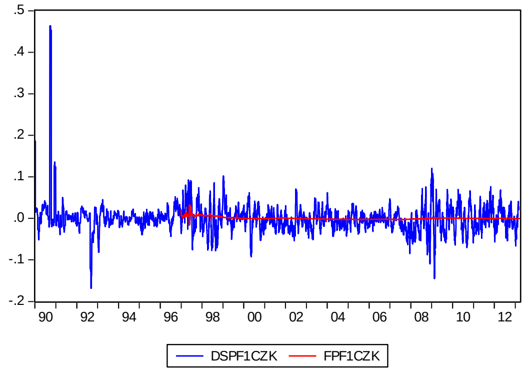
Panel B (DOLS)

		1W	1M	2M	3M	6M	9M	1Y	2Y
Sterling									
a=0	2	4	5	6	7	9	7	9	6
t β=1	9	13	24	25	23	21	23	25	18
a=0 & β=1	13	23	26	28	28	27	28	28	21
USD									
a=0	3	3	8	7	8	8	7	10	8
t β=1	9	23	24	24	25	26	28	26	21
a=0 & β=1	8	27	28	29	30	30	29	29	24
Euro									
a=0	2	5	7	10	12	13	15	15	9
t β=1	11	23	26	26	27	28	26	27	19
a=0 & β=1	10	24	25	28	30	30	30	31	23

Numbers in each row of the table represents of the number of economies that are rejected for the hypothesis α=0, β=1, and the joint test α=0 and β=1 respectively. Most periods contain all 31 economies data coverage, except only 24 economies for TN, and 30 economies for 9M. For 2Y forward rates, Sterling covers 22 economies, while both USD and Euro have 24 economies. For 1Y forward rates, Sterling has 29 economies and USD has 30 economies data coverage. Empty entries in table 3.7.1 to 3.7.6 indicates the economies with missing data.

Figure 3.1 One-month Sterling spot returns and forward premium

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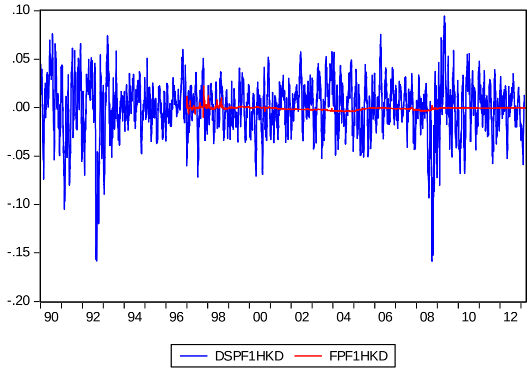
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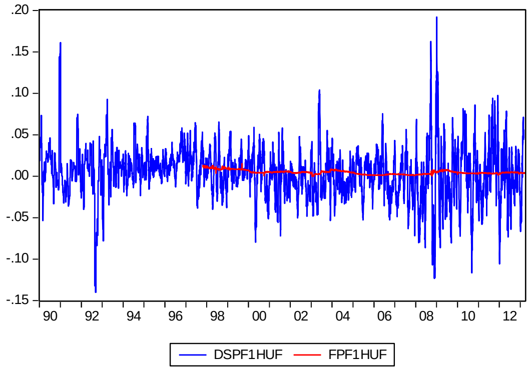
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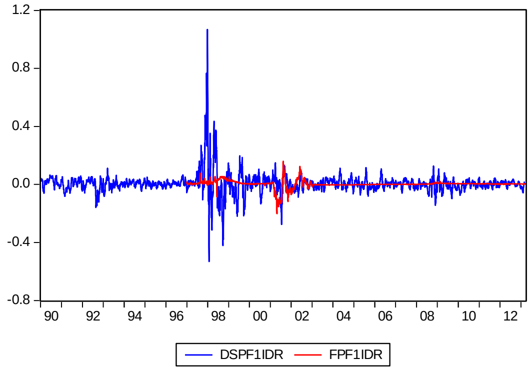
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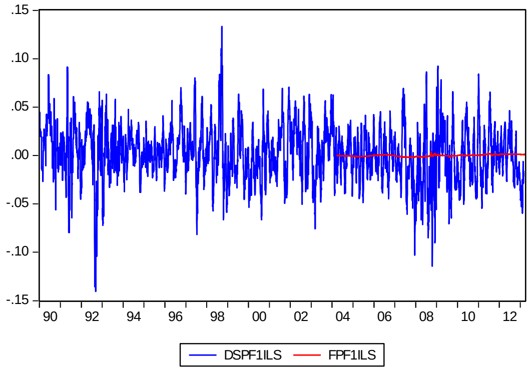
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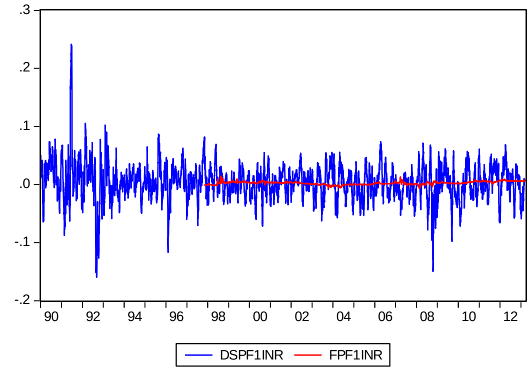
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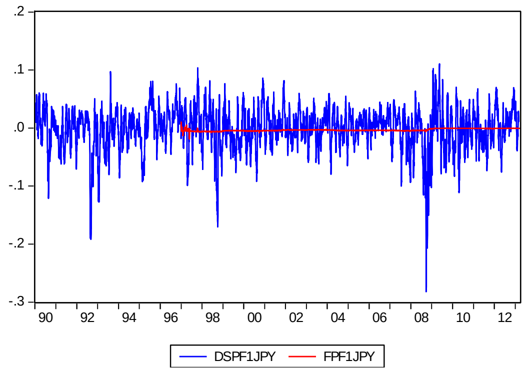
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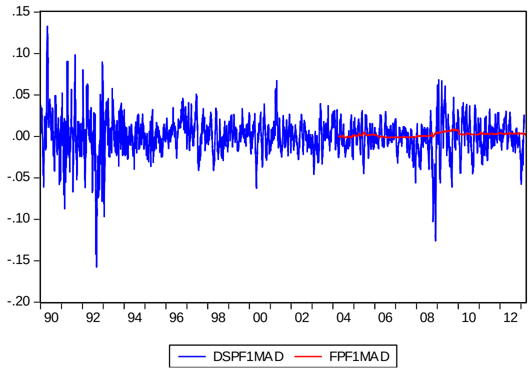
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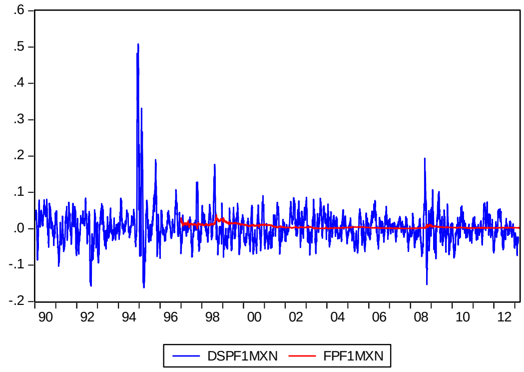
FPF1MAD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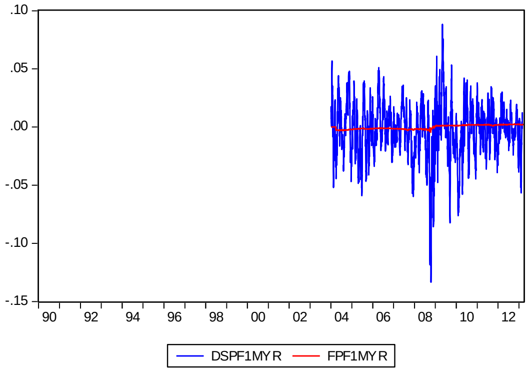
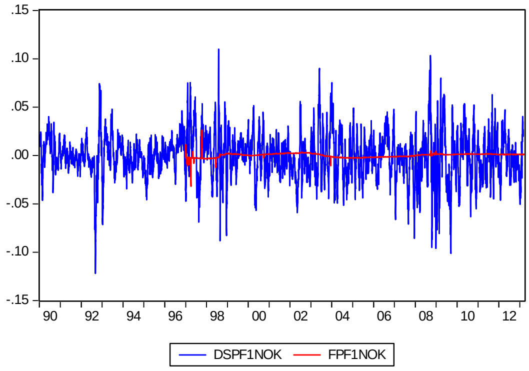
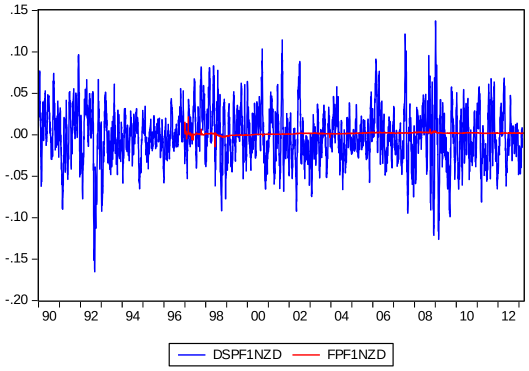
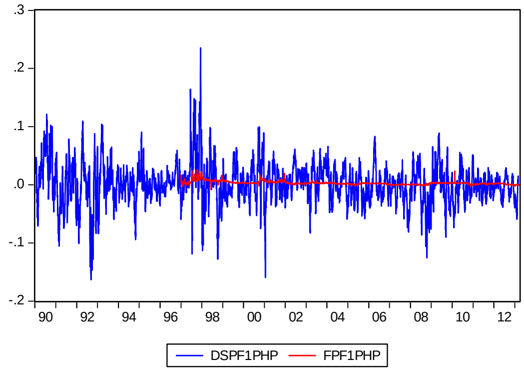
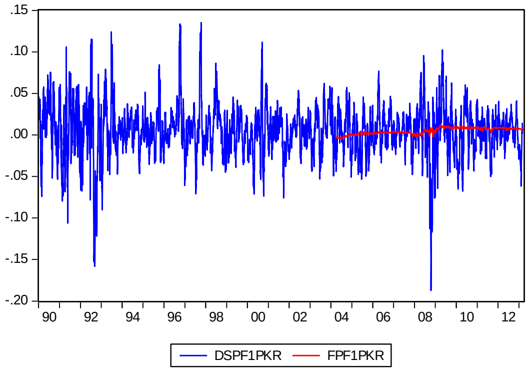
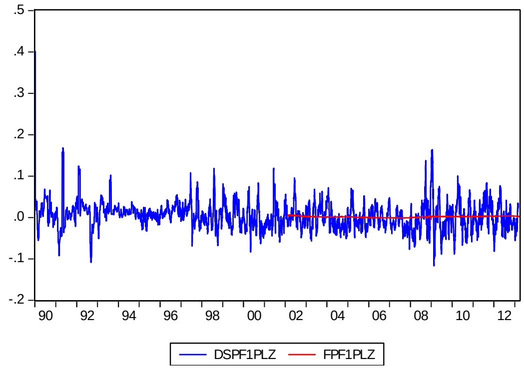
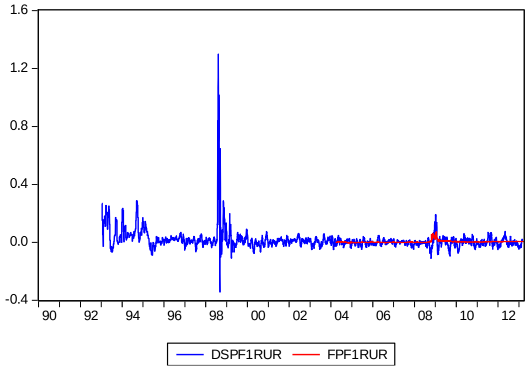
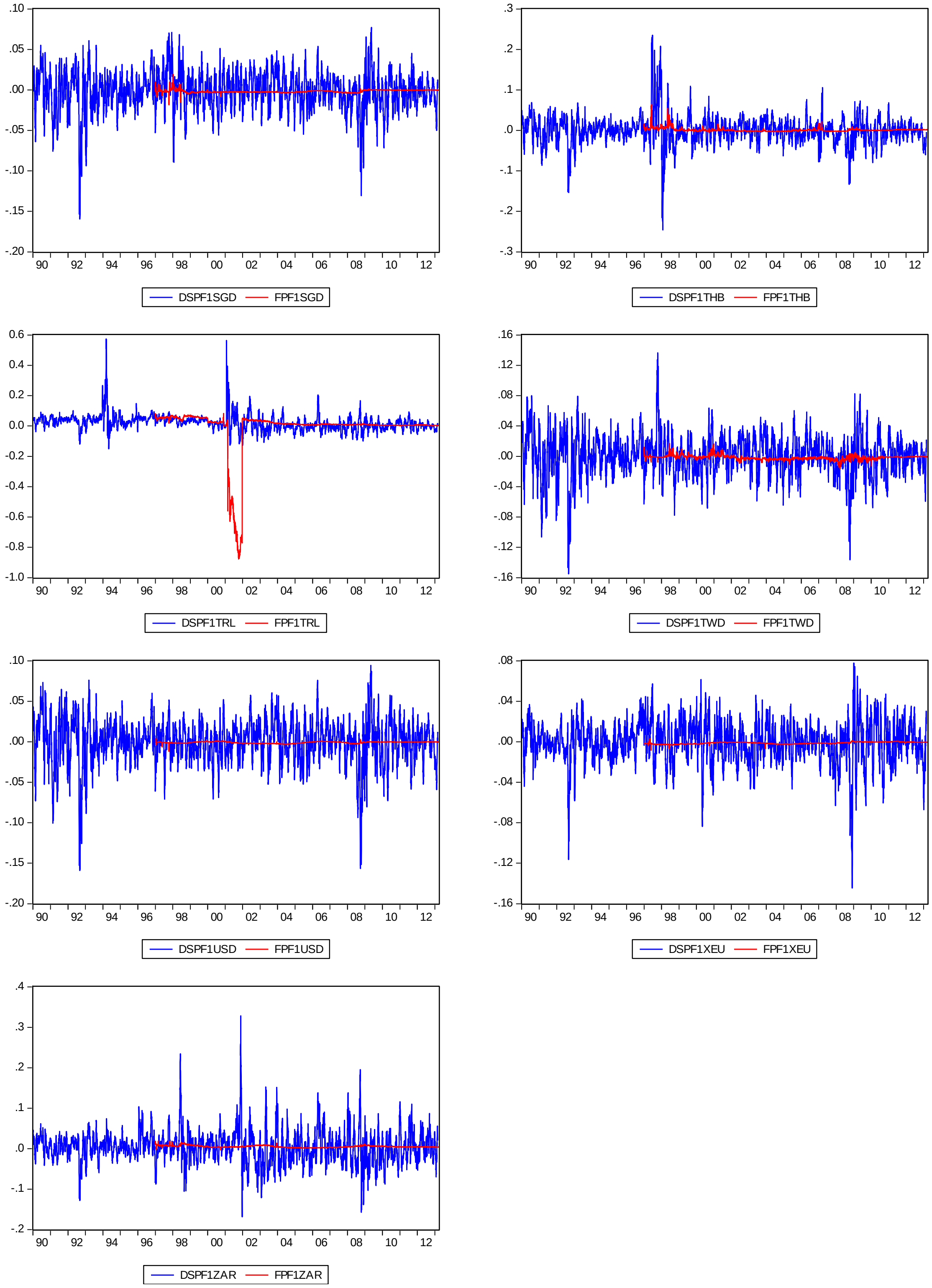
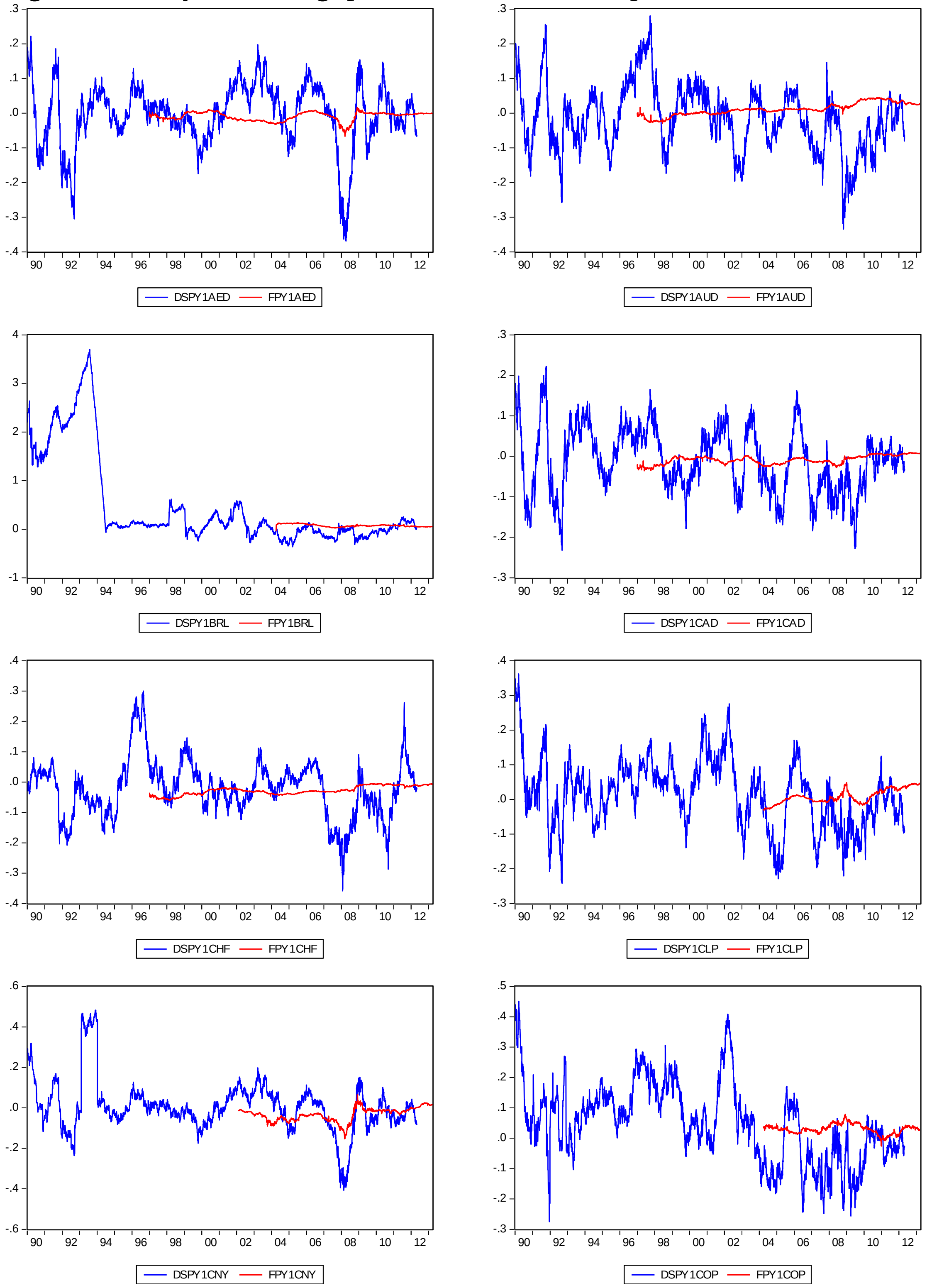
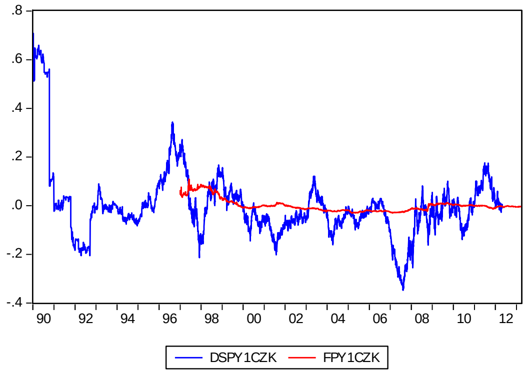

DSPF1MYR
FPF1MYR

DSPF1NOK
FPF1NOK

DSPF1NZD
FPF1NZD

DSPF1PHP
FPF1PHP

DSPF1PKR
FPF1PKR

DSPF1PLZ
FPF1PLZ

DSPF1RUR
FPF1RUR

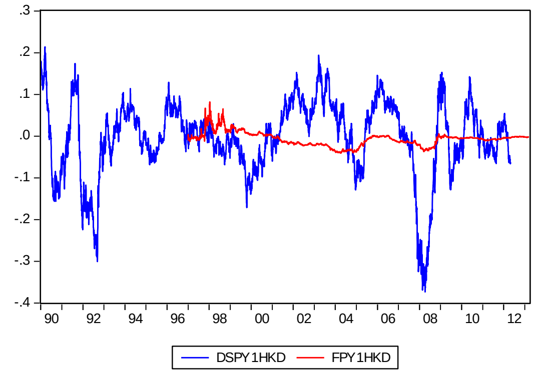


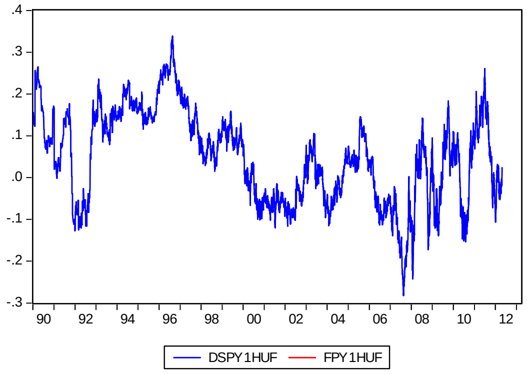
Blue line is the change in sport rate and the red line is the forward premium. These 31 graphs are arranged in alphabetical order of currency short codes. Horizontal axis is the time line from 1990 to 2013.

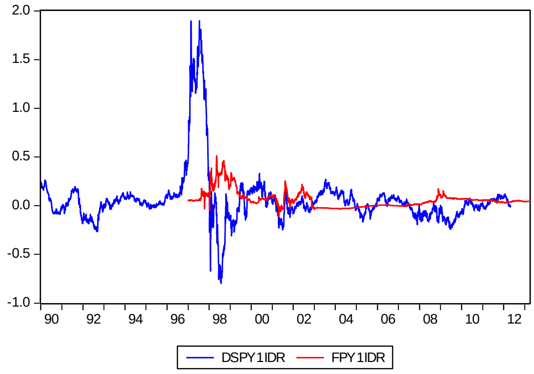
Figure 3.2 One-year Sterling spot returns and forward premium

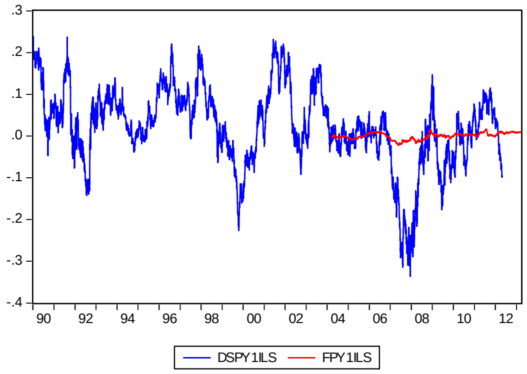


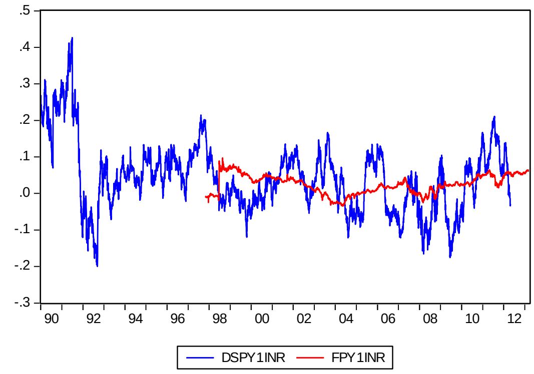

DSPY1CZK
FPY1CZK

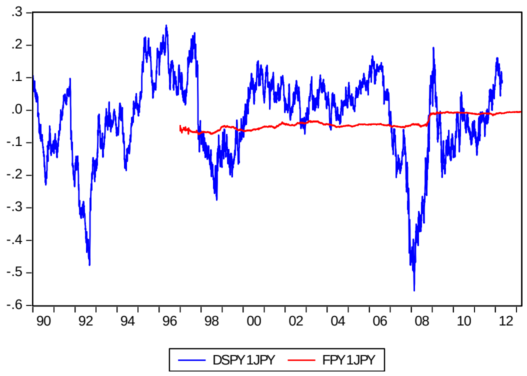

DSPY1HKD
FPY1HKD

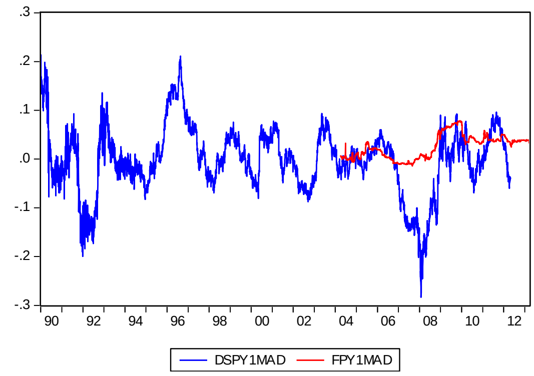

DSPY1HUF
FPY1HUF

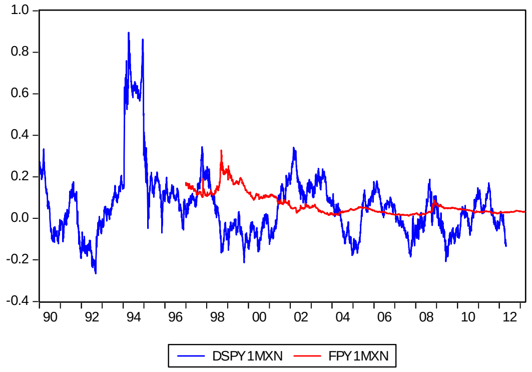
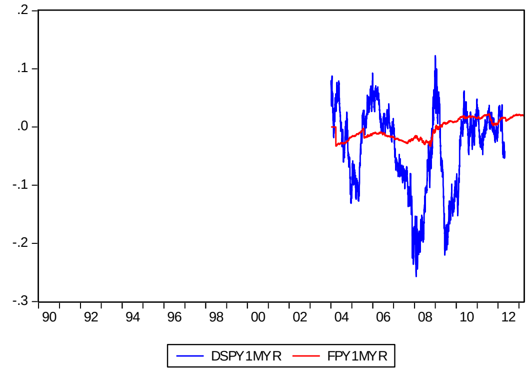
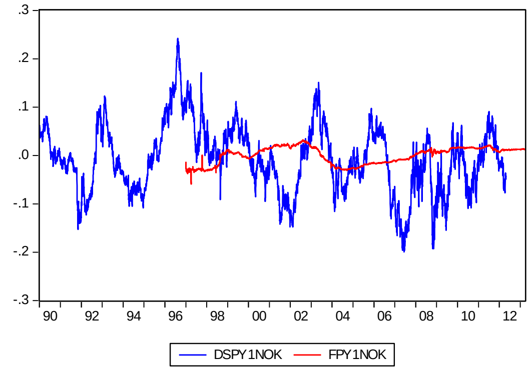
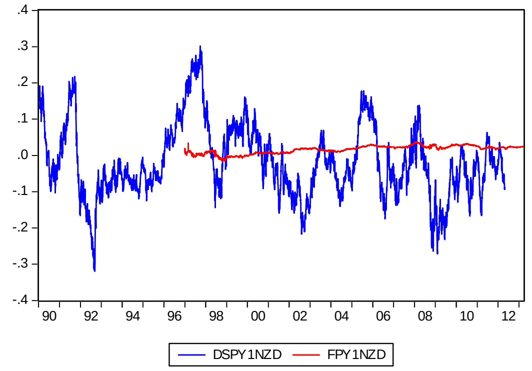
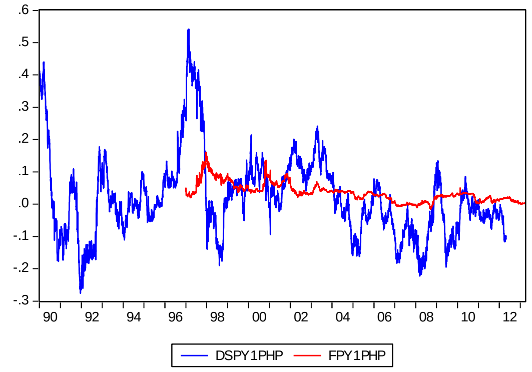
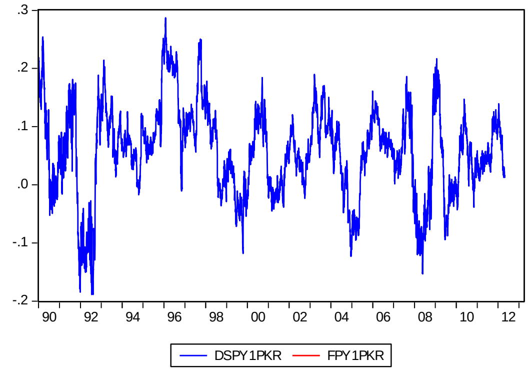
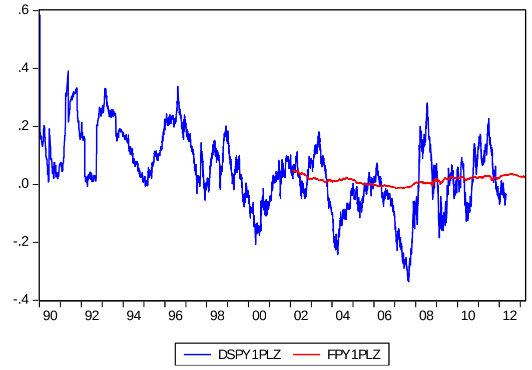
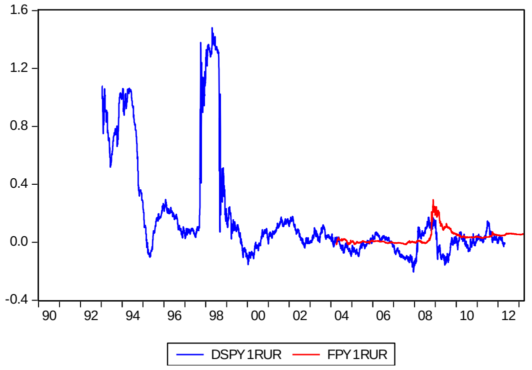

DSPY1IDR
FPY1IDR

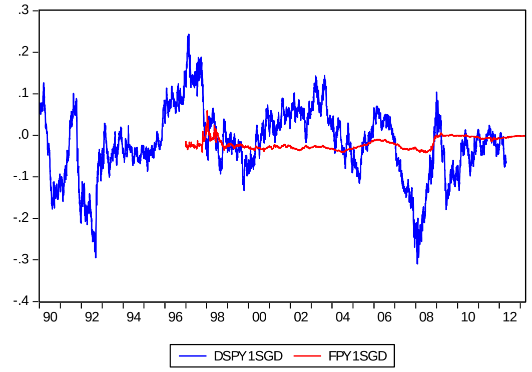

DSPY1ILS
FPY1ILS

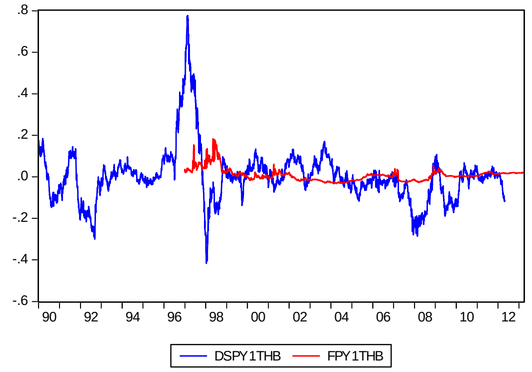

DSPY1INR
FPY1INR

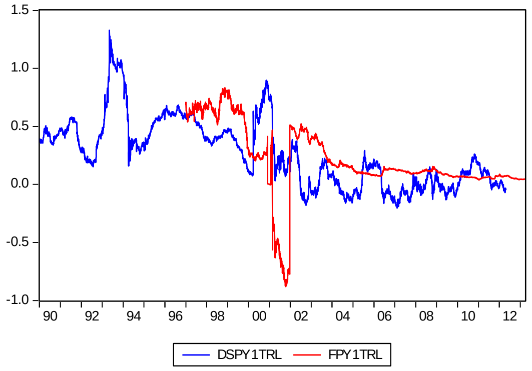

DSPY1JPY
FPY1JPY

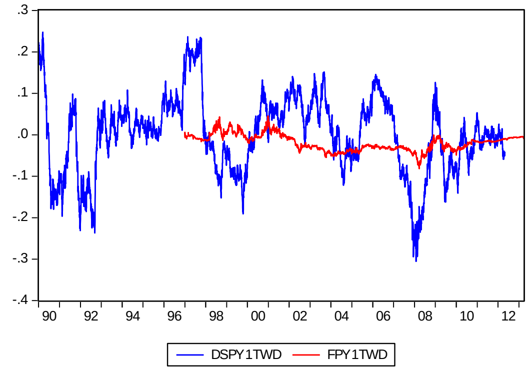

DSPY1MAD
FPY1MAD

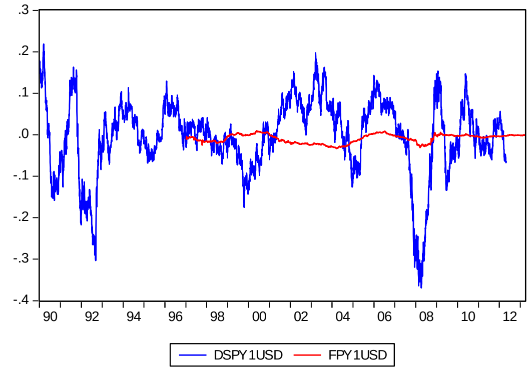

DSPY1MXN
FPY1MXN

DSPY1MYR
FPY1MYR

DSPY1NOK
FPY1NOK

DSPY1NZD
FPY1NZD

DSPY1PHP
FPY1PHP

DSPY1PKR
FPY1PKR

DSPY1PLZ
FPY1PLZ

DSPY1RUR
FPY1RUR

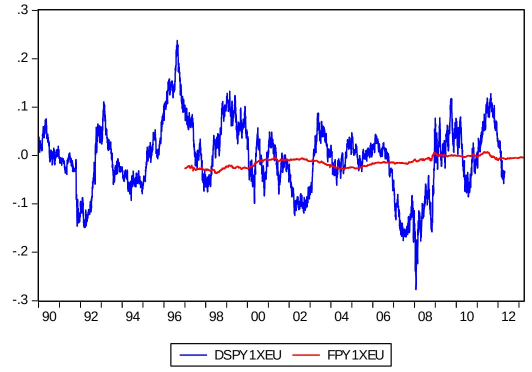


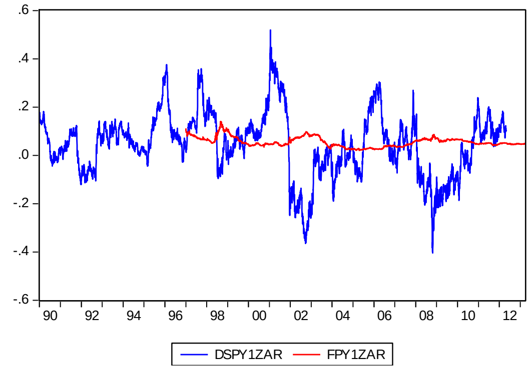






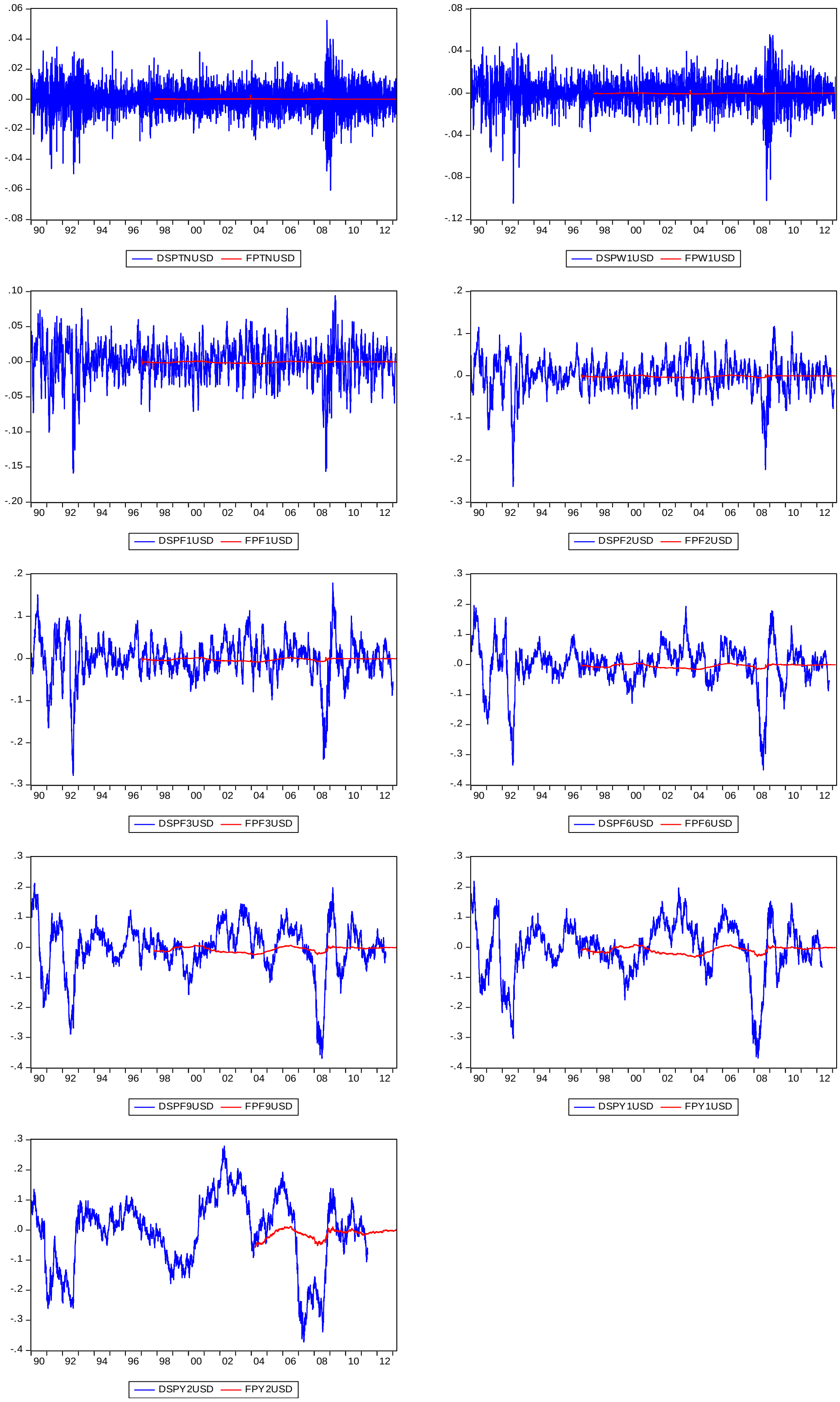






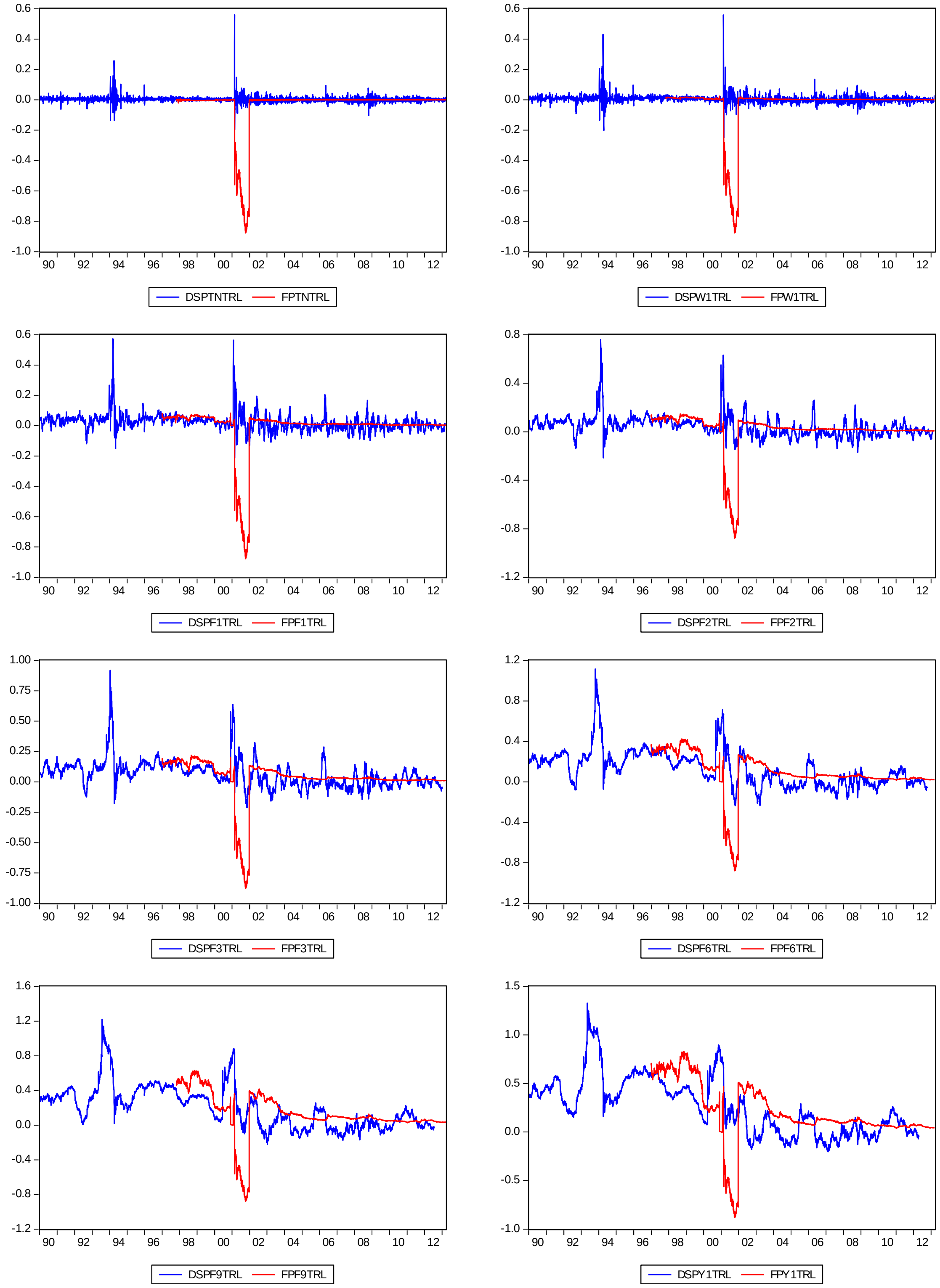
Blue line is the change in sport rate and the red line is the forward premium. These 31 graphs are arranged in alphabetical order of currency short codes. Horizontal axis is the time line from 1990 to 2013.

Figure 3.3 US dollar to Sterling spot returns and forward premium in different time horizons



Blue line is the change in sport rate and the red line is the forward premium. Graphs are ordered in the length of time horizons. i.e. from top left to bottom right, 1 day, 1 week, 1 month, 2 months, 3 months 6 months, 9 months, 1 year and 2 years.

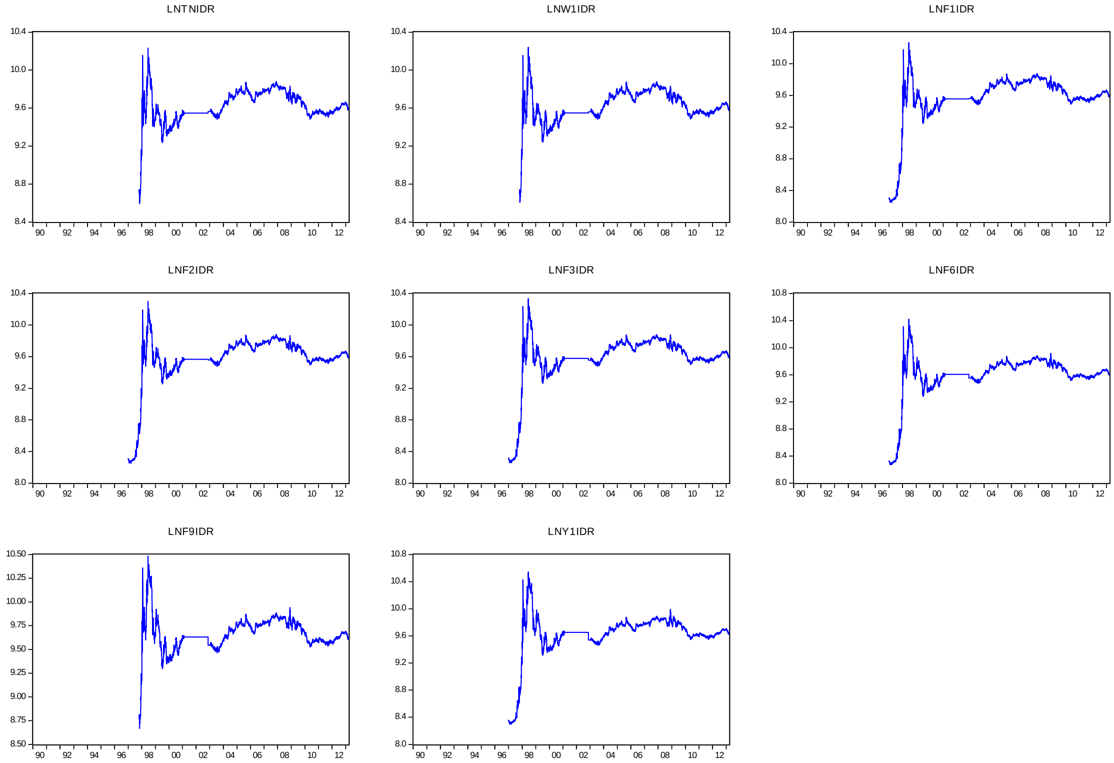
Figure 3.4 Turkish Lira to Sterling spot returns and forward premium in different time horizons



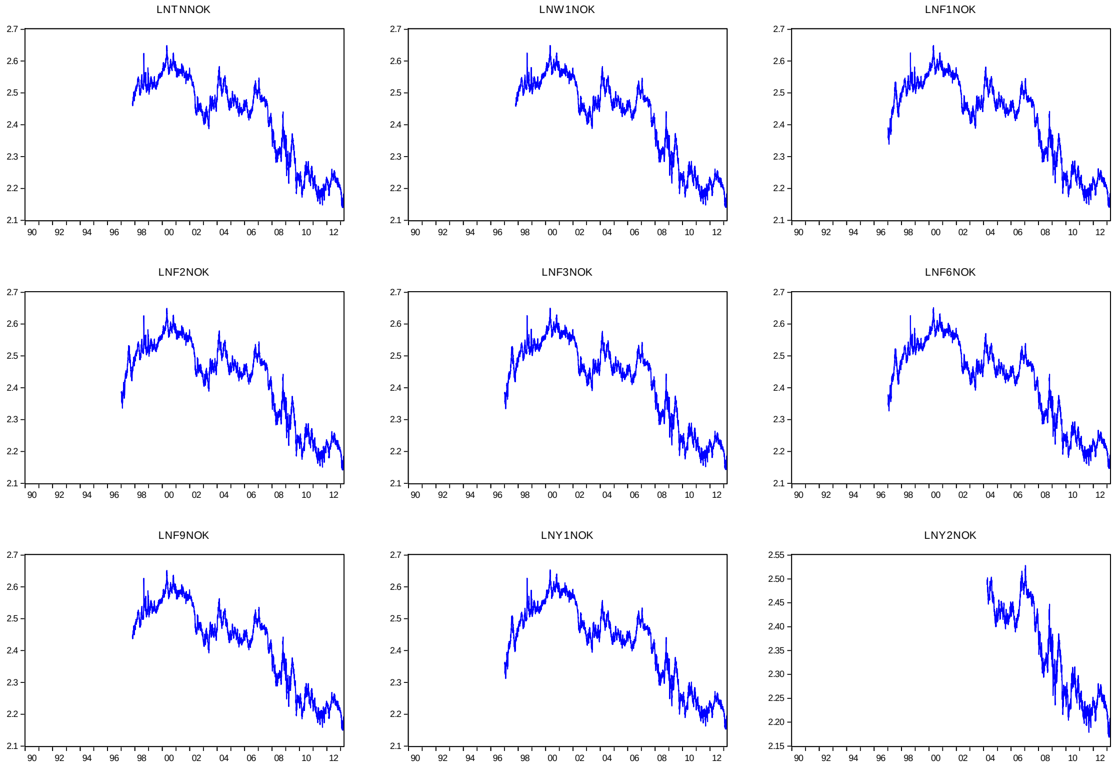
This Figure shows Turkish Lira experienced a dramatic decrease of forward premium in 2001.

Figure 3.5 Graphs of the forward rates that appear to be (trend) stationary

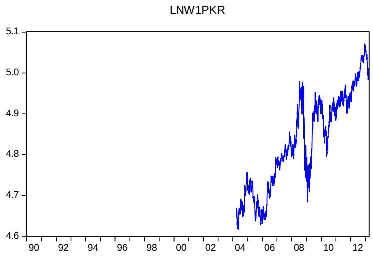
IDR

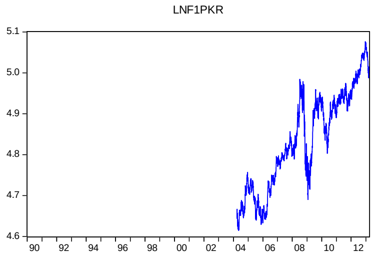


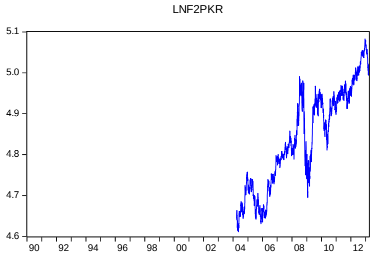
NOK

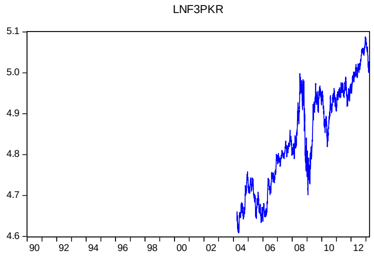


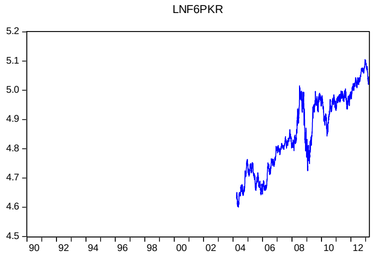
PKR


LNW1PKR
5.1
5.0
4.9
4.8
4.7
4.6
90 92 94 96 98 00 02 04 06 08 10 12

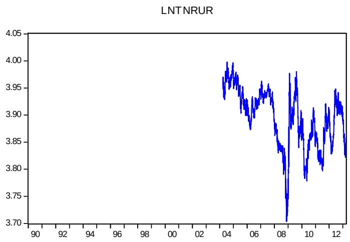

LNF1PKR
5.1
5.0
4.9
4.8
4.7
4.6
90 92 94 96 98 00 02 04 06 08 10 12

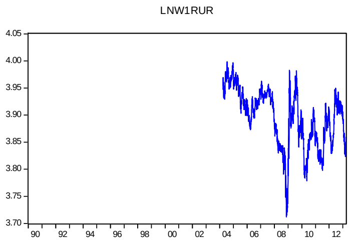

LNF2PKR
5.1
5.0
4.9
4.8
4.7
4.6
90 92 94 96 98 00 02 04 06 08 10 12

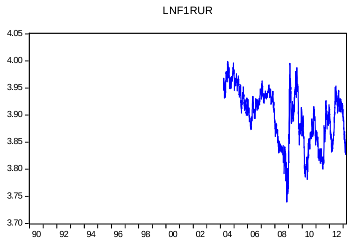

LNF3PKR
5.1
5.0
4.9
4.8
4.7
4.6
90 92 94 96 98 00 02 04 06 08 10 12

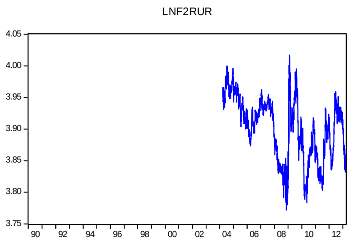

LNF6PKR
5.2
5.1
5.0
4.9
4.8
4.7
4.6
4.5
90 92 94 96 98 00 02 04 06 08 10 12

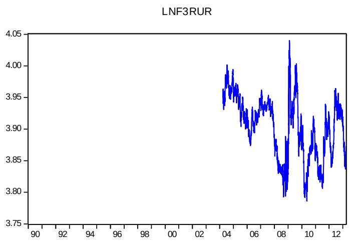
RUR

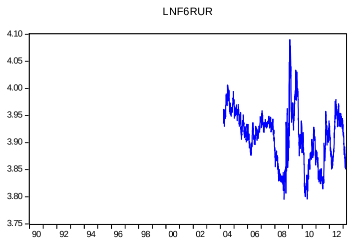

LNTNRUR
4.05
4.00
3.95
3.90
3.85
3.80
3.75
3.70
90 92 94 96 98 00 02 04 06 08 10 12

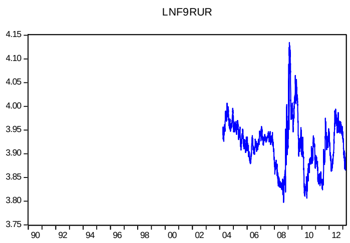

LNW1RUR
4.05
4.00
3.95
3.90
3.85
3.80
3.75
3.70
90 92 94 96 98 00 02 04 06 08 10 12


LNF1RUR
4.05
4.00
3.95
3.90
3.85
3.80
3.75
3.70
90 92 94 96 98 00 02 04 06 08 10 12


LNF2RUR
4.05
4.00
3.95
3.90
3.85
3.80
3.75
90 92 94 96 98 00 02 04 06 08 10 12


LNF3RUR
4.05
4.00
3.95
3.90
3.85
3.80
3.75
90 92 94 96 98 00 02 04 06 08 10 12


LNF6RUR
4.10
4.05
4.00
3.95
3.90
3.85
3.80
3.75
90 92 94 96 98 00 02 04 06 08 10 12


LNF9RUR
4.15
4.10
4.05
4.00
3.95
3.90
3.85
3.80
3.75
90 92 94 96 98 00 02 04 06 08 10 12

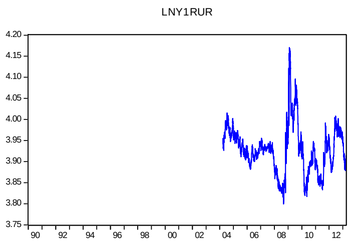
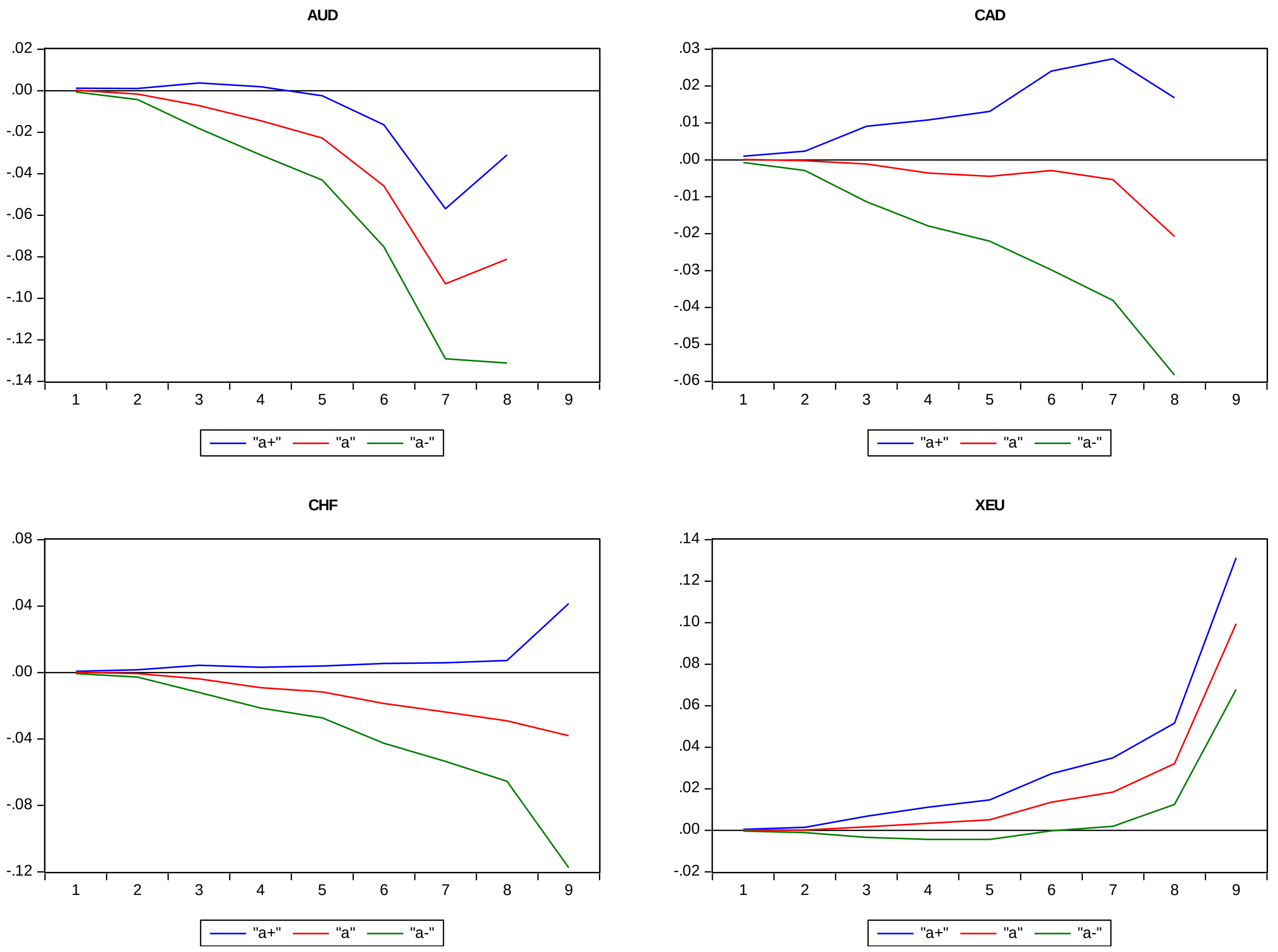
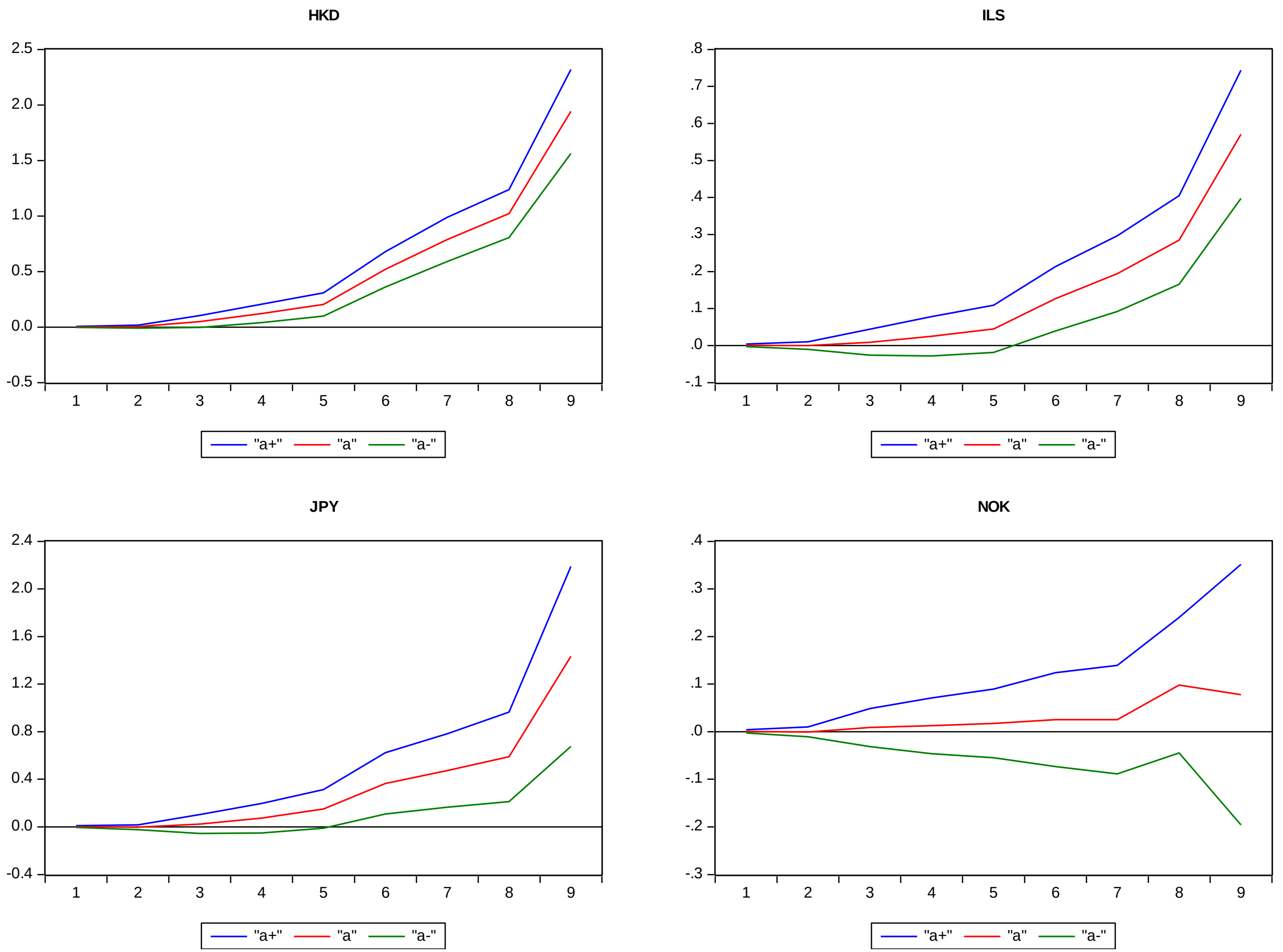
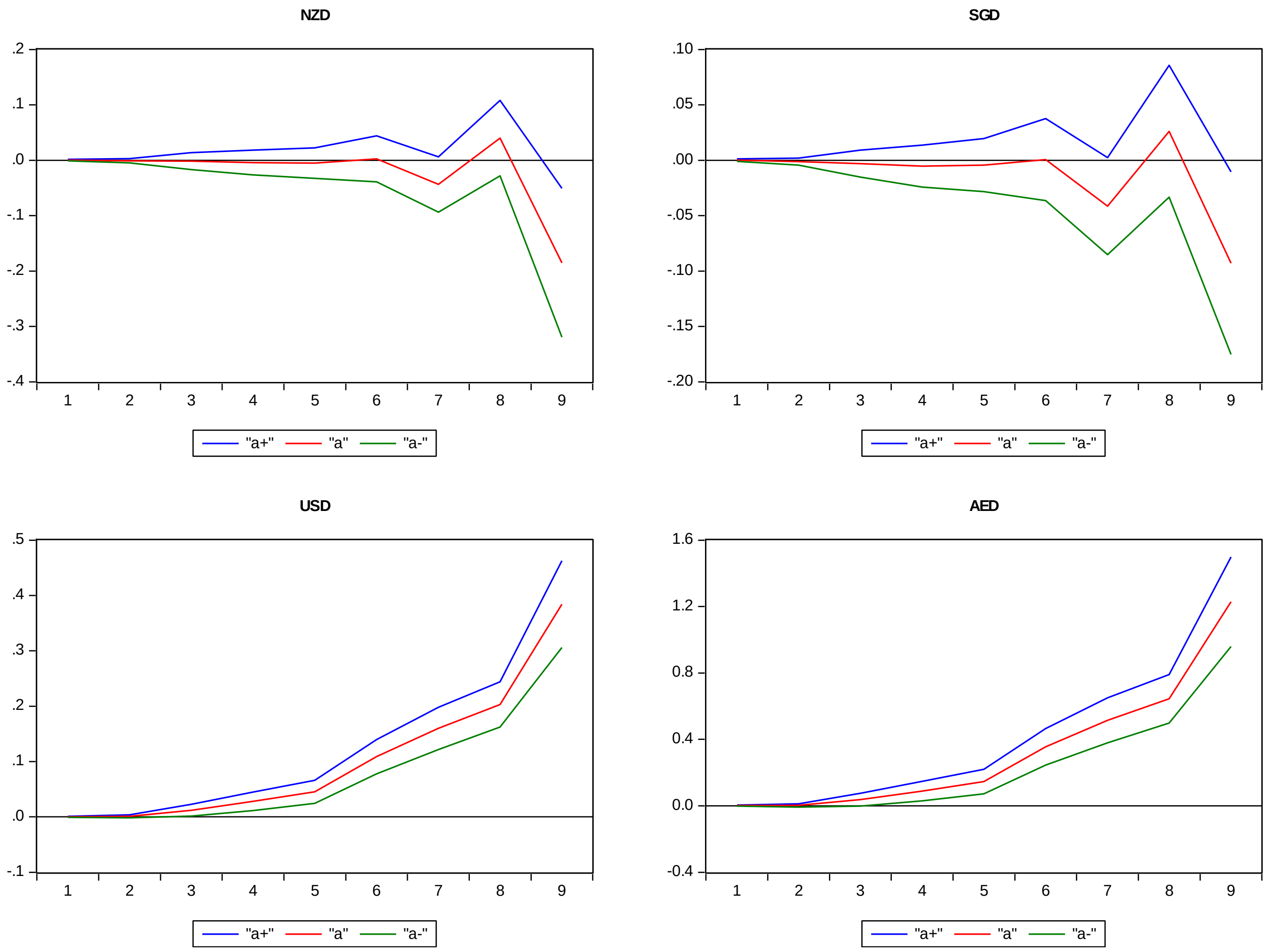
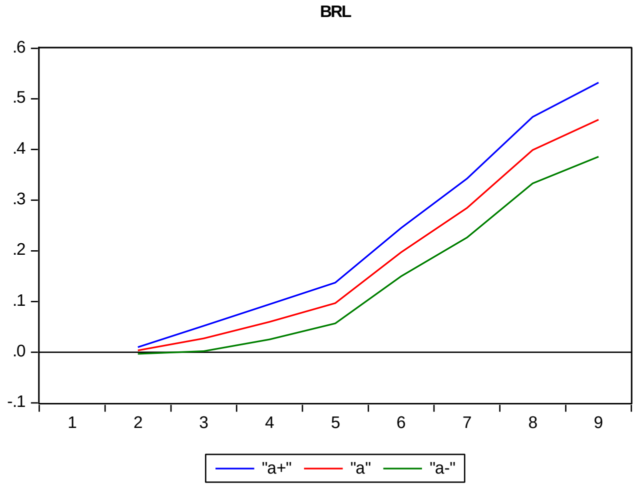

LNY1RUR
4.20
4.15
4.10
4.05
4.00
3.95
3.90
3.85
3.80
3.75
90 92 94 96 98 00 02 04 06 08 10 12

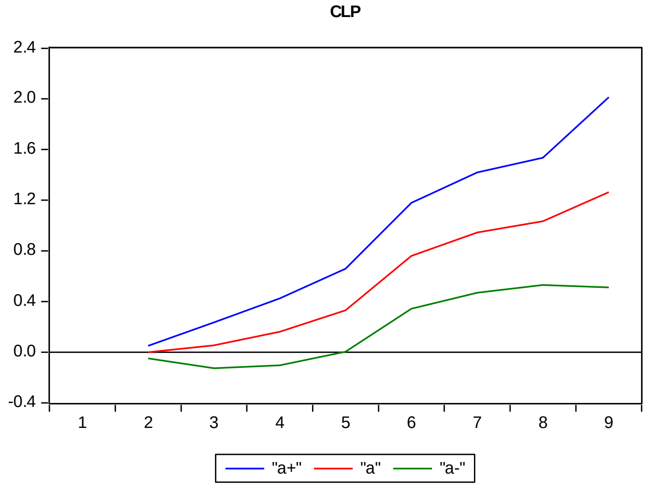
Figure 3.6 Line plot of the constant coefficient α

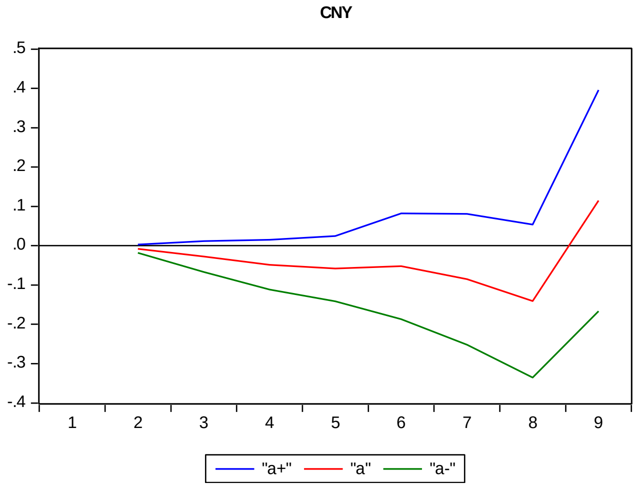


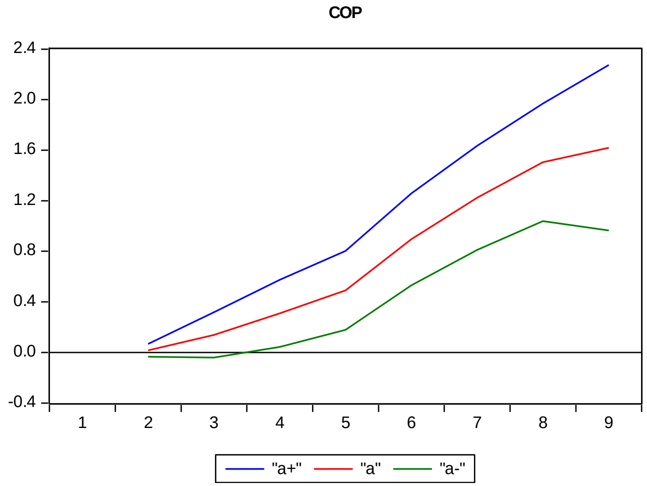

HKD
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"
ILS
.8
.7
.6
.5
.4
.3
.2
.1
.0
-.1
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"
JPY
2.4
2.0
1.6
1.2
0.8
0.4
0.0
-0.4
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"
NOK
.4
.3
.2
.1
.0
-.1
-.2
-.3
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

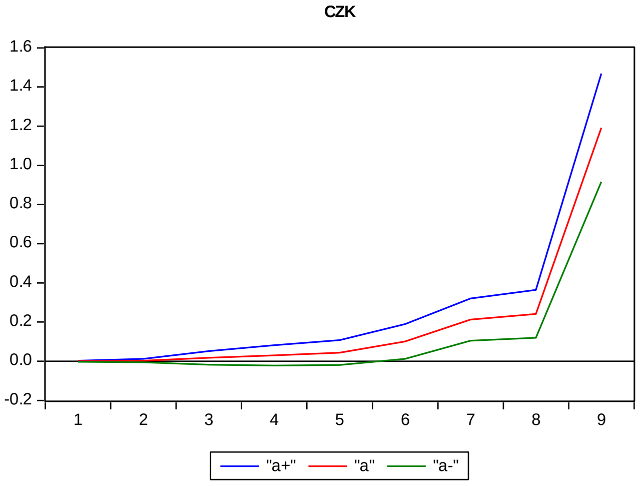

NZD
.2
.1
.0
-.1
-.2
-.3
-.4
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"
SGD
.10
.05
.00
-.05
-.10
-.15
-.20
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"
USD
.5
.4
.3
.2
.1
.0
-.1
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"
AED
1.6
1.2
0.8
0.4
0.0
-0.4
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

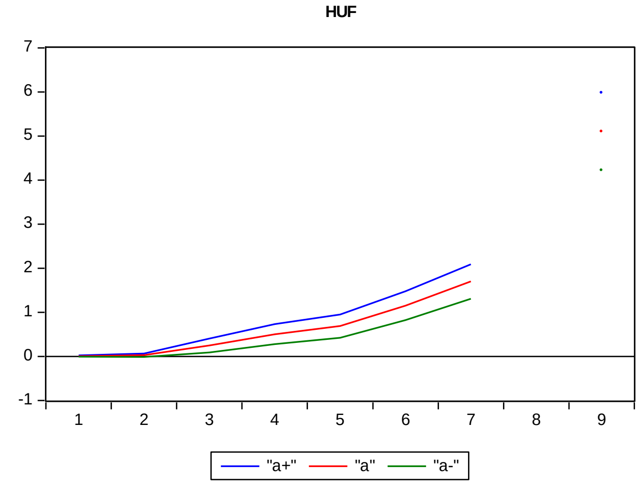

BRL
.6
.5
.4
.3
.2
.1
.0
-.1
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

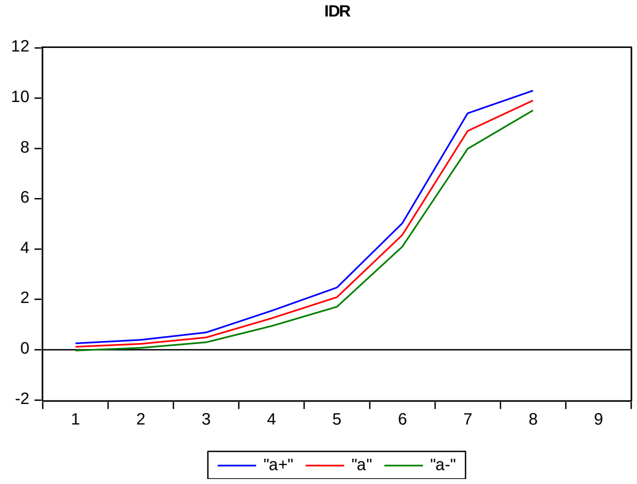

CLP
2.4
2.0
1.6
1.2
0.8
0.4
0.0
-0.4
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

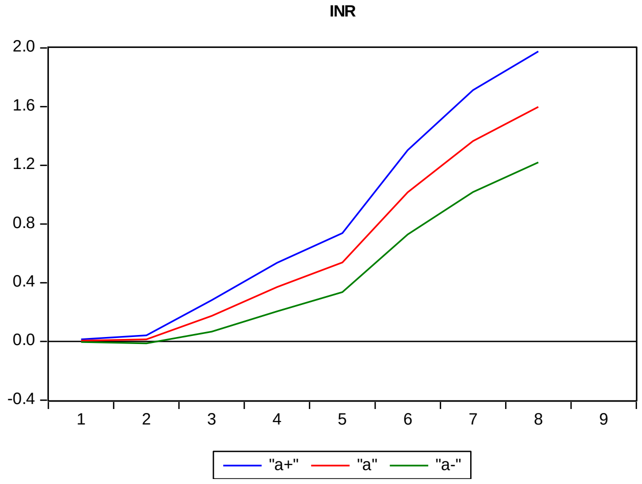

CNY
.5
.4
.3
.2
.1
.0
-.1
-.2
-.3
-.4
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

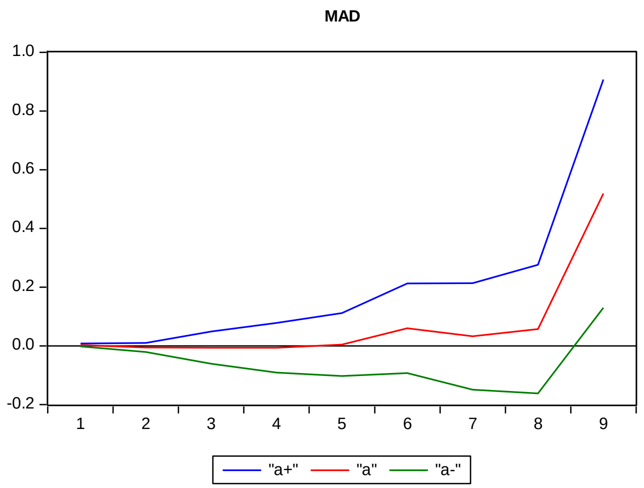

COP
2.4
2.0
1.6
1.2
0.8
0.4
0.0
-0.4
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

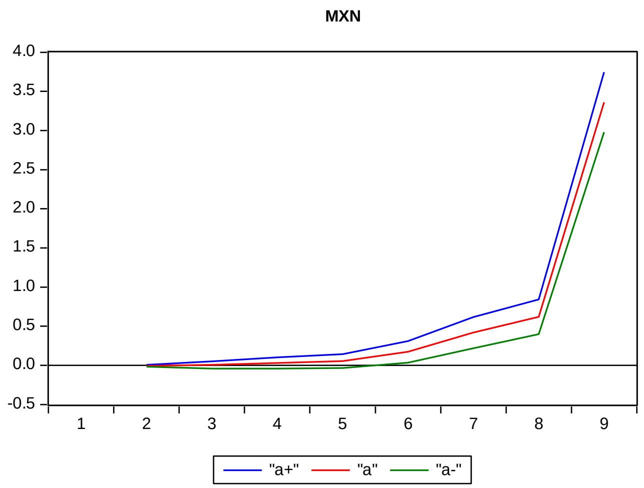

CZK
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

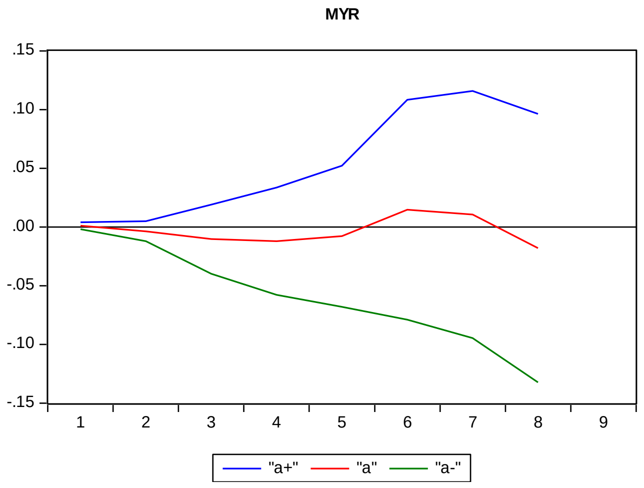

HUF
7
6
5
4
3
2
1
0
-1
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

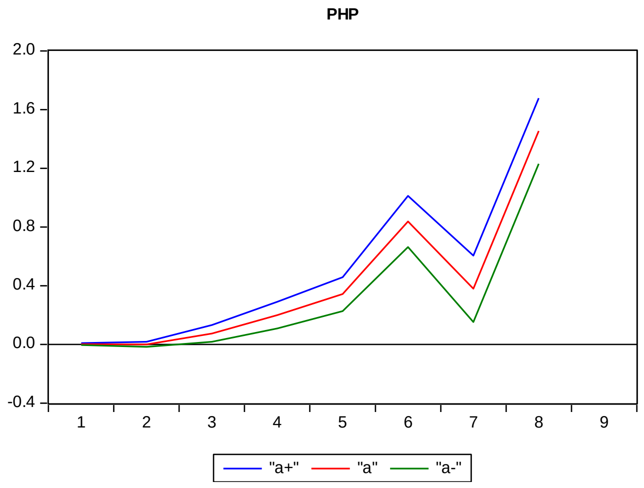

IDR
12
10
8
6
4
2
0
-2
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

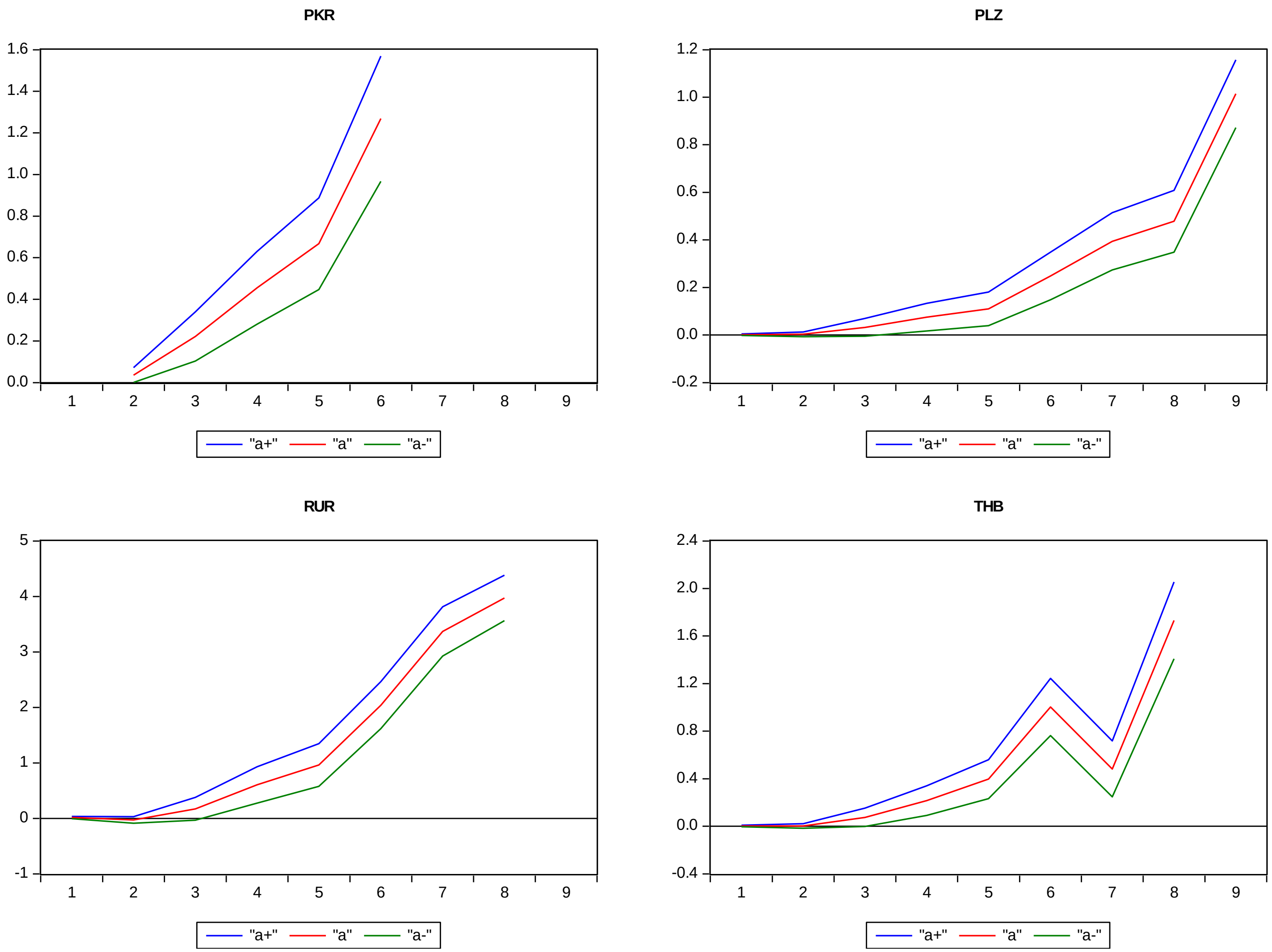

INR
2.0
1.6
1.2
0.8
0.4
0.0
-0.4
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

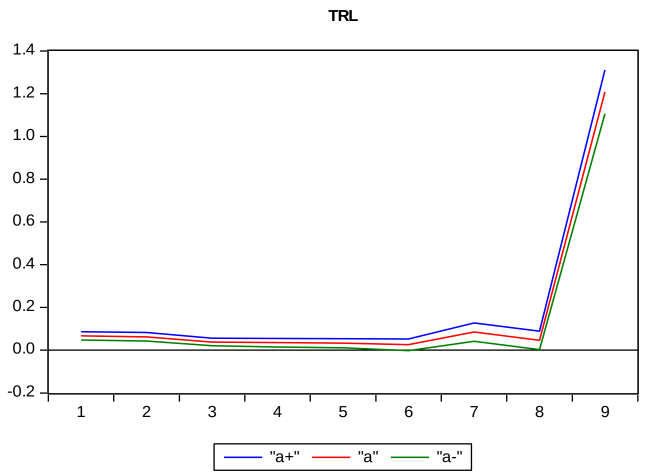

MAD
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

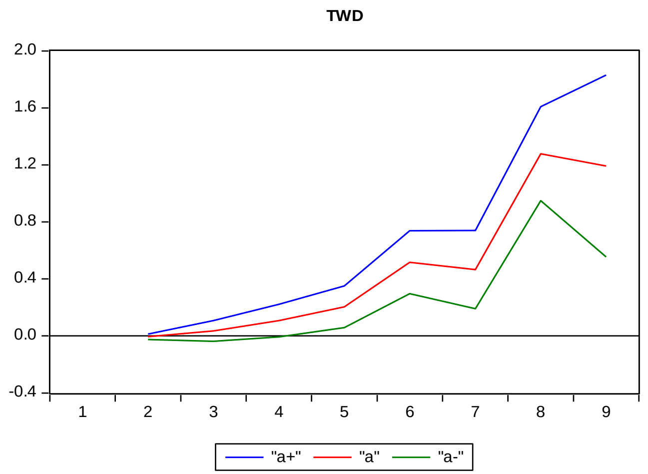

MXN
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

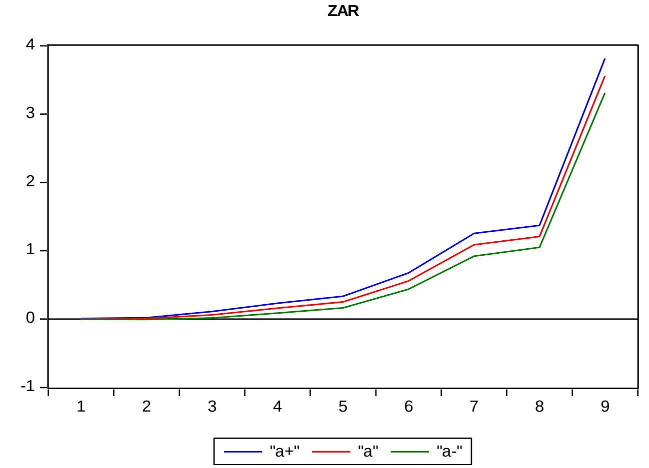

MYR
.15
.10
.05
.00
-.05
-.10
-.15
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"


PHP
2.0
1.6
1.2
0.8
0.4
0.0
-0.4
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"


PKR
"a+"
"a"
"a-"
PLZ
"a+"
"a"
"a-"
RUR
"a+"
"a"
"a-"
THB
"a+"
"a"
"a-"

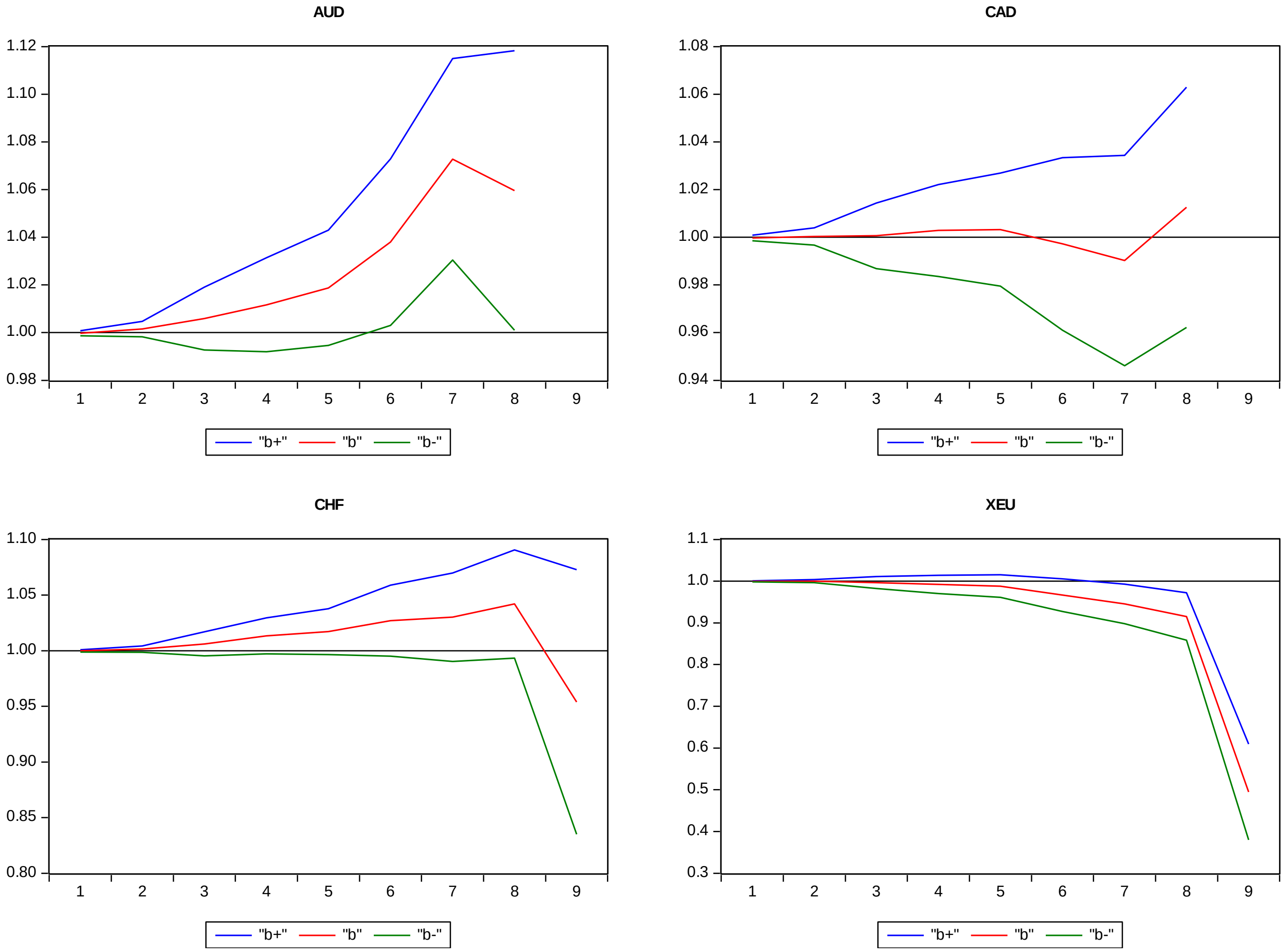


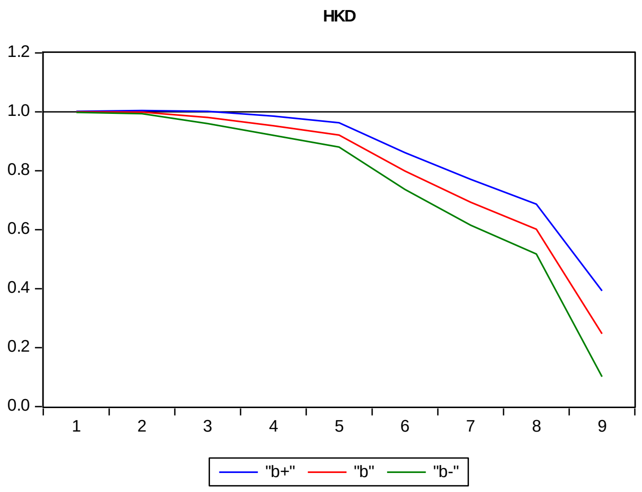


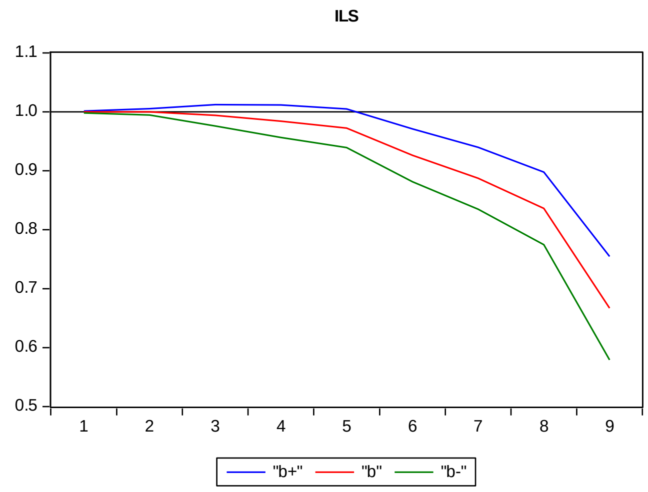


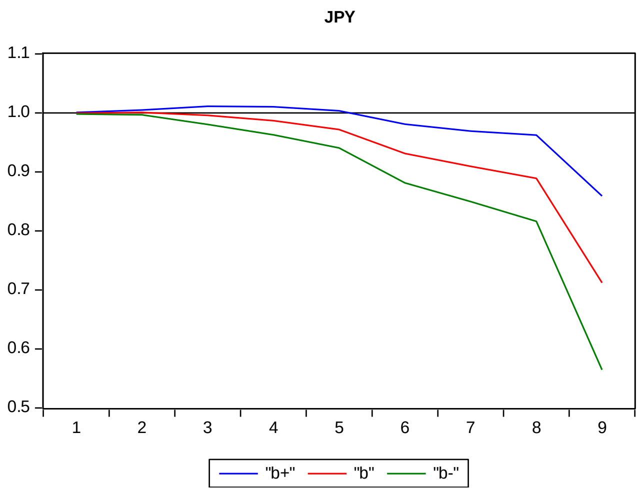
Line plot of the estimated coefficient α for each of the 31 economies, with the value of α on the vertical axis and the 9 different time to maturity periods on the horizontal axis. a+ and a- indicate the confidence interval. Coefficients correspond to Table 3.6.1 Simple efficiency hypothesis FMOLS test equation for Sterling exchange rates.

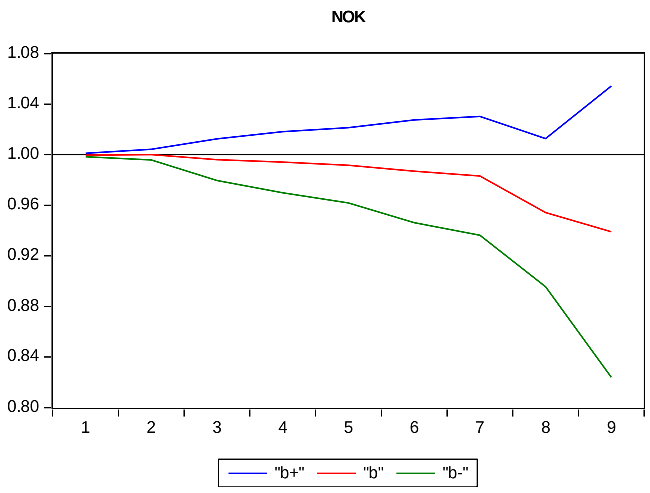
Figure 3.7 Line plot of the slope coefficient β

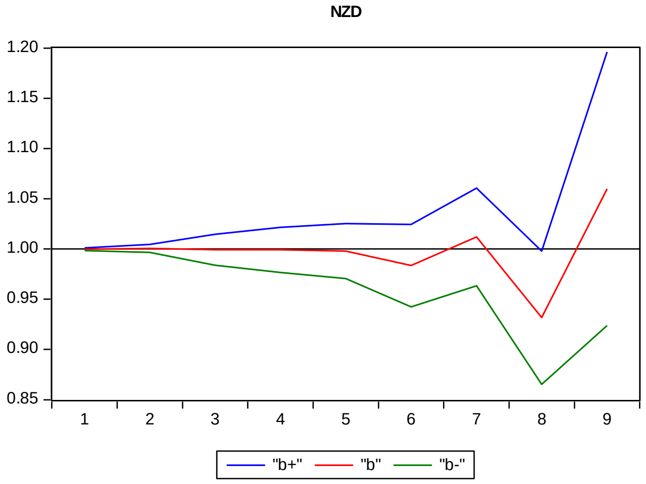


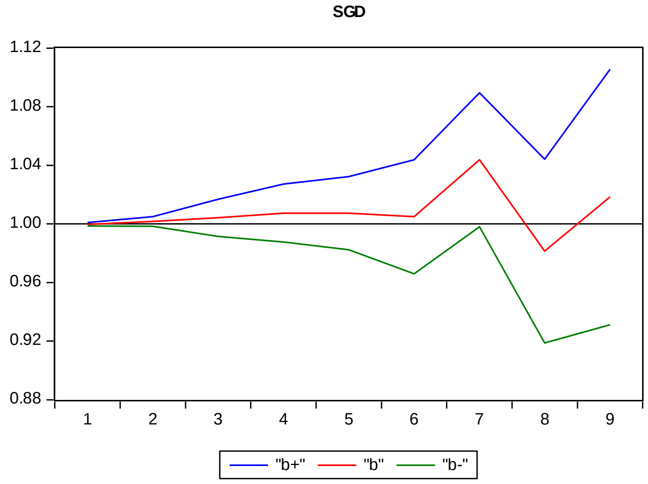

HKD
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"

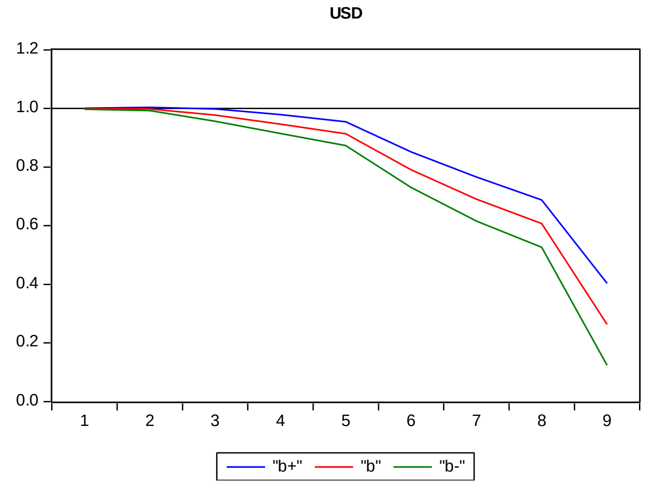

ILS
1.1
1.0
0.9
0.8
0.7
0.6
0.5
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"

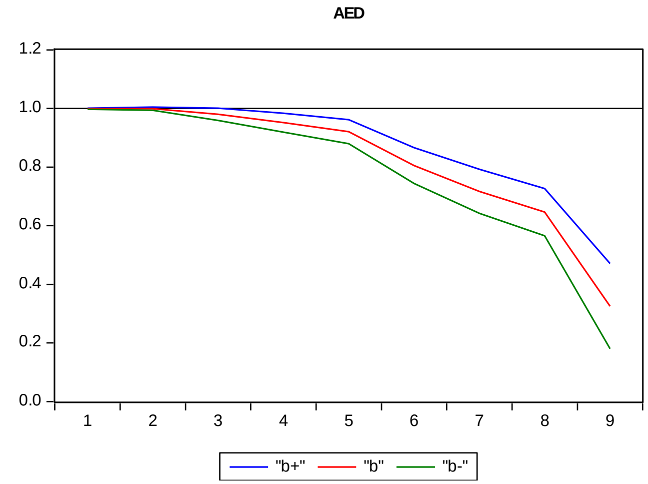

JPY
1.1
1.0
0.9
0.8
0.7
0.6
0.5
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"

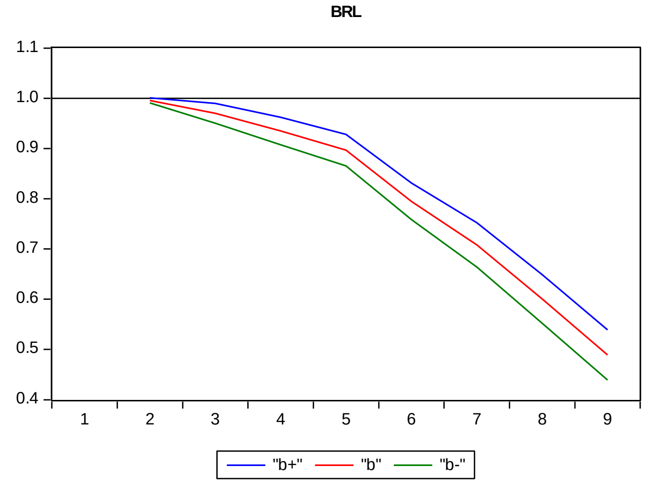

NOK
1.08
1.04
1.00
0.96
0.92
0.88
0.84
0.80
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"

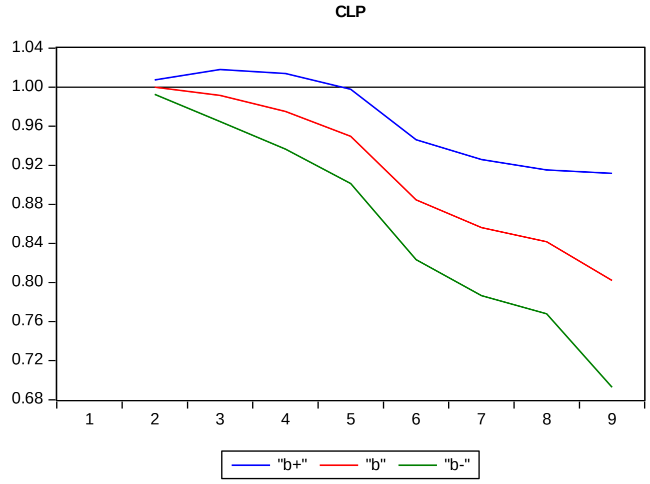

NZD
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"

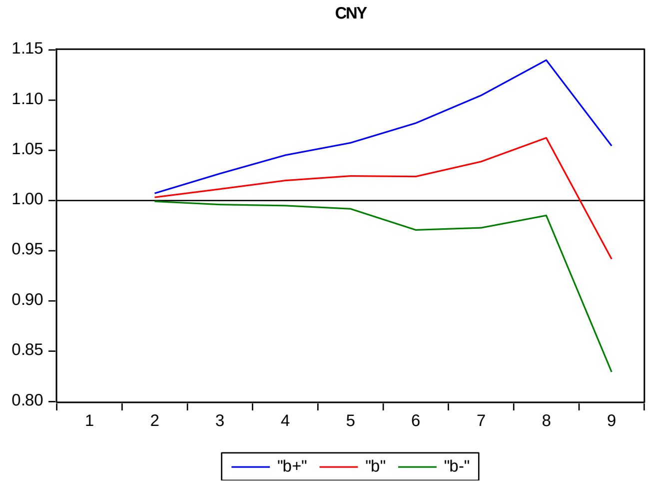

SGD
1.12
1.08
1.04
1.00
0.96
0.92
0.88
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"

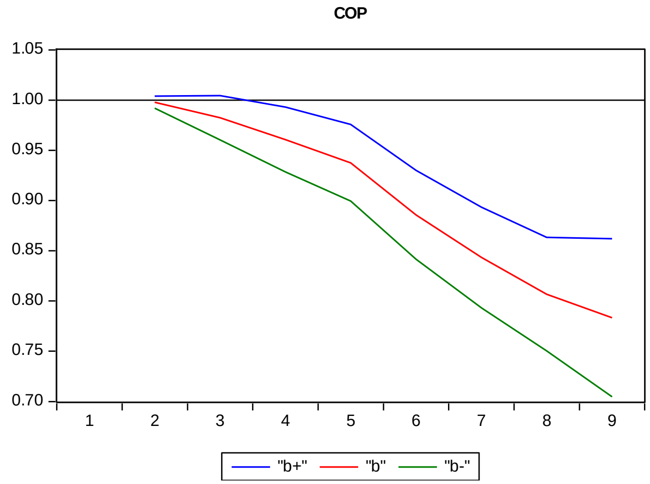

USD
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"

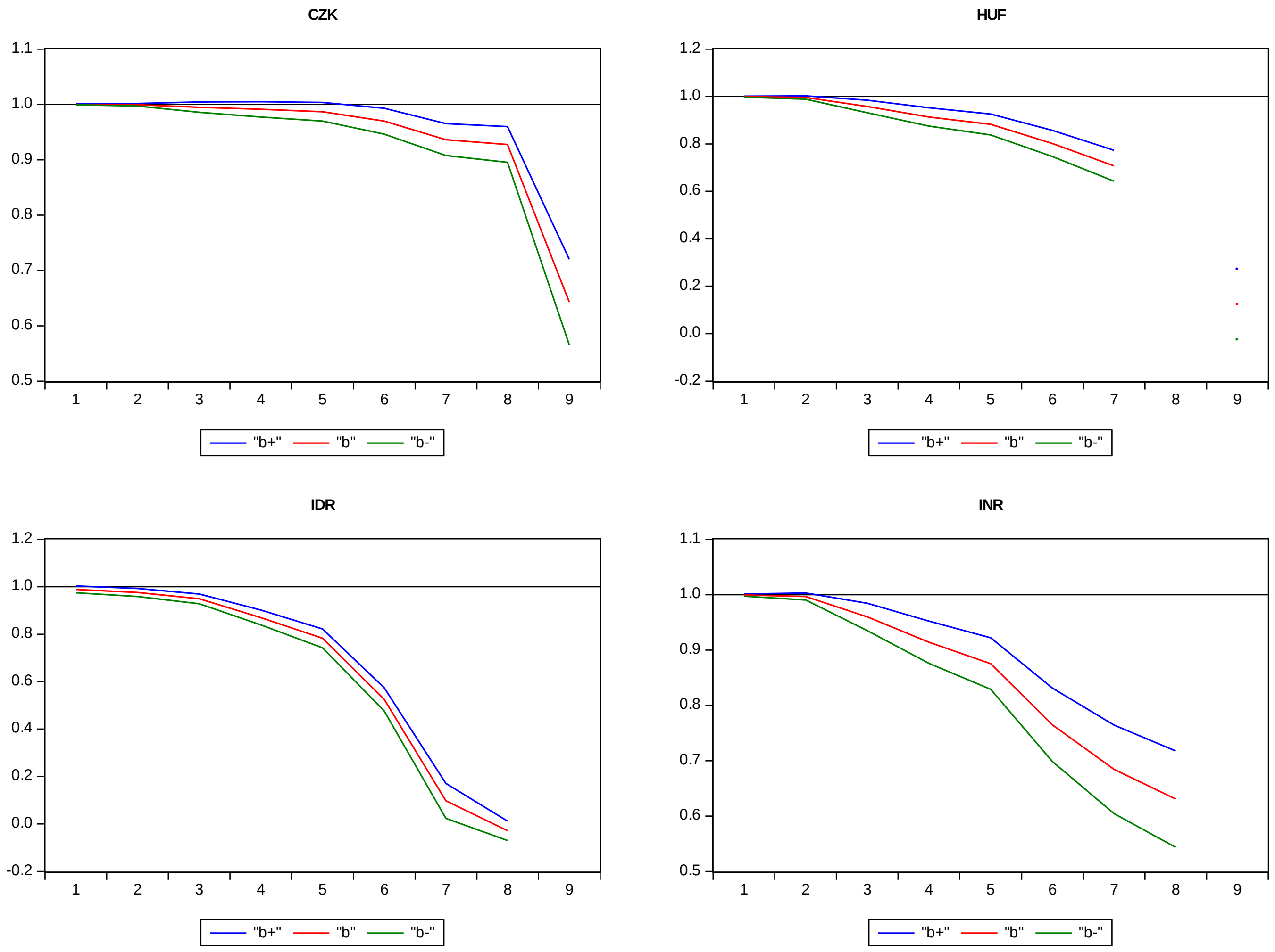

AED
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"

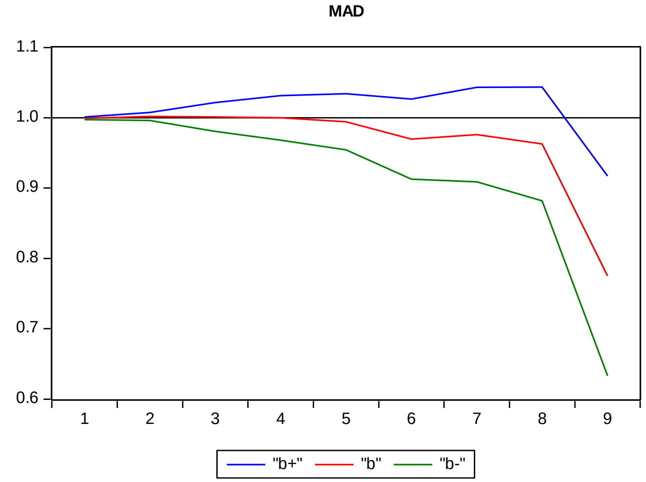

BRL
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"

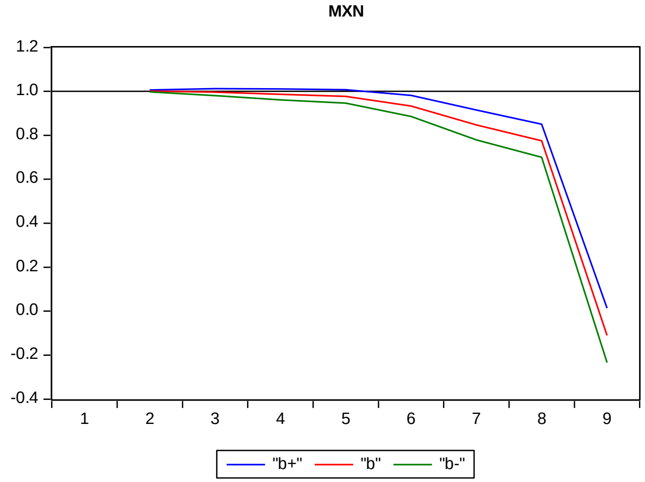

CLP
1.04
1.00
0.96
0.92
0.88
0.84
0.80
0.76
0.72
0.68
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"

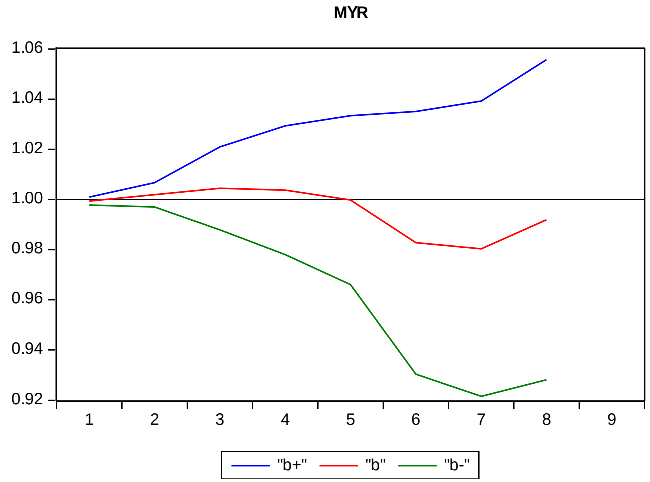

CNY
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"

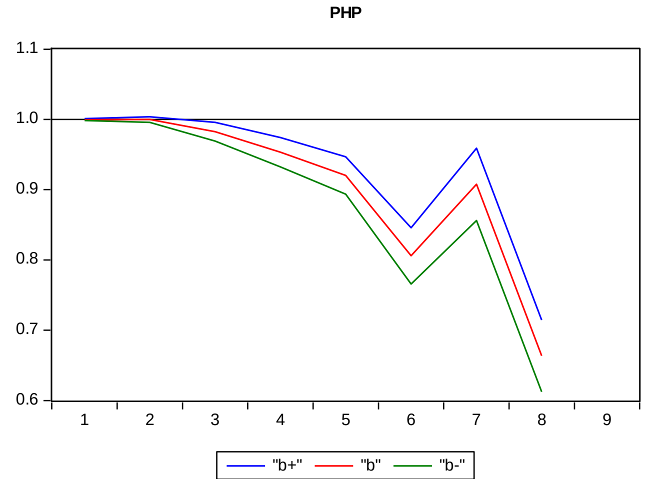

COP
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"

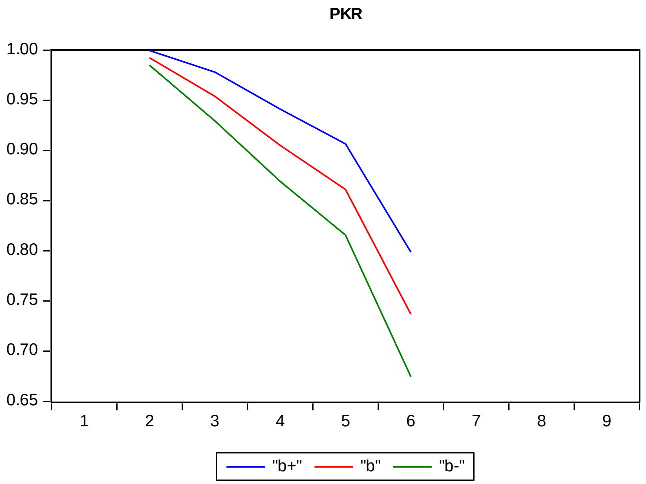

CZK
HUF
IDR
INR
"b+"
"b"
"b-"

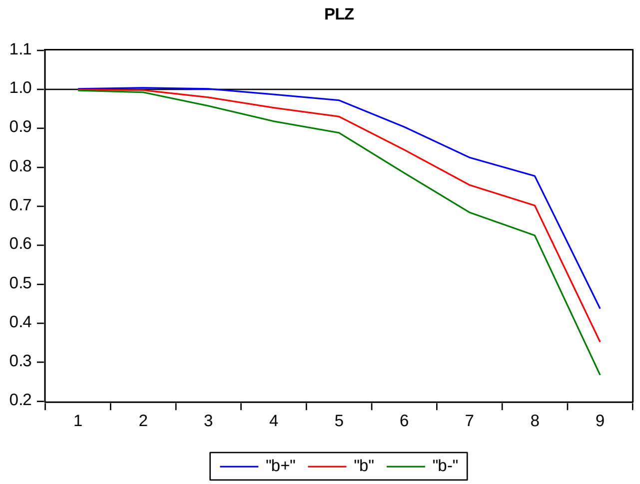

MAD
1.1
1.0
0.9
0.8
0.7
0.6
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"

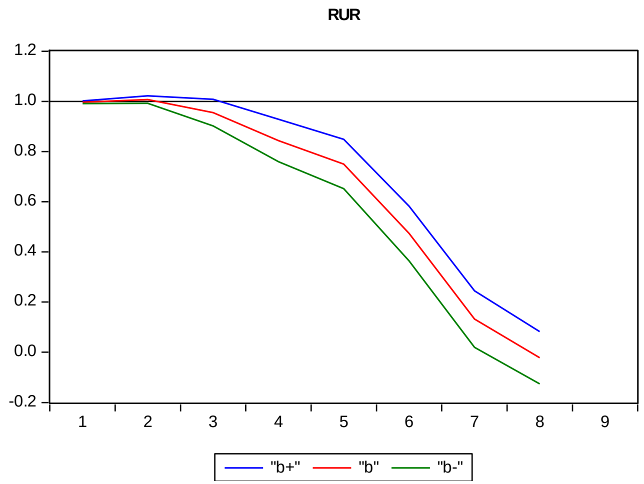

MXN
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"

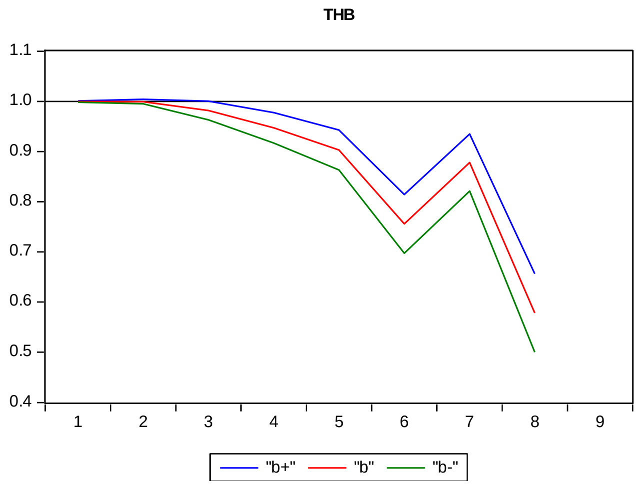

MYR
1.06
1.04
1.02
1.00
0.98
0.96
0.94
0.92
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"

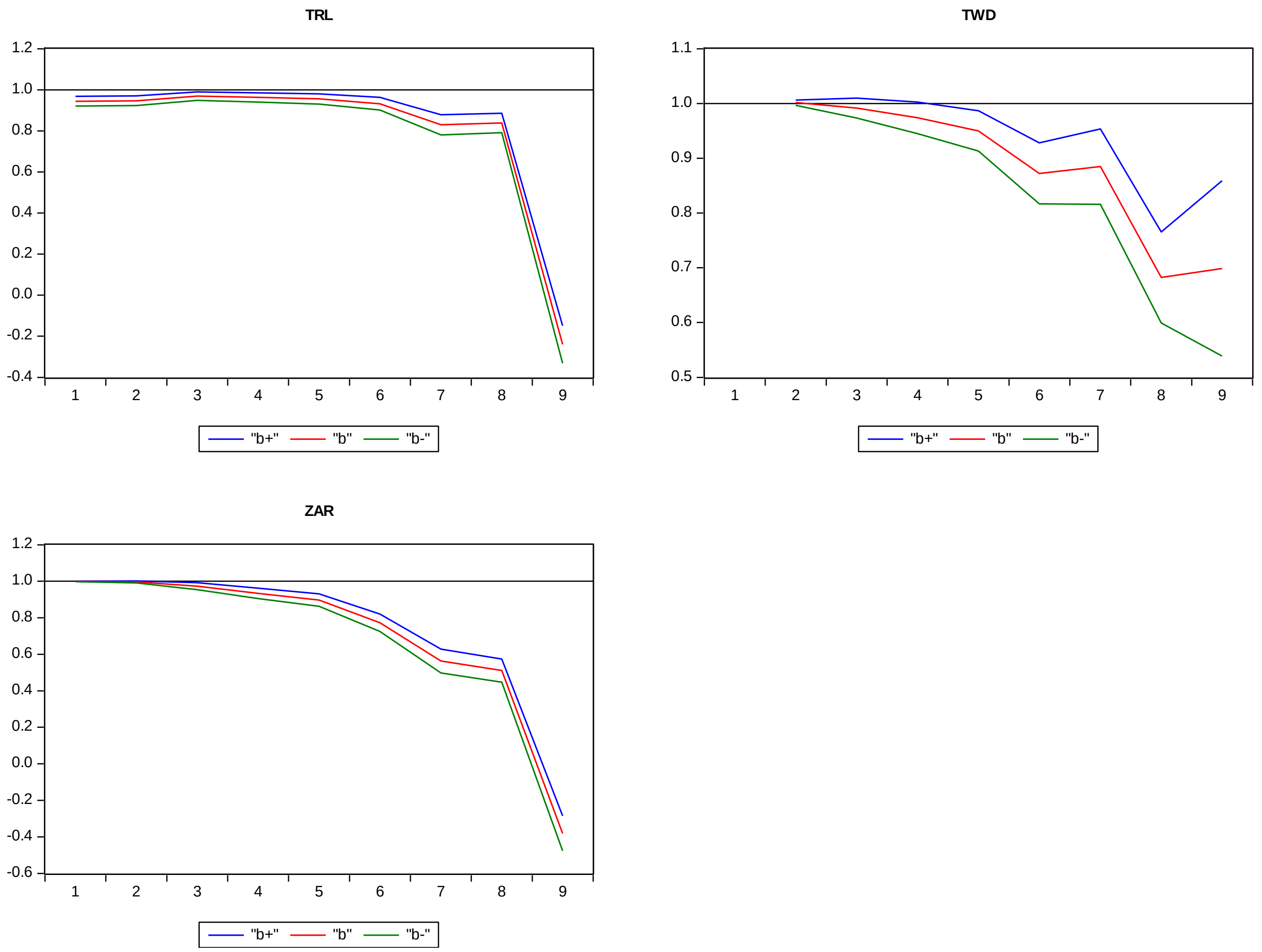

PHP
1.1
1.0
0.9
0.8
0.7
0.6
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"


PKR
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"


PLZ
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"

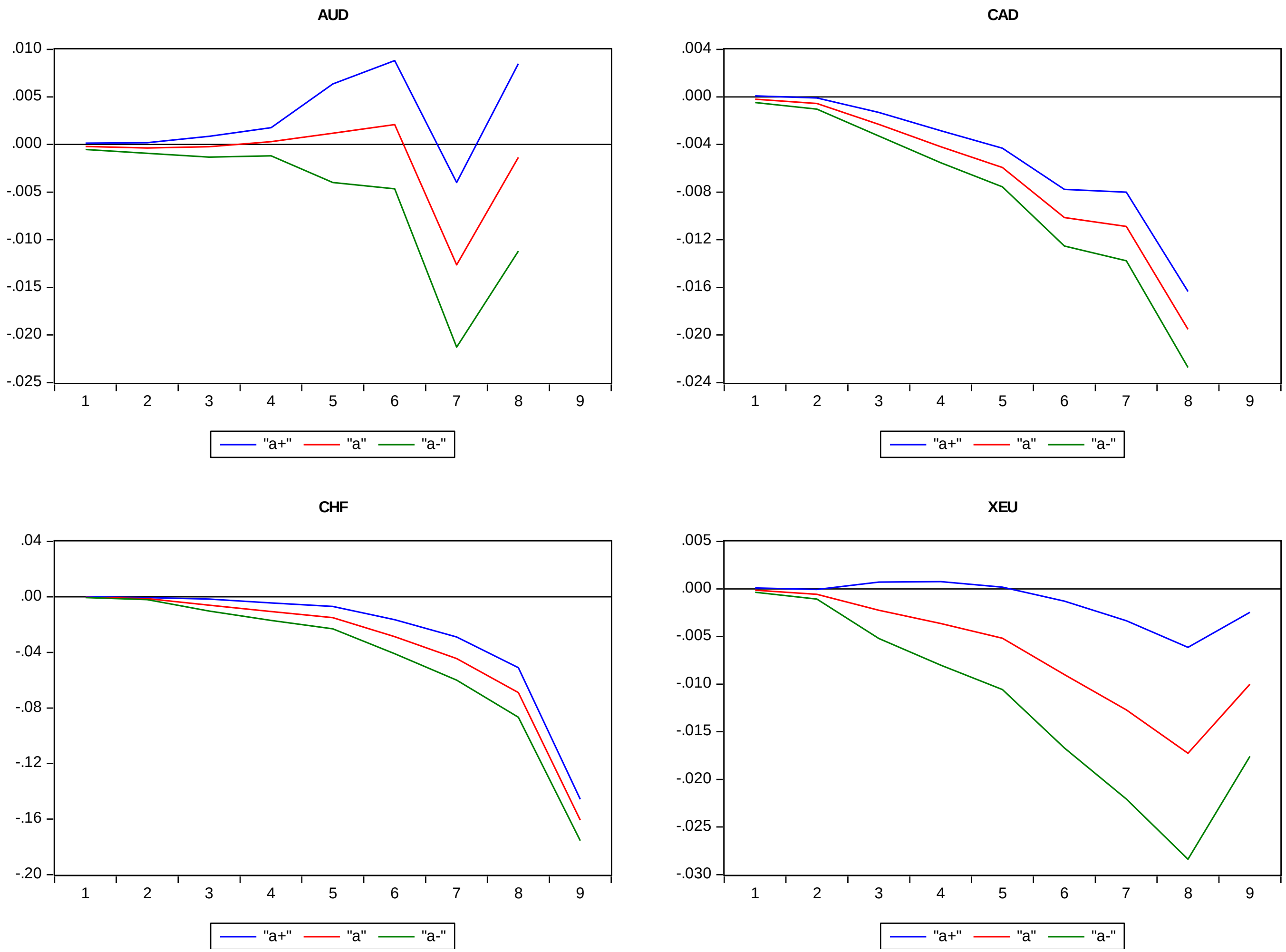

RUR
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"

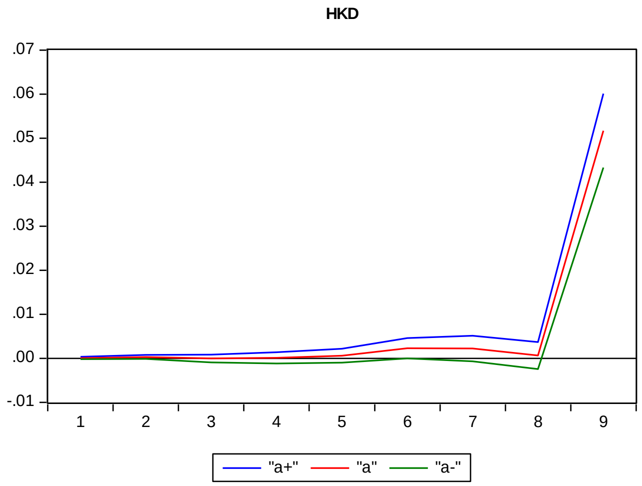

THB
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"

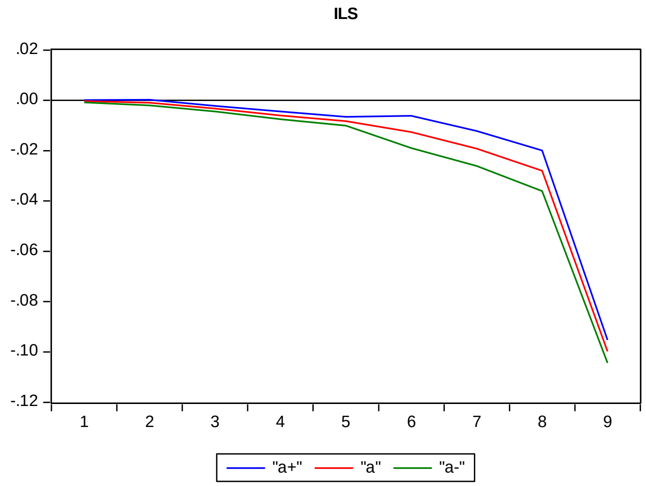


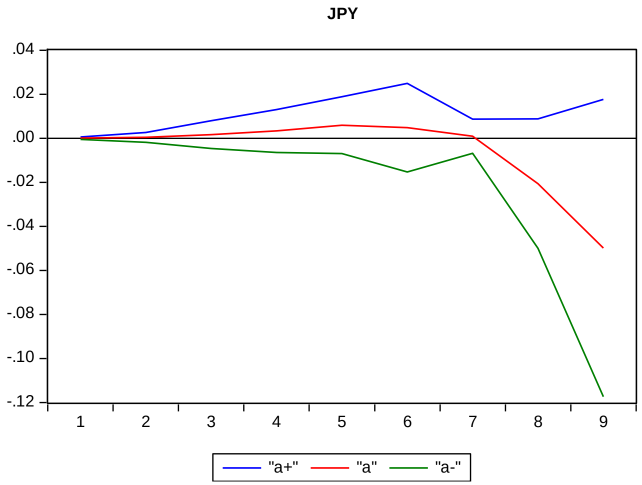
Line plot of the estimated slope coefficient β for each of the 31 economy, with the value of β on the vertical axis and the 9 different time to maturity periods on the horizontal axis. b+ and b- indicate the confidence interval. Coefficients correspond to Table 3.6.1 Simple efficiency hypothesis FMOLS test equation for Sterling exchange rates.

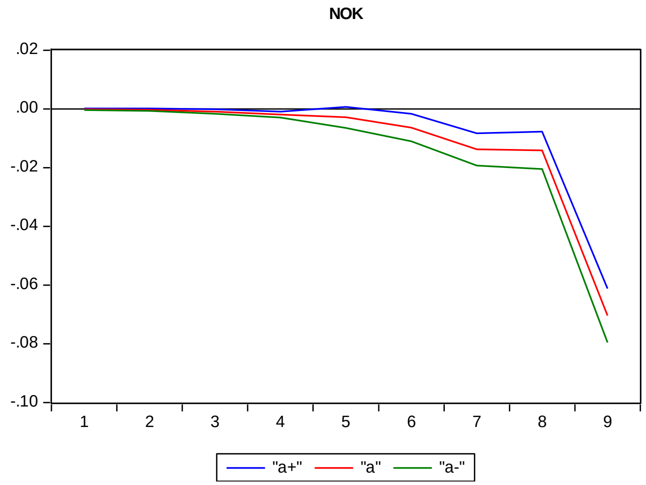
Figure 3.8 Line plot of the constant coefficient α from the Fama equation

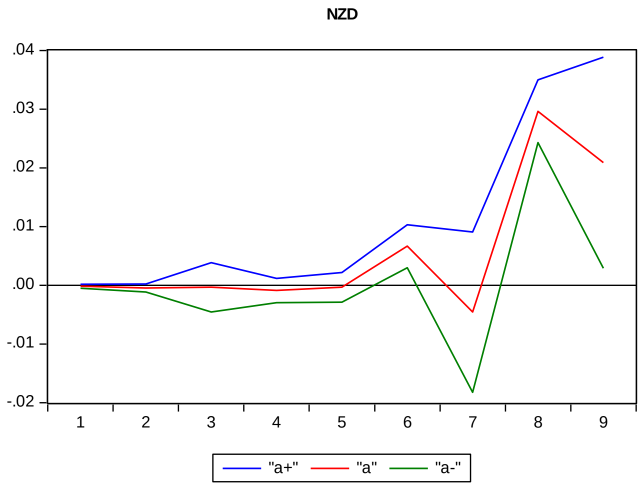


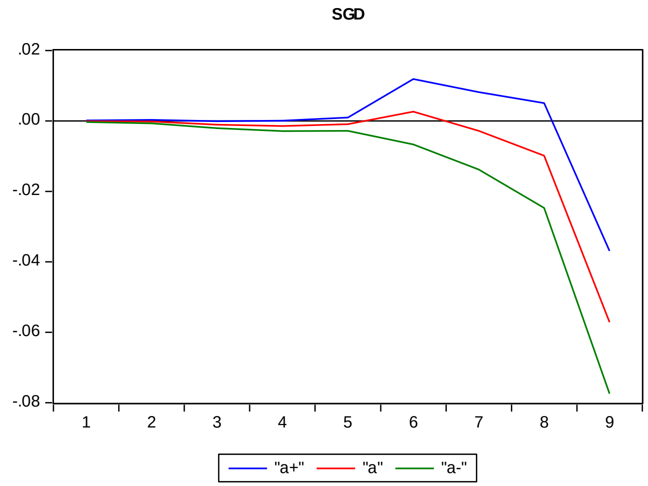

HKD
.07
.06
.05
.04
.03
.02
.01
.00
-.01
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

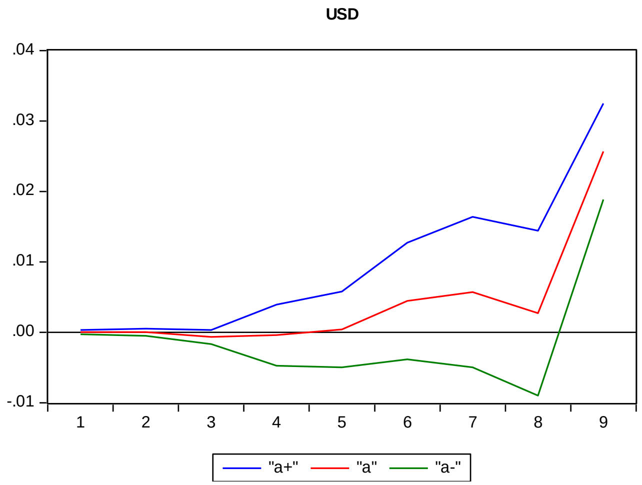

ILS
.02
.00
-.02
-.04
-.06
-.08
-.10
-.12
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

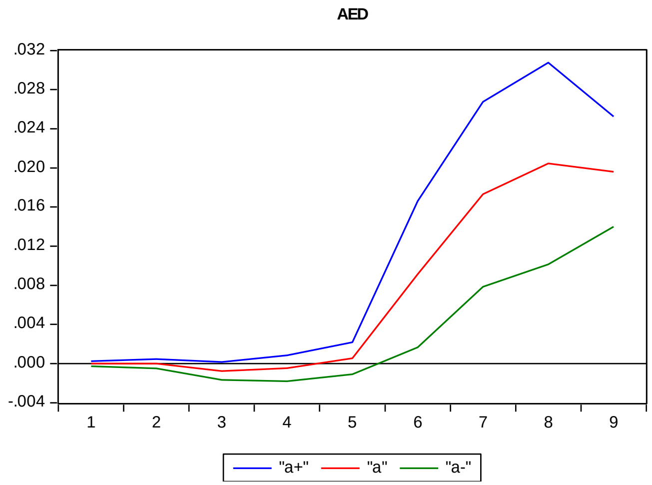

JPY
.04
.02
.00
-.02
-.04
-.06
-.08
-.10
-.12
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

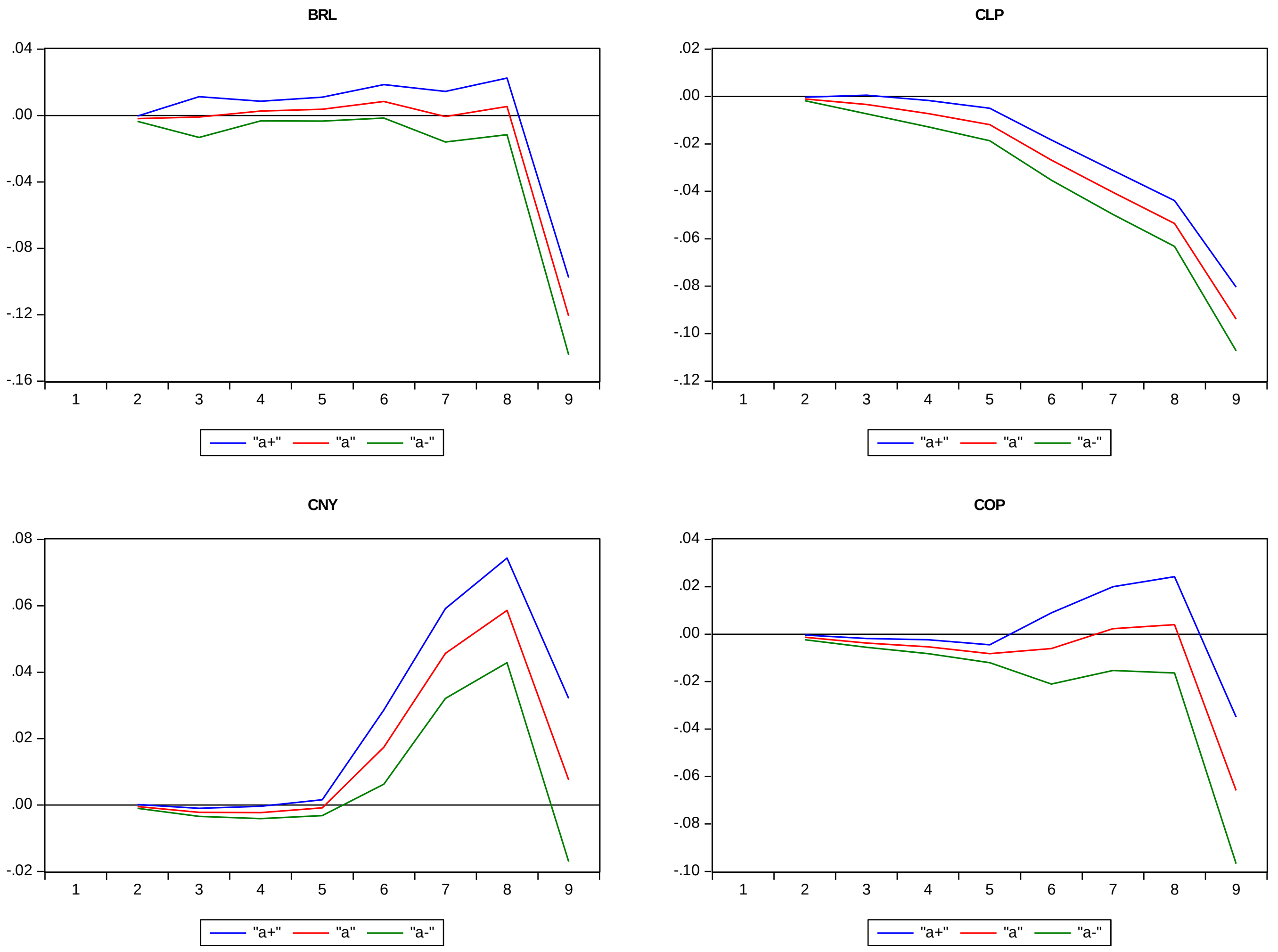

NOK
.02
.00
-.02
-.04
-.06
-.08
-.10
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

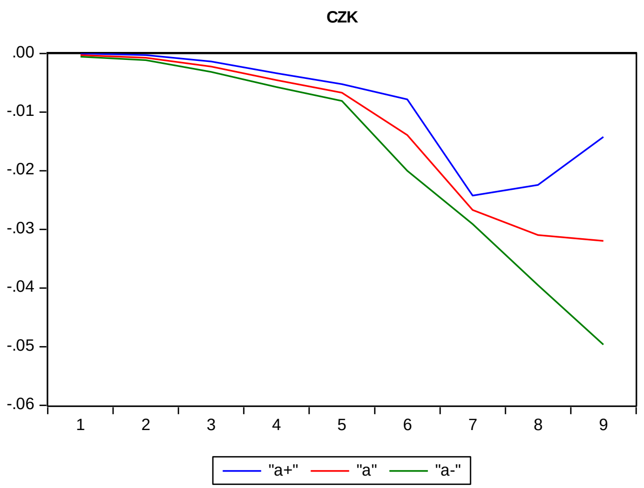

NZD
.04
.03
.02
.01
.00
-.01
-.02
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

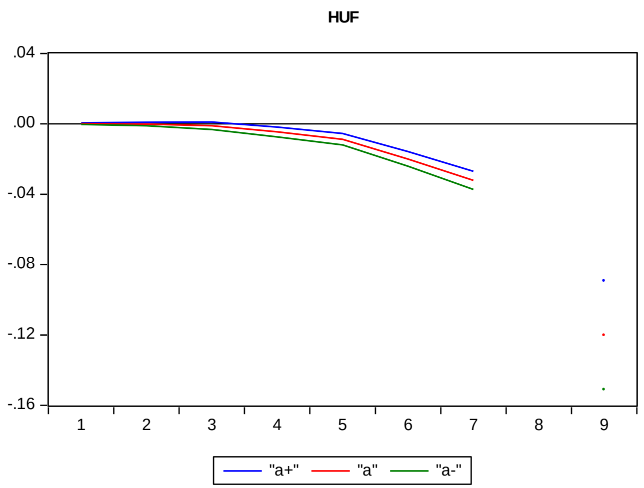

SGD
.02
.00
-.02
-.04
-.06
-.08
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

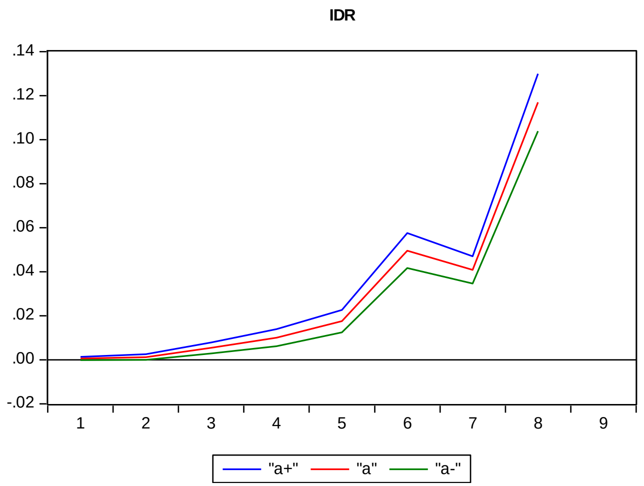

USD
.04
.03
.02
.01
.00
-.01
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

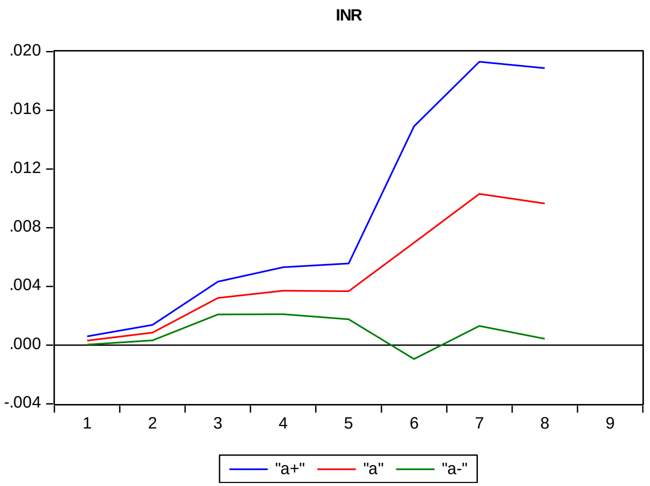

AED
.032
.028
.024
.020
.016
.012
.008
.004
.000
-.004
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

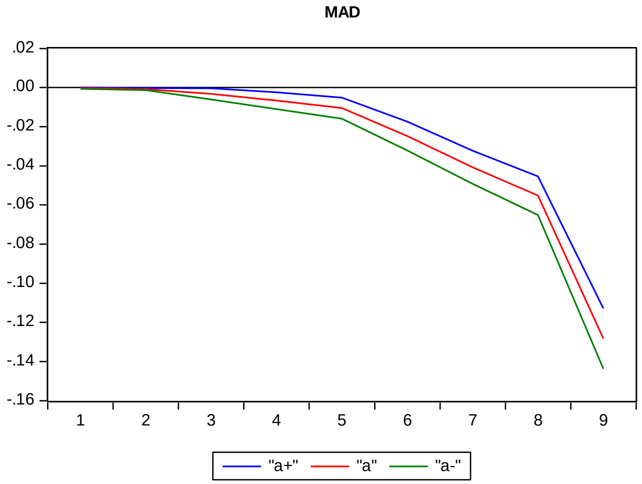

BRL
.04
.00
-.04
-.08
-.12
-.16
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"
CLP
.02
.00
-.02
-.04
-.06
-.08
-.10
-.12
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"
CNY
.08
.06
.04
.02
.00
-.02
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"
COP
.04
.02
.00
-.02
-.04
-.06
-.08
-.10
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

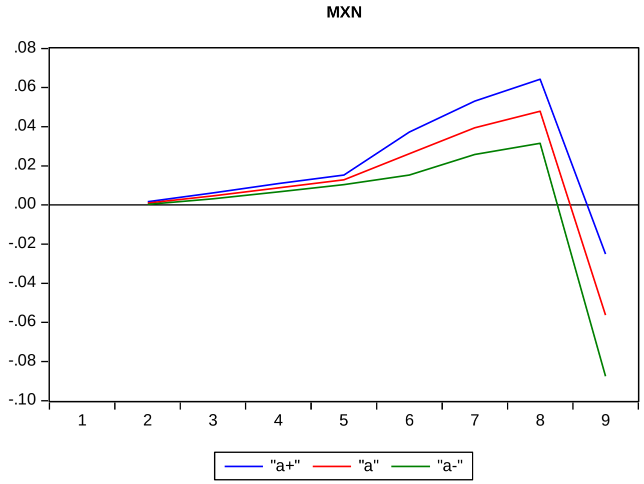

CZK
.00
-.01
-.02
-.03
-.04
-.05
-.06
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"

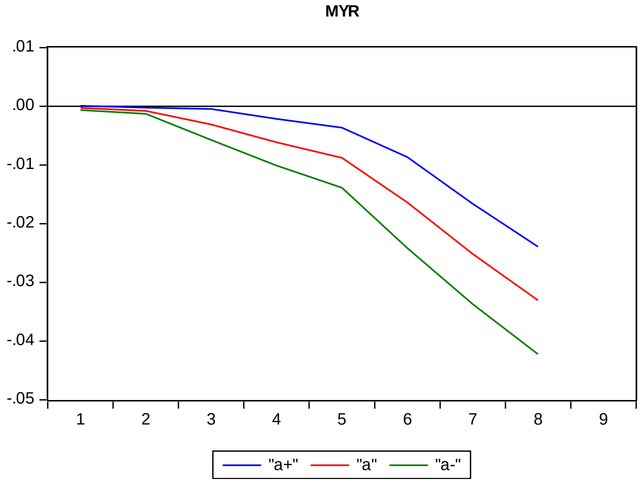

HUF
.04
.00
-.04
-.08
-.12
-.16
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"


IDR
.14
.12
.10
.08
.06
.04
.02
.00
-.02
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"


INR
.020
.016
.012
.008
.004
.000
-.004
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"


MAD
.02
.00
-.02
-.04
-.06
-.08
-.10
-.12
-.14
-.16
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"


MXN
.08
.06
.04
.02
.00
-.02
-.04
-.06
-.08
-.10
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"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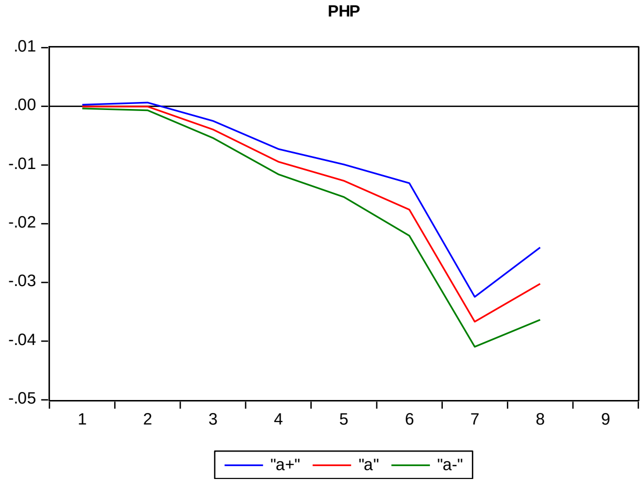
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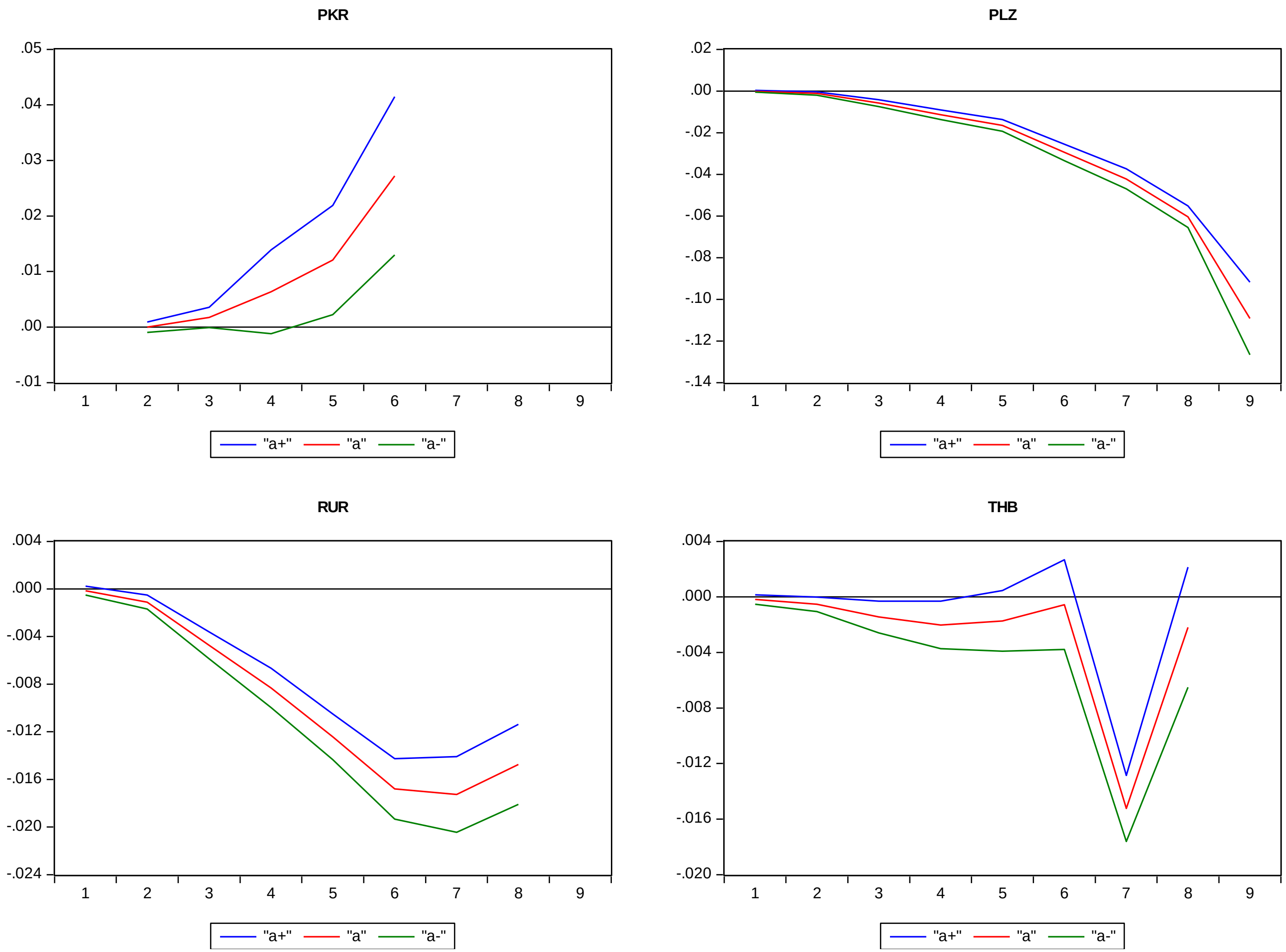
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-.12
-.14
1 2 3 4 5 6 7 8 9
"a+" "a" "a-"
RUR
.004
.000
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1 2 3 4 5 6 7 8 9
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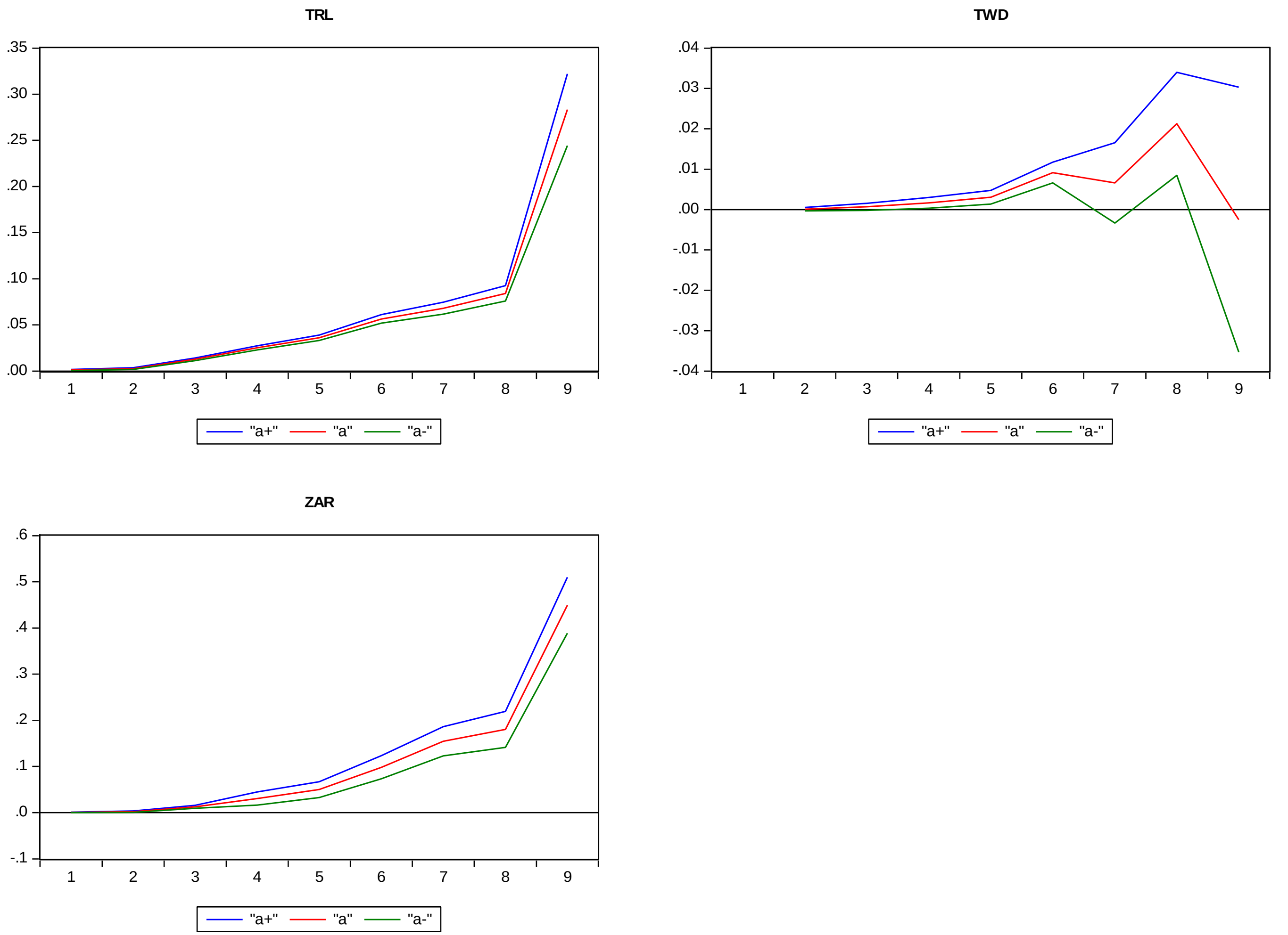
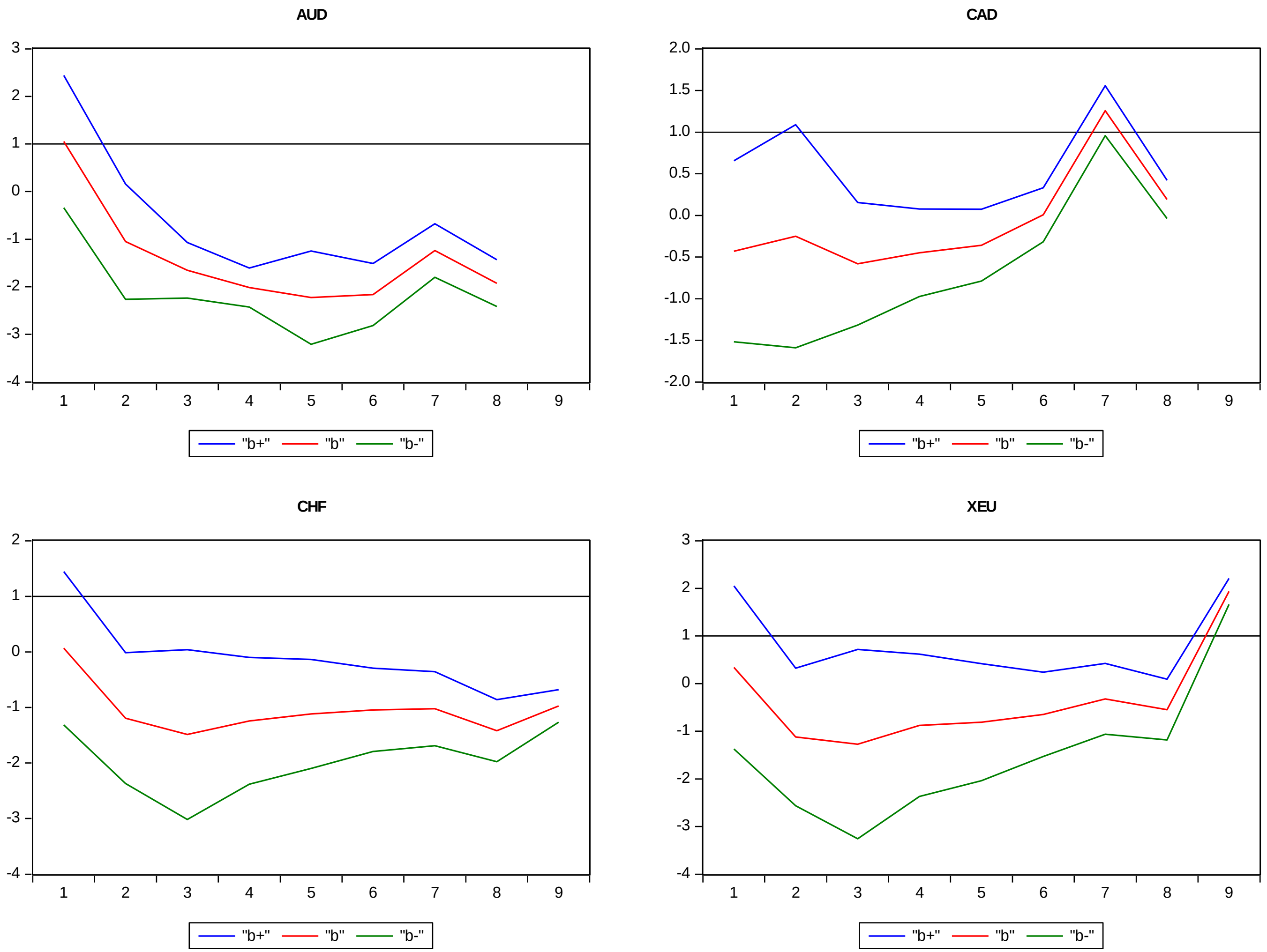


Line plot of the estimated coefficient α from the Fama equation for each of the 31 economy, with the value of α on the vertical axis and the 9 different time to maturity periods on the horizontal axis. a+ and a- indicate the confidence interval. Coefficients correspond to Table 3.10.1 Fama FMOLS regression for Sterling exchange rate.

Figure 3.9 Line plot of the slope coefficient β from the Fama equation



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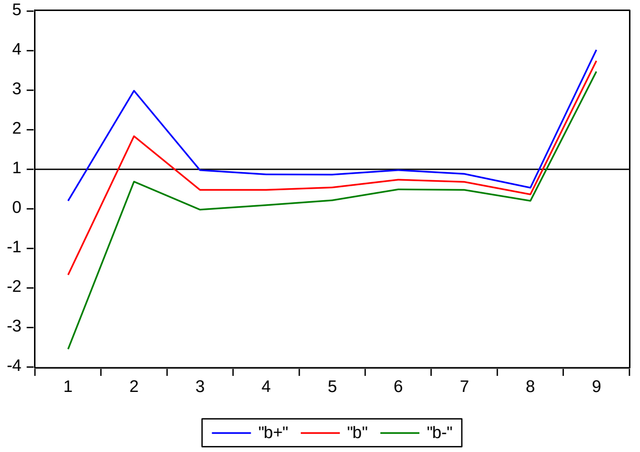

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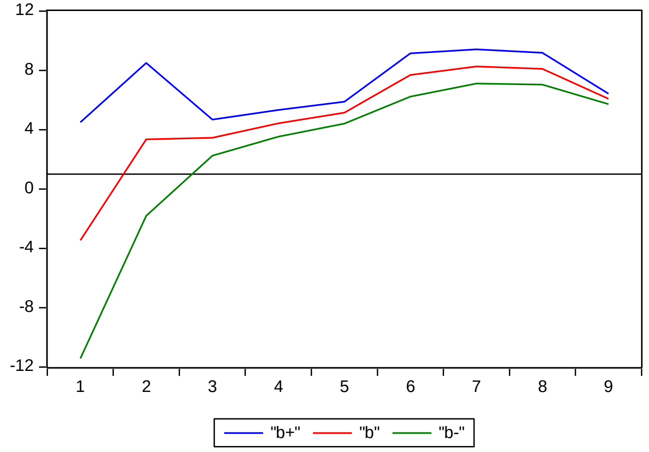

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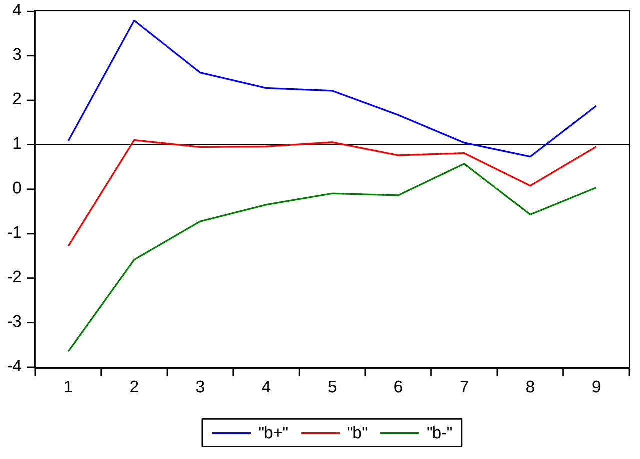
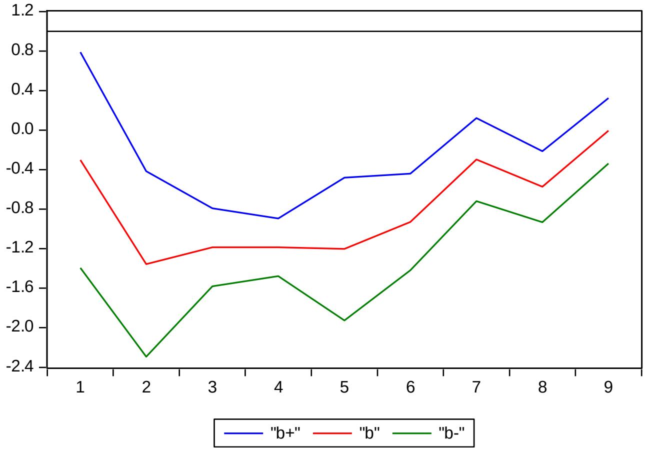
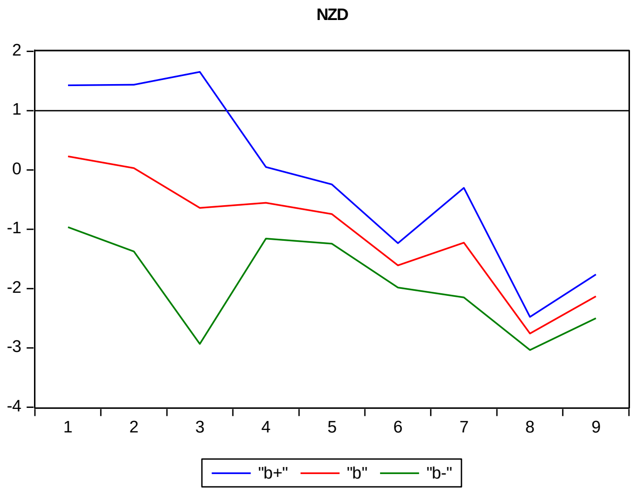


NOK

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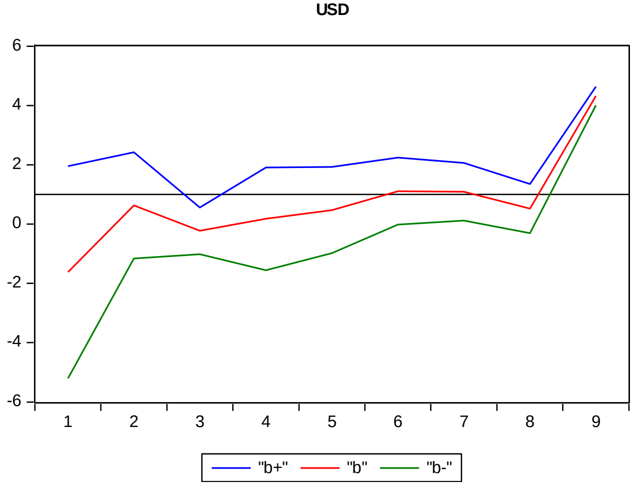
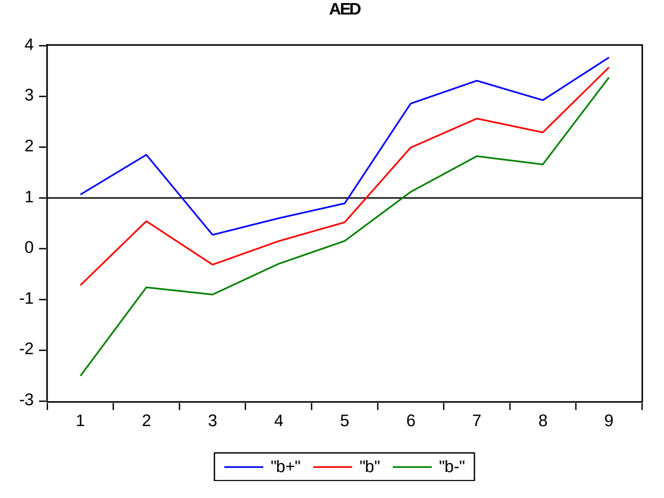
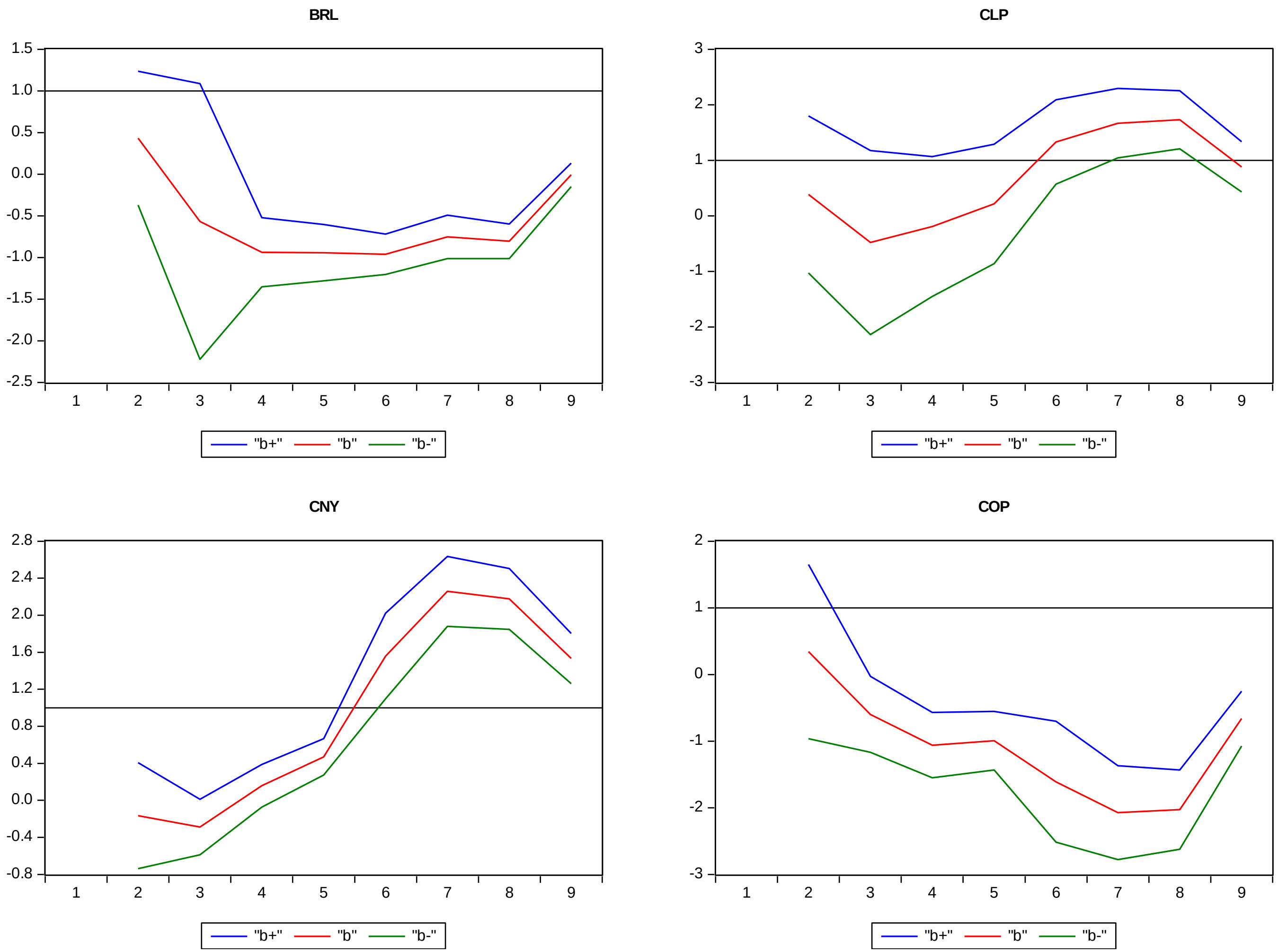
"b+"
"b"
"b-"


SGD
"b+"
"b"
"b-"


USD
"b+"
"b"
"b-"


AED
"b+"
"b"
"b-"


BRL
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0.5
0.0
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-1.5
-2.0
-2.5
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"
CLP
3
2
1
0
-1
-2
-3
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"
CNY
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0.0
-0.4
-0.8
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"
COP
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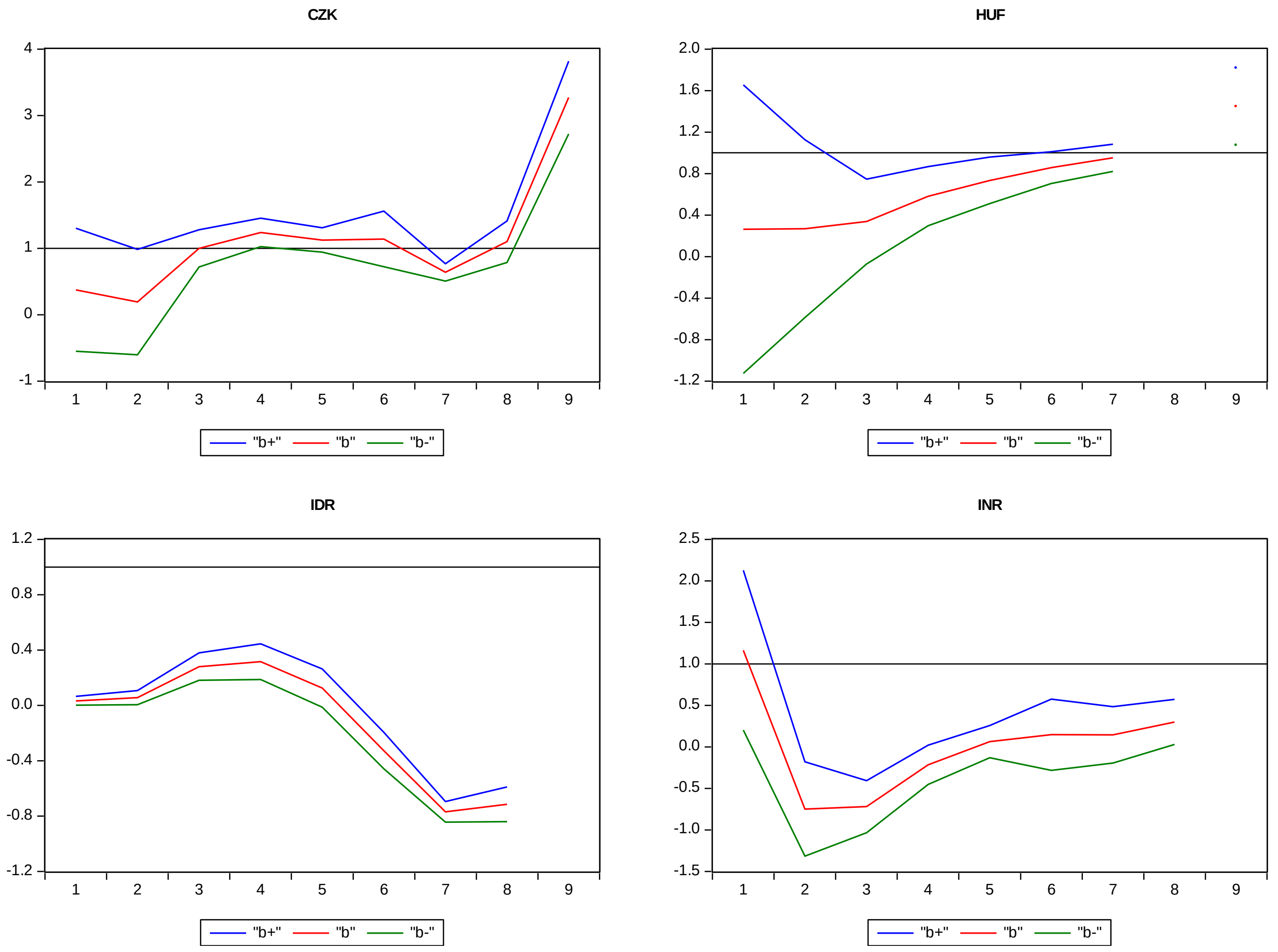
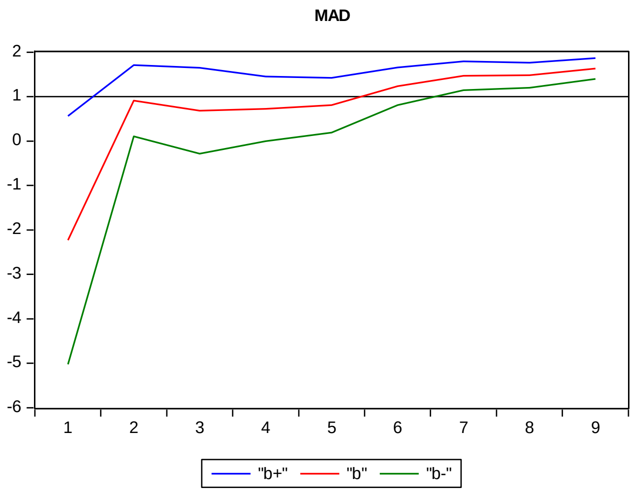
0
-1
-2
-3
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"



CZK
HUF
IDR
INR
"b+"
"b"
"b-"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-2
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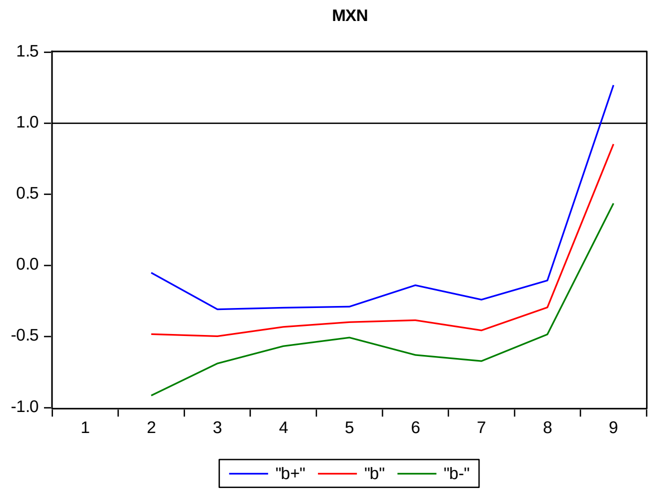
-4
-5
-6
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"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1 2 3 4 5 6 7 8 9
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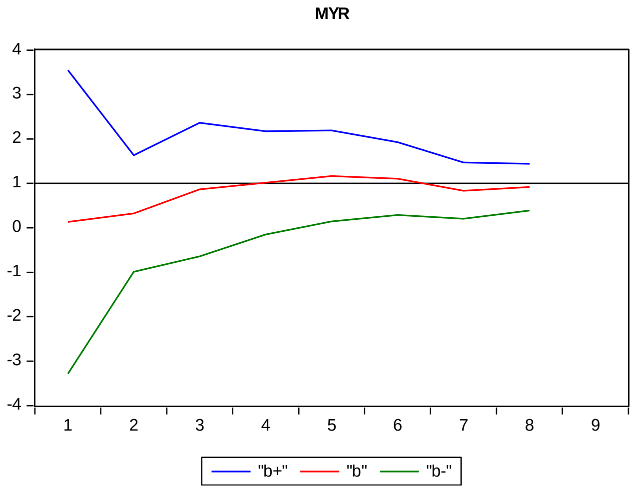
MYR
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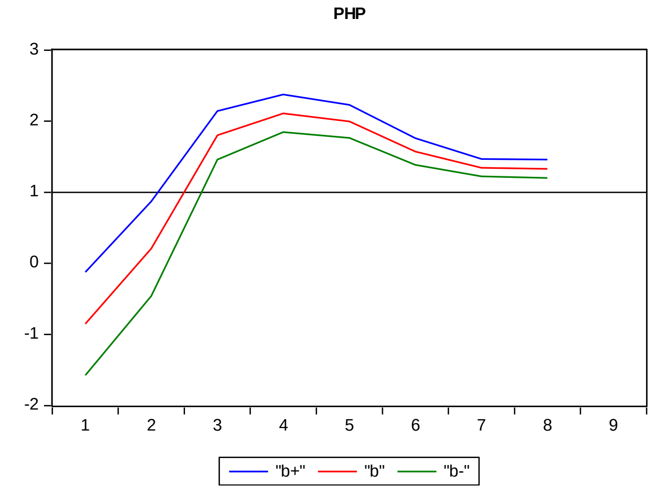
"b+" "b" "b-"


PHP
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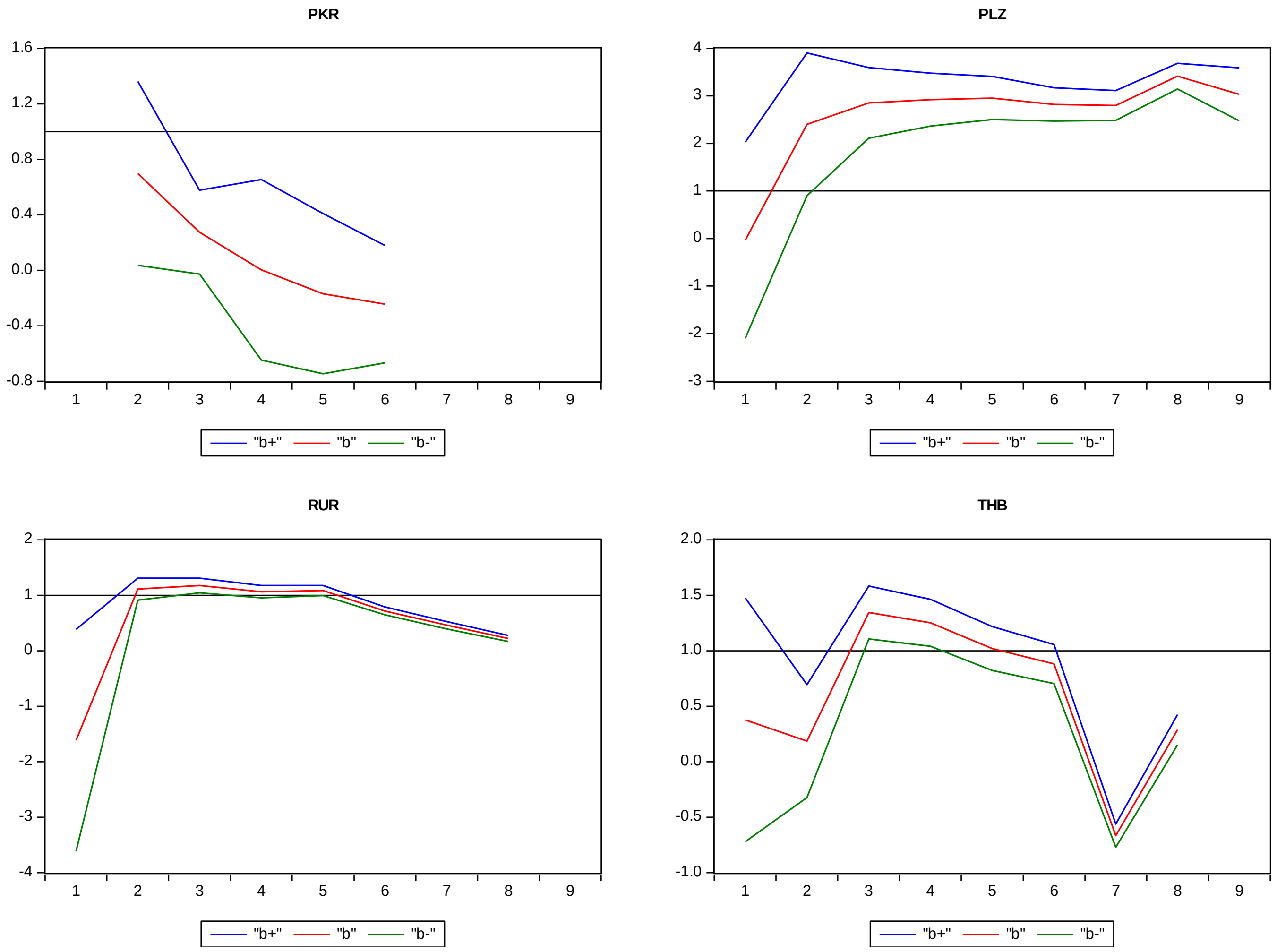
"b+" "b" "b-"


PKR
1.6
1.2
0.8
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-0.4
-0.8
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"
PLZ
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3
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-3
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"
RUR
2
1
0
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-2
-3
-4
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"
THB
2.0
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0.5
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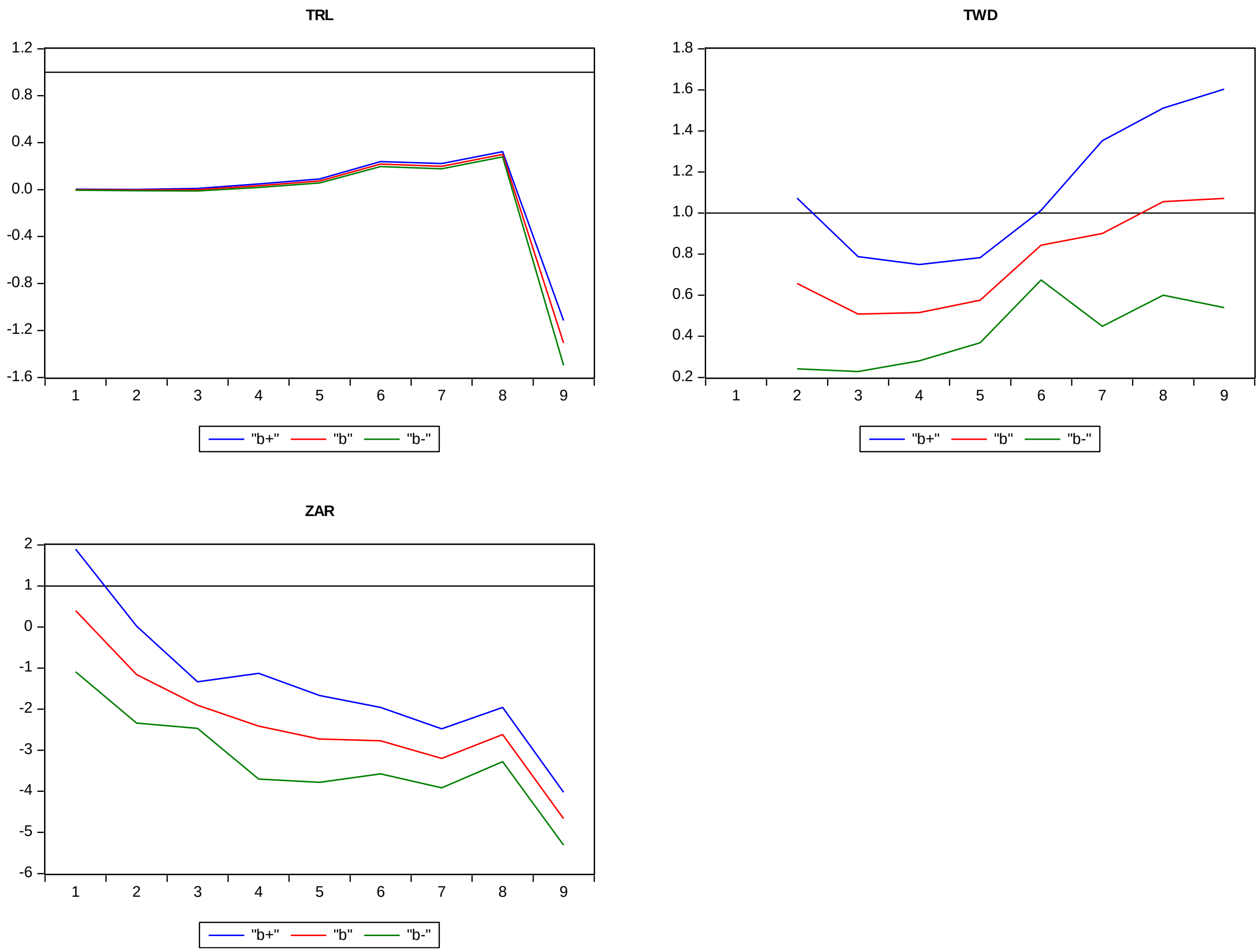
-0.5
-1.0
1 2 3 4 5 6 7 8 9
"b+" "b" "b-"



Line plot of the estimated slope coefficient β from the Fama equation for each of the 31 economy, with the value of β on the vertical axis and the 9 different time to maturity periods on the horizontal axis. a+ and a- indicate the confidence interval. Coefficients correspond to Table 3.10.1Fama FMOLS regression for Sterling exchange rate.

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Chapter 4 Financial Liberalization and Crisis

4.1 Introduction

Many countries started to liberalize their financial sectors during the 1980s and continually rising in a more rapid speed in the 1990s with the goal of achieving economic growth through financial sector development. However, financial liberalization has often been followed by financial instability and is often considered a cause of banking crisis (Caprio and Klingebiel 1996, Kaminsky and Reinhart 1999).

Financial liberalization can lead to financial fragility in two ways. One is that financial institutions take on more risk and with deposit insurance their downside risks are cushion and there is no cap on the upside rewards. The other one is that deregulation opens up the gates for banks to merge, and it becomes too big to fail, which makes it more imperative that reregulation rules to stop them from taking excessive risks. In this chapter we test whether financial liberalization has a role to play in explaining crisis.

Most existing studies capture financial liberalization using 0/1 dummy. The drawback of this method is that it only gives financial liberalization two states, liberalized or non-liberalized and it cannot capture the degree of financial liberalization. In this chapter we use a financial liberalization database on International Monetary Fund (IMF), which is a grade index constructed according to the degree of liberalization. This liberalization index captures various liberalization policies taken as well as the extent of liberalization. The index is constructed using 7 dimensions. Each dimension has a score from 0 to 3. That is, fully liberalized=3; partially liberalized =2; partially repressed =1; fully repressed =0. The data base is an index constructed using 7 different dimensions, namely credit controls and excessively high reserve requirement, interest rate controls, entry barriers, state ownership in the banking sector, financial account restriction, prudential regulations and supervision of the banking sector, and securities market policy. Therefore it has the advantage that it allows for policy reversals.

Figure 4.1 Financial Liberalization Index by Country Groups

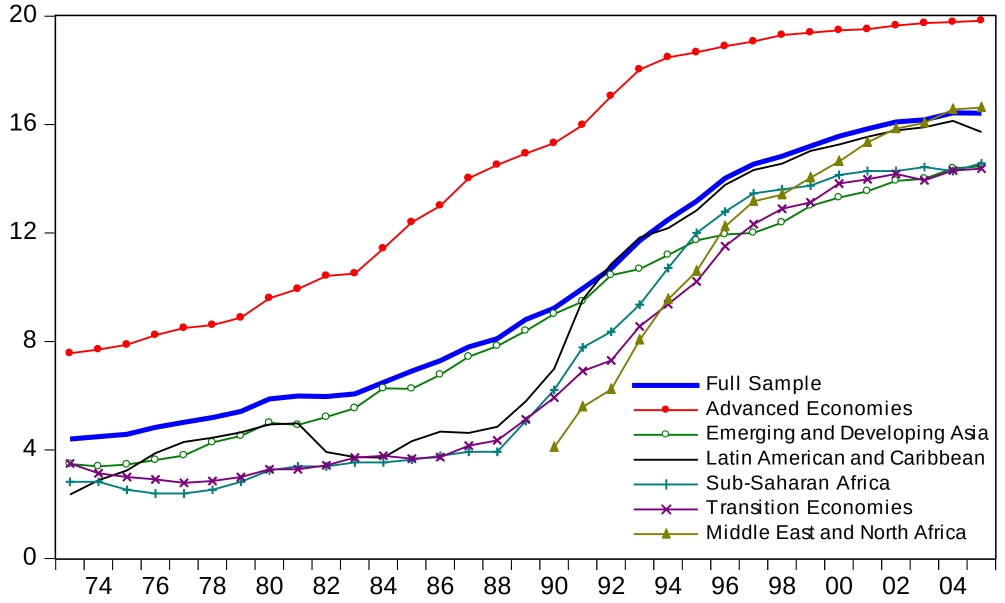


Figure 4.1 shows that financial reforms advanced substantially through much of the sample in the past 30 years. Countries in all income groups and in all regions are liberalized. Higher income economies remained more liberalized than lower-income economies throughout. For advanced economies, most liberalization happened in the 80s and early 90s, with the process slowing down after that.

Figure 4.2 Distribution of Financial Sector Policy Changes Over time (Full Sample)

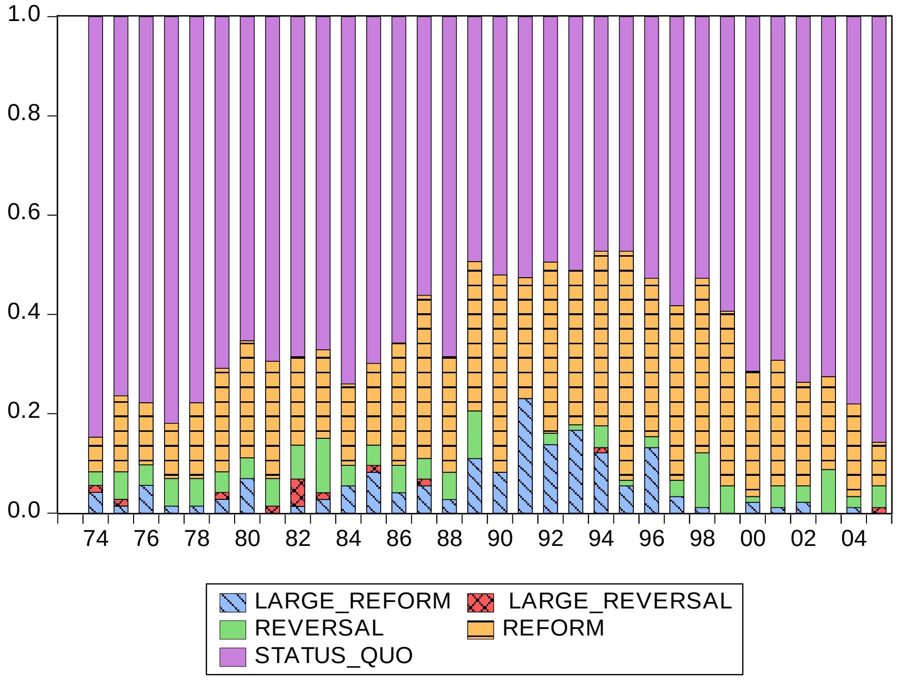
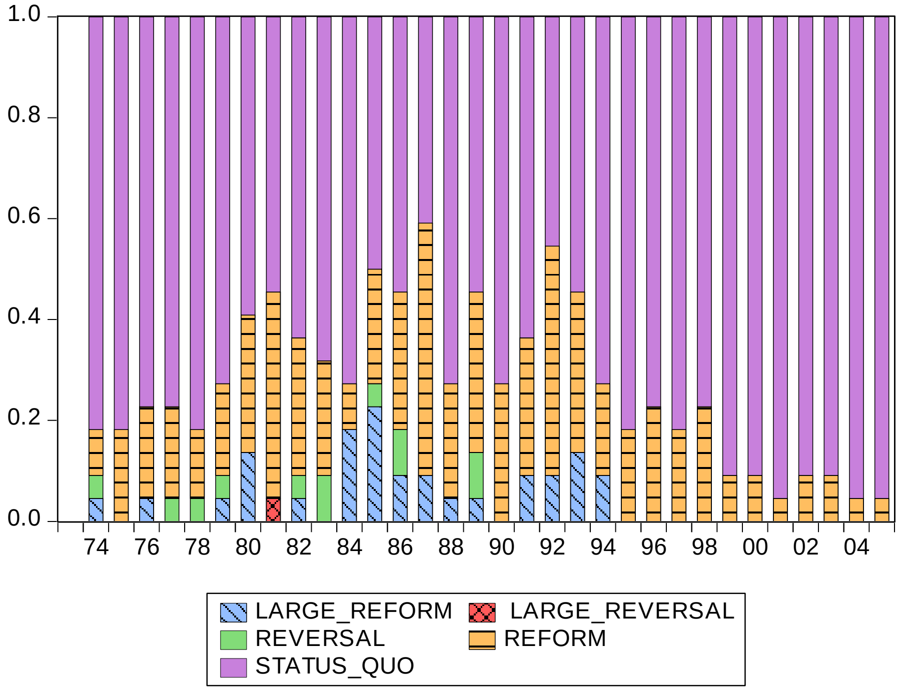


Figure 4.3 Distribution of Financial Sector Policy Changes Over time (Advanced Economy)



To examine the pace at which the liberalization took pace, the policy changes for each country-year is classified into five categories. A decrease in the financial liberalization measure by 3 points is classified as a large reversal; a decrease of 1 or 2 points as reversal; an increase by 1 or 2 points as a reform; and an increase of 3 or more points is classified as a large reform. Years when no changes were made are classified as status quo.

Figure 4.2 shows the distribution of various policy changes in the whole sample. It shows that most reforms concentrated in the first half of the 1990s. Liberalization was relatively rare in the early and late periods of the sample. This reflects the reforms in transition countries, and also the significant changes in Western Europe and Latin America. After peaking in 1995, the liberalization process began to slow down. This could be because a number of countries had essentially completed the liberalization process.

In chapter 2, we have discussed that the European banking industry has a strong culture of 'too big to fail'. Financial liberalization allows bank CEOs to take on excessive risk. Some argue that this could be a contributing factor to the financial crisis. As we can see in Figure 4.1 and Figure 4.3, towards the end of the sample period 2005, most countries in the advanced economies have nearly fully liberalized. Could it be that financial liberalization is one of the factors that led to the financial crisis in 2007? Our selections of sample countries are those countries that were mostly affected by the financial crisis. We use a sample of 10 European countries which are commonly used in the sovereign debt crisis literature, adding USA and Canada which are also severely affected by the financial crisis.

The 2007 crisis is one of the most serious crises we have ever seen. It lasted for a long time and resulted in a serious recession. The previous literature used panel data to investigate the relationship between financial crisis and all types of financial crises in general. We only focus the current episode of crisis in this study. In the same way, rather than using the conventional way of capturing crisis using 0/1 dummy variable, we use 10-year government bond yield spread relative to Germany as a proxy for crisis. The long-term government bond yield spreads relative to Germany have increased dramatically for most euro area countries since the recent crisis happened. The advantage of using spread is it also shows the extent and severity of the crisis. Spread is widely and commonly used as a proxy of financial liberalization in recent literature. However the literature using spread as an indicator of crisis is usually in a different context. For example Arghyrou and Tsoukalas (2011) empirically investigate the EMU sovereign crisis. They find evidence of contagion effects particularly among EMU periphery countries. The literature using spread as a measure of financial crisis and modelling sovereign debt issues, had not modelled the effect of financial liberalization. So there is scope for us to make contribution.

In order to test this hypothesis we follow a simple specification which is already established in the literature (Arghyrou and Tsoukalas 2011), augmented by the proxy of financial liberalization. We also conceive that fundamental policy changes, such as financial liberalization, which liberalize capital control in the banking and financial industry, may take some time to take effect. We test whether the past liberalization also contributes to the recent crisis. We use a panel data fixed effect model with the OLS estimator. We also use SUR to control for both heteroskedasiticiy and contemporaneous correlation, and 2SLS to account for endogeneity.

Contrary to Shehzad (2009), who examine the impact of financial liberalization on systemic and non-systemic banking crises for a sample of developing and developed countries for the period 1981 to 2002, suggesting that financial liberalization reduces the likelihood of systemic crises, our result shows that there is no contemporaneous relationship between financial liberalization and crisis, rather, the past liberalization has influence on present crisis.

The rest of this chapter is organised as follows. Section 4.2 summarises and discusses the literature. Section 4.3 provides details and analytical descriptions of the data. Section 4.4 presents the empirical models and the results. Section 4.5 concludes this chapter.

4.2 Literature review

It is believe that Financial Liberalization can spur growth, however it may also leads to crisis. One strand of the literature of financial liberalization investigates the impact of financial liberalization on economic growth. McKinnon (1973) and Shaw (1973) first strongly advocate increasing economic performance by fostering financial development in early years. Their work stimulated a fast-growing research on how financial development can stimulate economic growth. According to McKinnon and Shaw, financial repression, by forcing financial institutions to pay low and often negative real interest rates, reduces private financial savings, thereby decreasing the resources available to finance capital accumulation. From this point of view, through financial liberalization developing countries can stimulate domestic savings and growth, and reduce excessive dependence on foreign capital flows. Theoretical studies Greenwood and Jovanovic (1989) have presented models explaining the mechanism through which the increased growth was achieved. They show that the positive correlation between financial intermediation and growth is due to increased investment efficiency rather than the increased volume of investment.

De Gregorio and Guidotti (1995) find a positive correlation between the real interest rate (which was often used as a proxy for financial development in the early literature) and growth for thirty-four countries from 1965 to 1985. King and Levine (1993) find a significant and positive relationship between financial development and faster current and future economic growth. Jung (1986) finds a bi-directional causality between financial liberalization and economic growth. A positive effect of financial liberalization on economic growth was gradually established in the early 90s. Although an expanding body of literature has documented this effect across space and time, the channel through which financial liberalization affects the economic growth remains unclear (Inkoo and Jong-Hyup 2008).

Some has argued that the adverse effects of financial liberalization happen typically in countries with poor bank regulation and supervision, or poor “law and order”. Although there are benefits from financial deregulation, it may not be optimal to have an extensive deregulation for countries at an early stage in the liberalization process. Demirgüç-Kunt and Detragiache (1998) also point out that, financial liberalization gives banks another financial intermediaries more freedom of action, increases the opportunities to take on risk. However, because of limited liability, bankers take on risk higher that the socially desirable level. If prudential regulation and supervision fail to control banker’s behaviour and align incentives, liberalization may increase financial. Increased risk taking due to moral hazard can become a powerful source of financial fragility and leads to banking crisis. Mehrez and Kaufmann (2000) find that the probability of a crisis is higher in the period following financial liberalization in the country with poor transparency, where they use corruption as a proxy for transparency. Demirgüç-Kunt and Detragiache (1998) empirically examine the connection between financial liberalization and financial fragility for 53 countries during 1980-85. They also find that financial liberalization increases the probability of a banking crisis, though less so if legal institutions and governance are strong. Their institutional characteristics are rule of law, level of corruption and good contract enforcement. Rossi (1999) focuses on her new measures of capital controls, prudential regulation, supervision and depositors’ safety. Barth, Caprio et al. (1999) however, find mixed evidence regarding the impact of regulatory restrictions on bank performance. They find that countries that restrict securities market activities tend to have more fragile banking systems.

Aware the existence of the possible trade-off between the benefits of liberalization and the costs of increasing financial frailty, researchers also tried to weight up both sides of the impact from financial liberalization together. Taking account of both the positive effect of growth and negative effect of crisis, Inkoo and Jong-Hyup (2008) find a positive net effect from financial liberalization to growth. Johnston (1994)'s evidence suggest that only countries did not experienced financial crisis have higher economic from financial system reform, but countries faced a crisis experienced a deterioration in economic growth.

There has been an ongoing debate about the case for and against regulation. The case for free banking begins with the argument by analogy. If free trade and free competition is considered to be welfare superior to restricted trade and competition, why is free banking not better than central banks? This was the basis of much debate in the early mid-19th century[28]. Free bank mangers understand that their long-term survival depends on their ability to retain depositor's confidence. Government intervention in the form of deposit insurance has the opposite effect on capital ratios. The moral hazard created by deposit insurance will drive even conservative banks to take on extra risk when faced with competition from bad banks. The free-banking school argue that it is the 'bad' effect of depositor protection in the form of moral hazard that creates the needs for regulation.

The second argument in favour of free banking is the poor record of central banks in maintaining the value of the currency. The free banking school argued that monetary stability is a necessary prerequisite for bank stability (Benston and Kaufman, 1996), and the loss of purchasing power incurred by depositors from unexpected inflation is much greater than losses from bank failures in the USA (Schwartz, 1987). However, the argument that central banks and a regulated banking system are financially less stable than a free-banking system has lost force with the development of independent central banks, in combination with strict inflation targets. An intermediate position taken by a number of economists is to argue that the current regulated system should be redesigned so as to allow market discipline to

[28] For the historiacal arguments for the free banking case see Goodhart (1990) and smith(1936)

counteract the moral hazard problems created by deposit insurance. A popular suggestion is the use of subordinated debt in bank capital regulation. The existence of deposit insurance results in under-priced risk due to moral hazard. Wall (1989) proposes the use of subordinated debt aimed at creating a banking environment that functions as if deposit insurance did not exist. The advantage of the put characteristic of the subordinated debt is that the bank would always be forced to continuously satisfy the market of its soundness. An alternative proposal is the narrow banking scheme put forward by Tobin (1985) and strongly supported by the *Economists* (27 April 1996). His proposal is that deposit insurance and lender-of-last-resort facilities should be restricted to banks involved in the payment mechanism. These would be exclusively retail banks that would be required to hold only safe liquid assets such as Treasury and government bonds. Thus the banking market would be segmented in to a protected retail banking sector and a free-banking sector catering to corporate clients and sophisticated investors.

The case for regulation of banks and other financial institutions hinges on the Coase (1998) argument that unregulated private actions creates outcomes whereby social marginal costs are greater that private marginal costs. The social marginal costs occur because bank failure has a far greater effect throughout the economy than a manufacturing concern because of the widespread use of banks to make payments and as a store for savings. In contrast, the private marginal costs are borne by the shareholders and the employees of the company, and these are likely to be a smaller magnitude than the social costs. Nevertheless, it should be borne in mind that regulation involves real resource cost. These costs arise from two sources: direct regulatory costs and compliance costs borne by the firms regulated. With a high level of costs, the free market is preferable unless it can be shown that the benefits of regulation outweigh the costs involved. The main reason for regulation are three fold. First, consumers lack market power and are prone to exploitation from the monopolistic behaviour of banks.

Second, depositors are uninformed and unable to monitor banks and therefore require protection. Finally, regulation is needed to ensure the safety and stability of the banking system.

Another one of the main approach of financial liberalization is capital account liberalization. A speech[29] by Stanley Fischer, Deputy Director of the International Monetary Fund and world leading macroeconomist, who argued that free capital movements facilitates a more efficient global allocation of savings, and helps channel resources into their most productive uses, thus increasing economic growth and welfare. International capital flows have expanded the opportunities for portfolio diversification, and thereby provided investors with a potential to achieve higher risk adjusted rates of returns. And just as current account liberalization promotes growth by increasing access to sophisticated technology, and export competition has improved domestic technology, so capital account liberalization can increase the efficiency of the domestic financial system. However, some researchers argue that financial liberalization has led to capital flows that are volatile and procyclical and has raised the instability of domestic financial markets. Broner (2010) shows evidence that financial liberalization has increased both output and consumption volatility, and that financial liberalization has made domestic financial markets more unstable and prone to crises.

The Financial crisis highlighted several shortcomings in the policies and practices of some financial institutions, particularly in North America and Europe, and in the regulatory requirements for banks in respect of capital. In the lead-up to the Financial crisis, some financial institutions were highly leveraged (that is, their assets were funded by high levels of debt as compared to equity), with capital that proved insufficient to absorb the losses that they incurred. In several countries, governments provided funds to support failing banks,

[29] Stanley Fischer, "Capital Account Liberalization and the Role of the IMF," speech at the IMF Annual Meetings, September 19, 1997

effectively protecting holders of certain capital instruments from bearing losses, which came at a cost to the taxpayers. The complexity of capital rules, interaction with national accounting standards, and differences in application resulted in inconsistencies in the definition of regulatory capital across jurisdictions. Further, insufficient capital was held in respect of certain risks. This made it difficult for the market to assess the true quality of banks' regulatory capital and led some market participants to turn to simpler solvency assessment methods. The Basel Committee on Banking Supervision (BCBS) responded with new requirements for bank capital, collectively known as Basel III, which built on the existing frameworks of Basel I and Basel II. Basel III strengthens the minimum standards for the quality and quantity of banks' capital, and aims to reduce bank leverage and improve the risk coverage of the Basel Capital Accords. One of the purposes of Basel III is to make it more likely that banks have sufficient capital to absorb the losses they might incur, thus reducing the likelihood that a bank will fail, or that a government will be called on to use taxpayer funds to bail out a bank. Basel III also introduced an international standard on bank liquidity. However Basel III focuses primarily on the risk of a run on the bank, requiring differing levels of reserves for different forms of bank deposits and other borrowings. Reserves were created as a by-product of policies designed to mitigate the effects of a disruption in financial markets. Researchers have found that the lack of international reserves contributes significantly to financial crisis vulnerability[30].

Interest rate liberalization is also a mean of financial liberalization. The Government can set the interest rate, let it subject to a binding celling or floor, or fluctuate within a bind. The conjecture is that controls on bank interest rates limit the ability of banks to benefit from investment in high-risk, high-return projects, thereby curbing the moral hazard created by deposit insurance (Hellmann et al. 2000). The interest rate liberalization focused on freeing

[30] See discussion in Mendoza (2004)

interest rates and credit allocations, but very often it made much less effort to improve the institutional basis of finance - a much harder, longer task. Some researchers also point out that interest rate liberalization increase the likelihood of banking crises. Goldfajn and Valde´s (1995) show how changes in international interest rates and capital inflows are amplified by the intermediating role of banks and how such swings may also produce an exaggerated business cycle that ends in bank runs and financial and currency crashes. Demirgüç and Detragiache (2002) analysed empirical evidence for a large panel of countries for 1980–1997. They find that explicit deposit insurance tends to be detrimental to bank stability, the more so where bank interest rates have been deregulated and where the institutional environment is weak. However, where institutions are good, opportunities for moral hazard are more limited, and more effective prudential regulation and supervision better offset the adverse incentives created by deposit insurance.

4.3 Data and Stylized Facts

Researcher has used different ways to proxy financial liberalization. Real interest rate has been used to proxy for financial liberalization (De Gregorio and Guidotti 1995, Fry 1997, Bandiera, Caprio et al. 2000). However Demirgüç-Kunt and Detragiache (1998) point out that it may be limited in a cross-country study. In a panel data a positive correlation between real interest rates and crisis may simply reflect the fact that they are high during economic downturns, while financial liberalization plays no rule. Kaminsky and Reinhart (1999) show that the increase in growth domestic credit two years ago which they argue is a proxy for financial liberalization can help explain banking crises. Many others create a dummy variable according to policy changes using survey such as Williamson and Mahar (1998). Bekaert, Harvey et al. (2005) create a financial liberalization dummy based on the dates of official equity-market liberalization in each country. For liberalizing countries, their Official Liberalization indicator takes a value of one when the equity market is officially liberalized and zero otherwise. The Official Liberalization dates are based on Bekaert and Campbell R. Harvey *A Chronology of Important Financial, Economic and Political Events in Emerging Markets*[31].

In this chapter we use data on financial liberalization is from Abiad, Detragiache et al. (2010). This data base covers 91 economies over 1973-2005. Comparing other data bases using a dummy variable to measure financial liberalization, the advantage of this database is that it has time-series measures for the intensity of reform. As noted in their analysis of the pace of financial reform, there is variation among countries in terms of type of liberalization, intensity, and speed of reform. The database of financial reforms covers 91 economies over 1973-2005. Compare to other graded indexed data base of financial liberalization such as

[31] http://people.duke.edu/~charvey/country_risk/chronology/chronology_index.htm

Bandiera, Caprio et al. (2000), Kaminsky and Schmukler (2003), Laeven (2003), this database has the widest and most extensive recent coverage.

For each economy, 7 different dimensions are used to capture financial liberalization. The first one is credit controls and excessively high reserve requirements, which looks at the percentage of reserve requirement, and whether minimum amounts of credit must be channelled to certain sectors, any credits supplied to certain sectors at subsidised rates, and any aggregate ceiling exists. The second one is interest rate controls. This considers whether deposit rates and lending rates are being control by the government; fluctuate within a band or freely floating. The third one is entry barriers, which is based on the extent the government allow foreign banks to enter into a domestic market, the entry of new domestic banks, the restrictions on branching, and whether government allow banks to engage in a wide range of activities. The fourth one is state ownership in the banking sector, which is constructed on the percentage of privatization of banks. The fifth one is financial account restrictions, which looks at the exchange rate regime and restrictions on capital inflows and outflows. The sixth one is prudential regulations and supervision of the bank sector. The last one is the securities market policy, which examine the existent and development of securities markets, and whether the equity market is open to foreign investors. Along each dimension, a country is given a final score on aggraded scale from zero to three, with zero corresponding to the highest degree of repression and three indicating full liberalization. The total score of these 7 dimensions is the measure of financial liberalization.

Given that each component takes the value between 0 and 3, the sum of these 7 components which is measure of financial liberalization takes values between 0 and 21, with 21 being fully liberalized. This database also classifies policy changes for each country-year into five categories. A decrease in the financial liberalization measure by 3 or more points is classified as a large reversal; a decrease of 1 to 2 points as a reversal; an increase by 1 or 2 points as a reform; and an increase of 3 or more points is classified as large reform. Finally years in which no policy changes were undertaken are classified as status quo observations.

Figure 4.1 shows that financial reforms advanced substantially through much of the sample through much of the sample in the past 30 years. Advanced economies remained more liberalized than lower-income economies throughout. Figure 4.2 shows the distribution of liberalization over the sample period. Changes were relatively rare in the early and late part of the sample, with most reforms concentrated in the first half of the 1990s. After peaking in 1995, the liberalization process began to slow down. For the advanced economies, no large reform has happened since the year 1995 as it is shown in Figure 4.3. Moreover many advanced economies had completed the liberalization process, i.e. their liberalization index had reached the maximum 21. Based on these observations, we fill the series of financial liberalization index of the advanced economies from 2006 onwards with the value of 2005 since the data coverage is only up to 2005.

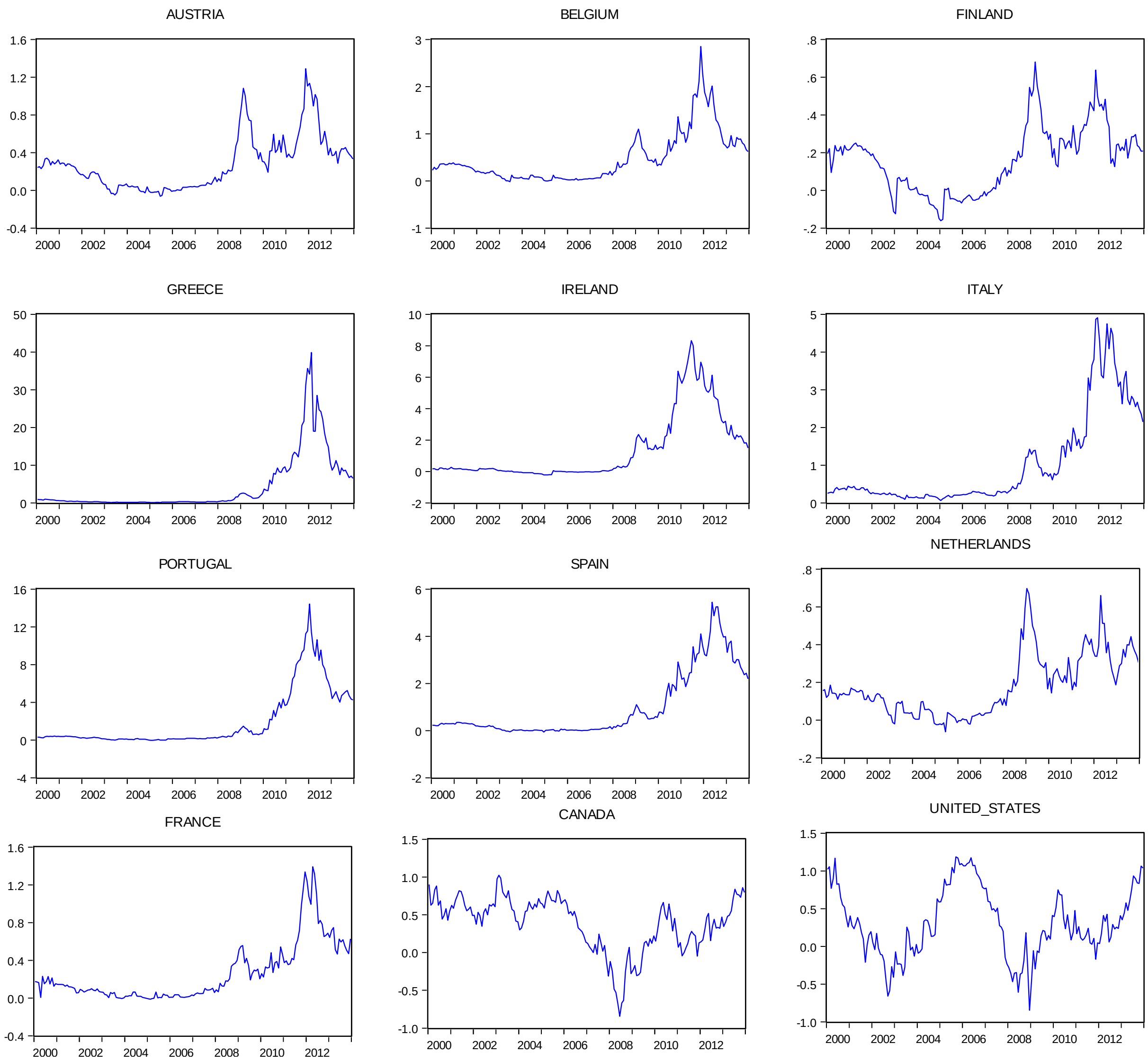
Financial crisis has already emerged and documented in the 19th century[32]. Researcher has been looking at the cause of crises. In particular, banking crisis and currency crisis, which are typically picked up by 0, 1 dummy variable. For example one of the most used data base is from Glick and Hutchinson (2000) who incorporated both banking crises and currencies and formed a "twin crisis" indicator. Their work is followed up by Caprio and Klingebiel (2002) and Ranciere, Tornell et al. (2006). This data base covers the period from1980 to 2002. A more recent database is given by Caprio, Klingebiel et al. (2005), which is later extended by Laeven and Valencia (2008). Their data base covers the systemic banking crises for the period 1970-2007, with detailed data on crisis containment and resolution policies for 42 crisis episodes, and also includes data on the timing of currency crises and sovereign debt

[32] Reinhart, C. M. (2010) maps the cyclical history of financial crisis from 1810 to 2010 for sixty-six countries. It includes the four major financial crisis types (sovereign default, banking, currency, and inflation) along with stock market crashes.

crisis. Often researchers use these data bases, and estimate their models using Logit or Probit estimation. While this crisis data looking very interesting, informative and valuable, however it doesn't include the recent global financial crisis happened in 2007 and the sovereign debt crisis in Eurozone since 2009. Moreover, the way that crisis is captured by dummy variables does not distinguish between the severity of crisis which happened in different countries.

The measure of financial crisis in this chapter is the monthly 10-year government bond yield spread relative to Germany. Germany has come under pressure due to not having a government budget deficit and funding it by borrowing more. Germany was not affected by the sovereign debt crisis and since then, German officials have resisted pressure to increase the debt, saying that too much deficit spending is what caused the European current problems. Our sample includes 10 Eurozone countries: Austria, Belgium, Finland, France, Greece, Ireland, Italy, Netherlands, Portugal and Spain. We also include 2 Northern America countries: Canada and United States. Figure 4.4 presents the 10-year government bond yield spreads versus Germany. During the pre-crisis period, the spread of the European countries are steady despite deteriorating macroeconomic fundamentals in many countries. It is very clear from the figure that the spread had increased during the crisis period. In Austria, Finland and Netherlands, spread has increased sharply for globe financial crisis in 2007 and 2008, also the sovereign debt crisis since 2010. However spread decreased during 2009. We can see two spikes in these countries. For other European countries, spread has increased since 2008, and they are serious affected by the following up sovereign debt crisis, from which we see their spread increased substantially in 2010. Although spread has come down since the year 2012, however they have not reached the pre-crisis level. In fact many of them are well above the crisis level such as Greece, Spain, Italy and Portugal. For the 2 Northern American countries USA and Canada, spread also increase since the year 2007. However spread fluctuated at a fairly high level the pre-crisis periods, it may or may not be the best tool to capture financial crisis for these two countries.

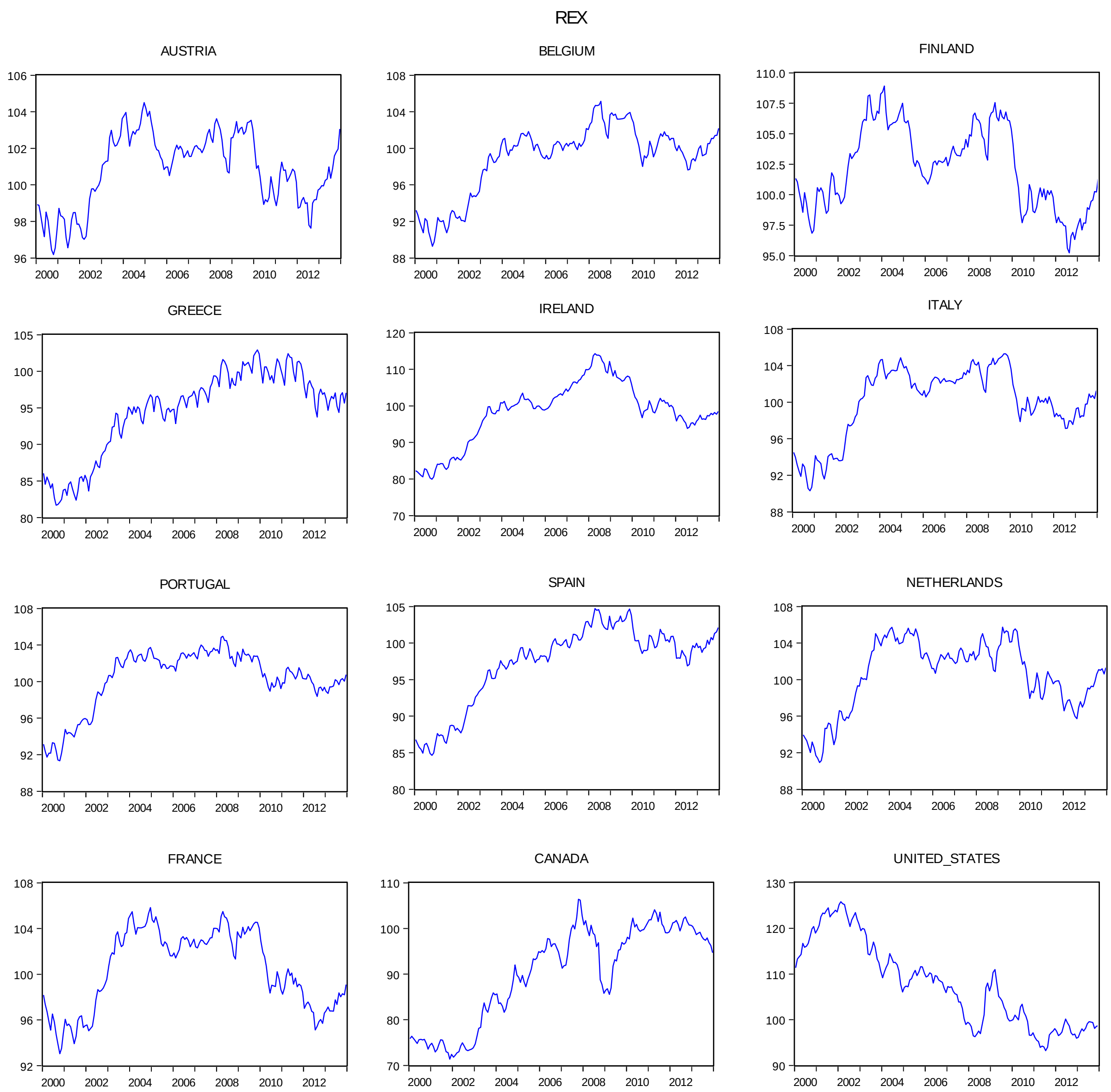
Figure 4.4 10-year government bond yield spreads versus Germany



We also have two other independent variables to capture the macro environment. The real exchange rate and the volatility of the stock market return. Volatility is calculated using 6 months moving standard deviation of market price return using the following market index: ATX (Austria), BEL20 (Belgium), S&P/TSX-60 (Canada), OMXH (Finland), CAC-40

(France), ATHEX (Greece), IESQ (Ireland), FTSE MIB (Italy) AEX (Netherlands), PSI-20 (Portugal), IBEX-35 (Spain) and NASDAQ (United States). Figure 4.5 plots the real exchange rate published by IMF, with an increase in the series indicating real appreciation. Figure 4.5 suggests a trend for real appreciation between 2001 and 2009 for the majority of the sample countries, especially for Belgium, Greece, Ireland, Portugal and Spain.

Figure 4.5 Real effective exchange rate



4.4 Empirical frame work and results

The overall state of macro-fundamentals is approximated by the real exchange rate. Empirical evidence generally is generally supportive of PPP’s validity in the long-run among European countries, suggesting that European real exchange rates are stationary (Arghyrou and Tsoukalas 2011). In accordance with literature on currency crises and many theoretical models of international economics, this assumption implicitly acknowledges that purchasing power parity (PPP) holds as a long-run equilibrium condition. Given that PPP is eventually mean-reverting, the movements of real exchange rate represent deviations from the economy’s steady-state equilibrium. Under PPP’s validity, real exchange rate offers quantitative measure of the size of macroeconomic imbalances. In addition we added the volatility of stock market index to capture the macro environment. We also added the lagged spreads to account for spread persistence (see Gerlach, Schulz et al. (2010) Attinasi, Checherita et al. (2009)). Overall, our baseline model is an extension of Arghyrou and Tsoukalas (2011)’s model by:

$$Spread_{it} = \alpha + \beta_1 DREX_{it} + \beta_2 VOLIND_{it-1} + \beta_3 Spread_{it-1} + \beta_4 FL_{it} + e_{it} \qquad (4.1)$$

where Spread is 10-year government bond yield spread relative to Germany, REX is real exchange rate, DREX is the first difference of real exchange rate, VOLIND is the volatility of stock market return, FL is the financial liberalization index. We first started by estimating simple OLS. There are large and small countries, and it is likely to have the problem of hetroskedasticity. The potential hetroskedasticity may contaminate standard errors and create problems in inference. Also crisis simultaneously happened in the countries, the errors are likely to be correlated. We use cross-section SUR in our penal estimation which control for both heteroskedasiticiy and contemporaneous correlation. In addition consider the potential issue of endogeneity so we 2SLS to account for endogeneity. One may argue that combing SUR and 2SLS, one can use 3SLS system estimation, but we only interested in the one way relationship between spread and financial liberalization. We applied fixed effects to all panel estimations. As we have discussed in Chapter 2, a potential problem is that the use of a lagged dependent variable in a fixed-effect estimation may produce bias in the estimates because the unobserved regional effects could be correlated with it. Judson, R. A. and A. L. Owen (1999) show that, this would only be a problem if the time dimension 'T' is small relative to the cross-section dimension 'n'. They use Monte Carlo to evaluate several different techniques for estimating dynamic models with panel characteristic of many macroeconomic panel datasets. They conclude that macroeconomists should not dismiss the (least square dummy variable) LSDV bias as insignificant. Even with a time dimension as large as 30, they find that the bias may be equal to as much as 20% of the true value of the coefficient of interest. However, using a root-mean-square error (RMSE) criterion, the LSDV performs just as well or better than many alternatives when T=30. With a smaller time dimension, LSDV does not dominate the alternatives. In our sample, we have a large time dimension (T>30), and also it is much larger relative to the cross-section dimension, which justifies our choice of using the fixed effect model. Arghyrou, M. G. and A. Kontonikas (2012) also use a dynamic panel fixed effect model in their study.

Many literatures in financial liberalization have used the 2SLS estimator in their studies. Chinn and Ito (2002) estimate from 2SLS with instrumental variables of regional dummies, lagged government budget surplus and current account balance, and suggest that the rate of financial development is linked to the capital controls liberalization. Ito (2006) uses 2SLS instrumenting the capital account opening index and find that trade openness is found to be a prerequisite for successful inducement of financial development via capital account liberalization. Cubillas and González (2014) use the 2SLS approach to separate different effects of financial liberalization. They find that financial liberalization increases bank risk-taking in both developed and developing countries but through different channels. Some financial liberalization literatures also use SUR estimation. Bekaert et al. (2005) report both OLS and SUR standard errors in their study. They find that in some cases the SUR estimates are close to the OLS estimates, although SUR standard errors are generally smaller than the OLS standard errors, because of the heteroskedasticity adjustment. They show that equity market liberalizations, on average, lead to a 1% increase in annual real economic growth. Bekaert and Harvey et al. (2006) also use SUR estimation that allows residual correlation across countries. They show that financial liberalization is mostly associated with lower consumption growth volatility, and it is also associated with declines in the ratio of consumption growth volatility to GDP growth volatility.

Table 4.1 shows the result of panel estimation. The regression model is estimated over the time period 2000 to 2013. Result shows that spreads are persistent. The estimates of the autoregressive parameter of spreads are highly significant. Arghyrou and Kontonikas (2012) finds the real exchange rates is either insignificant or significant with a negative sign for pre-crisis period, and it is positive and significant for the crisis period. Volatility of stock market picks up new information. When information comes in the market, market price reacts to that information. More frequent changing of information, either good or bad will increase the volatility. Our result suggest that new information such as government policies aim to resolving crisis (reducing spread) also increase the volatility of stock market return. Therefore the volatility of market return is significant and carries a negative sign.

The main interest of this chapter however, is examine whether a high degree of financial liberalization in the developed countries contribute to the financial crisis. Result in Table 4.1 shows that financial liberalization index on its own is not significant, which suggests that there is no contemporaneous relationship between financial liberalization and financial crisis. Our hypothesis is that is contemporaneous liberalization does not have effect on financial crisis, but it takes time for it to work its way through the system. We now examine whether financial liberalization in the past explain the current crisis.

We use an approach similar to King and Levine (1993), where they conducted a study using data averaged over the 1960s, 1970s, and 1980s. Here we take the average of the financial liberalization index over the 1970s, 1980s, 1990s and 2000s across countries, and denote them as FL70, FL80, FL90 and FL00. The financial liberalization FL in the baseline model is now replaced by these averages across countries in the past four decades. We also construct a interacted dummy variable D=1 for the year 2006 to 2013 as it is shown in equation 4.2. Results are presented in Table 4.2 to Table 4.5 in the Appendix.

$$Spread_{it} = \alpha + \beta_1 DREX_{it} + \beta_2 VOLIND_{it-1} + \beta_3 Spread_{it-1} + \beta_4 D * FL_i + e_{it} \qquad (4.2)$$

The results for the macro variables are consistent in Table 4.2, 4.3, 4.4 and 4.5. We observe a persistent spread as the coefficient of lagged spread is positive and significant. The coefficient of the change in the real exchange rate DREX is negative. It is significant at 5% significance level using the OLS estimator, and it is at 10% significance level with the SUR adjusted error. However the estimate is positive but insignificant using the 2SLS estimator. The coefficient of the volatility of stock market return VOLIND is negative and significant at

5% significance level with the OLS and the 2SLS estimator. It is also significant at 10% significant level with the SUR adjusted error. These results are also consistent with the result from Equation 4.1 in Table 4.1. Table 4.2 shows that the OLS estimate of the coefficient of FL70 is insignificant. However after control for heteroskesdasicity and contemporaneous correlation, the result of the SUR estimate shows the coefficient of FL70 is positive and significant at 5% significance level. We also use 2SLS to account for endogeneity. The result shows that the coefficient of FL70 is positive and significant at 10% significance level. Table 4.3 shows the result of the FL80 index, which is very similar to Table 4.2 with the FL70 index. Table 4.4 and Table 4.5 show that both the estimates of the coefficient of FL90 and FL00 are positive and significant with the OLS, 2SLS and SUR estimation. When comparing the coefficient of the FL index from Table 4.2 to Table 4.5, we find that the level of significance increases as time comes near to the recent decade (crisis period).

Figure 4.1 in the previous section shows the financial liberalization index by country groups, where the curve at the top represents the advanced economies. From the scale of 0 to 21, the average value of the liberalization over advance economies in the year 1970, 1980, 1990 and 2000 are 7.57, 9.59, 15.32 and 19.48 respectively. Most aggressive financial liberalization has finished during the 80s and early 90s. Although financial liberalization might have induced growth in the advanced economies, a fully financial liberalized economy may lead to crisis. Our result suggests that if the financial liberalization was maintained at a level below 10 (pre 80s level), it could have prevented financial crisis, or at least reduced the severity of financial crisis.

Demirgüç-Kunt and Detragiache (1998) investigate the empirical relationship between banking crises and the financial liberalization using data from 1980-95 for 53 countries. Their findings suggest that banking crises are more likely to occur in liberalized financial systems. However, the indicator of financial liberalization of Demirgüç-Kunt and Detragiache (1998) can be criticized as they took the first year in which some interest rates were liberalized as the start date of financial liberalization. Though interest rate liberalization is important, it is quite a narrow definition of financial liberalization, covering only a minor part of the financial sector reform. Kaminsky and Reinhart (1999) analyse 76 currency crises and 26 banking crises for 20 countries during 1970 to 1995. One of their main findings is that financial liberalization often precedes banking crises. Their indicator for financial liberalization is two-year lagged domestic credit growth. Caprio and Martinez (2000) investigate the relationship between government ownership of banks and banking crisis using panel data. They find that government ownership of banks increases the likelihood of banking crisis. However, Barth et al. (2004) using cross-country analysis, do not find that government ownership is significantly associated with increases in bank fragility once they control for the regulatory and supervisory environment. Our data on financial liberalization come from IMF which is an index constructed using 7 different dimensions. They are credit controls and excessively high reserve requirement, interest rate controls, entry barriers, state ownership in the banking sector, financial account restriction, prudential regulations and supervision of the banking sector, and securities market policy. The database has the advantage that it allows for policy reversals.

Our result shows that there is no contemporaneous relationship between financial liberalization and crisis; rather, the past liberalization has influence on present crisis. We suggest that financial liberalization may not have immediate impact on financial fragility, but our evidence shows that financial liberalization takes time to build up its effect. It might have increased the financial instability and is maybe one of the factors contributing to the financial crisis.

4.5 Conclusion

In this chapter we offered an empirical investigation whether financial liberalization plays a role in explaining the crisis since 2007, which includes the financial crisis from 2007 to 2008 and the European sovereign debt crisis since 2010. We use fixed effect panel estimation for 12 developed countries over the time period 2000 to 2013.

The measure of financial liberalization is an index constructed using 7 different dimensions. They are credit controls and excessively high reserve requirement, interest rate controls, entry barriers, state ownership in the banking sector, financial account restriction, prudential regulations and supervision of the banking sector, and securities market policy. Our proxy for crisis is the 10-year government bond yield spread relative to Germany.

Our evidence suggests that financial liberalization does play a role in explaining the current crisis. However there is no contemporaneous relationship between financial liberalization and crisis, rather, the past liberalization has influence on present crisis. Although it is generally established a positive link between financial liberalization and economic growth, we argue that a fully financial liberalized banking system might not be the best option for developed economies because it is prone to crisis. However we don’t mean the deregulation process should be reverse. We argue that after the deregulation, a different type of reregulation is needed to monitor the activities of the banks.

The deepening crisis in 2008 and 2009 has already led to some reregulation around the world. Basel III was developed in response to the deficiencies in financial regulation revealed by the financial crisis of 2007–08. It was agreed upon by the members of the Basel Committee on Banking Supervision in 2010–11, and was scheduled to be introduced from 2013 until 2015; however, changes from 1 April 2013 extended implementation until 31 March 2018 and again extended to 31 March 2019. Basel III is intended to strengthen bank capital requirements by increasing bank liquidity and decreasing bank leverage. It increases the required capital for banks in the form of risk-weighted asset form 2.5% to 7%. The bank leverage is designed to limit the size of banks' balance sheet compare to its capital. The liquidity requirement compels banks to have sufficient liquidity available during 30 days of stressed conditions.

Ever since the Northern Rock Bank failed in September 2007, the UK financial regulatory authorities have looked at how they operate and whether changes were needed to the existing system. New legislation in the form of the Financial Services Act 2012 has been passed. This established the new regulatory framework for the financial services industry. In parallel with the passage of that legislation was the publication of the Report of the Independent Commission on Banking headed by Sir John Vickers. The Vickers Commission proposed a fundamental change in the way that banks in the UK are organised. The main change is that a 'ring fence' would separate retail 'utility ' banking work from a range of investment banking and corporate finance activities. It also proposes that banks retain higher capital and loss absorbing reserves than is currently proposed under the Basel rules. The Government has accepted the Commission's main proposals. Many of the recommendations of Vickers and of the Parliamentary Commission on banking standards were given effect by provisions in the Financial Services (Banking Reform) Act 2013.

There have been many debates about whether deregulation should be followed up by reregulation. Our study find that past financial liberalization is one of the factors contributed to the financial crisis. Financial liberalization is dismantling rules. That has led to excessive risk taking, and that excess risk taking led to greater financial fragility. Policy makers should take necessary actions to prevent crisis in the future. Banks play a particular important role in the financial system and problems in the banking sector have been an important factor promoting financial crisis. To prevent financial crisis, governments need to pay particular attention to creating and sustaining a strong bank regulatory and supervisory system to reduce excessive risk-taking in their financial system. Consider limiting too-big-to-fail. Too-big-to-fail reduces market discipline on large financial institutions and thus increases their moral hazard incentives to take on excessive risk. Also some level of capital controls should be considered to reduce financial instability.

Appendix

Table 4.1

Variable	Coefficient	Std. Error	t-Statistic	P-value
	OLS			
C	-0.9445	0.9454	-0.9990	0.3179
$DREX_{it}$	-4.1296	1.5939	-2.5908	0.0096
$VOLIND_{it-1}$	-1.1307	0.5059	-2.2351	0.0255
$SPREAD_{it-1}$	0.9637	0.0062	156.3234	0.0000
FL_{it}	0.0531	0.0478	1.1117	0.2664
Adj-R_2	0.9394			
	SUR			
C	-0.9445	1.1979	-0.7884	0.4305
$DREX_{it}$	-4.1296	2.2758	-1.8145	0.0697
$VOLIND_{it-1}$	-1.1307	0.6228	-1.8157	0.0696
$SPREAD_{it-1}$	0.9637	0.0184	52.3326	0.0000
FL_{it}	0.0531	0.0607	0.8750	0.3817
Adj-R_2	0.9394			
	2SLS			
C	-0.9582	0.9753	-0.9824	0.3260
$DREX_{it}$	13.3135	8.5926	1.5494	0.1214
$VOLIND_{it-1}$	-1.4136	0.5309	-2.6626	0.0078
$SPREAD_{it-1}$	0.9731	0.0069	141.2749	0.0000
FL_{it}	0.0538	0.0493	1.0906	0.2756
Adj-R_2	0.9358			

Regression models are estimated over the time period 2000m1 to 2013m12. The panel members include Austria, Belgium, Spain, Finland, France, Greece, Ireland, Italy, Netherlands, Portugal, Canada and USA. Dependent variable is 10-year government bond yield spread relative to Germany. REX is real exchange rate. DREX is the change is real exchange rate. VOLIND is volatility stock market return. FL is financial liberalization index. SUR denote fixed effects panel estimation with Seemingly Unrelated Regression which control for heteroskedasticity and contemporaneous correlation. 2SLS denote two-stage least squares fixed effects panel estimates which account for endogeneity. The instruments used in the 2SLS estimations are the lagged values of the independent variables.

Table 4.2

Variable	Coefficient	Std. Error	t-Statistic	P-value
	OLS			
C	0.0963	0.0367	2.6194	0.0089
$DREX_{it}$	-4.1365	1.6903	-2.4472	0.0145
$VOLIND_{it-1}$	-1.2473	0.5525	-2.2577	0.0241
$SPREAD_{it-1}$	0.9632	0.0065	148.7141	0.0000
$D*FL70_{it}$	0.0050	0.0036	1.4159	0.1570
$Adj\text{-}R_2$	0.9391			
	SUR			
C	0.0963	0.0460	2.0920	0.0366
$DREX_{it}$	-4.1365	2.3320	-1.7738	0.0763
$VOLIND_{it-1}$	-1.2473	0.6687	-1.8651	0.0623
$SPREAD_{it-1}$	0.9632	0.0186	51.7347	0.0000
$D*FL70_{it}$	0.0050	0.0023	2.2249	0.0262
$Adj\text{-}R_2$	0.9391			
	2SLS			
C	0.0892	0.0382	2.3349	0.0197
$DREX_{it}$	14.8508	9.3790	1.5834	0.1135
$VOLIND_{it-1}$	-1.5944	0.5864	-2.7192	0.0066
$SPREAD_{it-1}$	0.9724	0.0072	134.7934	0.0000
$D*FL70_{it}$	0.0069	0.0039	1.7934	0.0731
$Adj\text{-}R_2$	0.9349			

Regression models are estimated over the time period 2000m1 to 2013m12. The panel members include Austria, Belgium, Spain, Finland, France, Greece, Ireland, Italy, Netherlands, Portugal, Canada and USA. Dependent variable is 10-year government bond yield spread relative to Germany. REX is real exchange rate. DREX is the change is real exchange rate. VOLIND is volatility stock market return. FL70 is the average value of financial liberalization index over the 1970s. D is a dummy variable equals one for the year 2007 to 2013. SUR denote fixed effects panel estimation with Seemingly Unrelated Regression which control for heteroskedasticity and contemporaneous correlation. 2SLS denote two-stage least squares fixed effects panel estimates which account for endogeneity. The instruments used in the 2SLS estimations are the lagged values of the independent variables.

Table 4.3

Variable	Coefficient	Std. Error	t-Statistic	P-value
	OLS			
C	0.0929	0.0371	2.5049	0.0123
$DREX_{it}$	-4.1243	1.6900	-2.4405	0.0148
$VOLIND_{it-1}$	-1.2403	0.5521	-2.2465	0.0248
$SPREAD_{it-1}$	0.9628	0.0065	148.0555	0.0000
$D*FL80_{it}$	0.0042	0.0027	1.5699	0.1166
$Adj\text{-}R_2$	0.9392			
	SUR			
C	0.0929	0.0464	2.0006	0.0456
$DREX_{it}$	-4.1243	2.3305	-1.7697	0.0769
$VOLIND_{it-1}$	-1.2403	0.6685	-1.8554	0.0637
$SPREAD_{it-1}$	0.9628	0.0187	51.4945	0.0000
$D*FL80_{it}$	0.0042	0.0019	2.2557	0.0242
$Adj\text{-}R_2$	0.9392			
	2SLS			
C	0.0858	0.0386	2.2247	0.0262
$DREX_{it}$	14.8838	9.3716	1.5882	0.1124
$VOLIND_{it-1}$	-1.5833	0.5855	-2.7040	0.0069
$SPREAD_{it-1}$	0.9720	0.0072	134.3935	0.0000
$D*FL80_{it}$	0.0055	0.0029	1.9072	0.0567
$Adj\text{-}R_2$	0.9349			

Regression models are estimated over the time period 2000m1 to 2013m12. The panel members include Austria, Belgium, Spain, Finland, France, Greece, Ireland, Italy, Netherlands, Portugal, Canada and USA. Dependent variable is 10-year government bond yield spread relative to Germany. REX is real exchange rate. DREX is the change is real exchange rate. VOLIND is volatility stock market return. FL80 is the average value of financial liberalization index over the 1980s. D is a dummy variable equals one for the year 2007 to 2013. SUR denote fixed effects panel estimation with Seemingly Unrelated Regression which control for heteroskedasticity and contemporaneous correlation. 2SLS denote two-stage least squares fixed effects panel estimates which account for endogeneity. The instruments used in the 2SLS estimations are the lagged values of the independent variables.

Table 4.4

Variable	Coefficient	Std. Error	t-Statistic	P-value
	OLS			
C	0.0829	0.0369	2.2467	0.0248
$DREX_{it}$	-4.0378	1.6888	-2.3910	0.0169
$VOLIND_{it-1}$	-1.2971	0.5525	-2.3475	0.0190
$SPREAD_{it-1}$	0.9606	0.0066	145.1898	0.0000
$D*FL90_{it}$	0.0045	0.0019	2.3593	0.0184
$Adj\text{-}R_2$	0.9393			
	SUR			
C	0.0829	0.0479	1.7324	0.0834
$DREX_{it}$	-4.0378	2.3266	-1.7355	0.0828
$VOLIND_{it-1}$	-1.2971	0.6638	-1.9542	0.0508
$SPREAD_{it-1}$	0.9606	0.0189	50.7076	0.0000
$D*FL90_{it}$	0.0045	0.0019	2.3438	0.0192
$Adj\text{-}R_2$	0.9393			
	2SLS			
C	0.0765	0.0384	1.9905	0.0467
$DREX_{it}$	15.2156	9.3747	1.6231	0.1048
$VOLIND_{it-1}$	-1.6500	0.5877	-2.8076	0.0050
$SPREAD_{it-1}$	0.9696	0.0073	132.4360	0.0000
$D*FL90_{it}$	0.0053	0.0021	2.5896	0.0097
$Adj\text{-}R_2$	0.9349			

Regression models are estimated over the time period 2000m1 to 2013m12. The panel members include Austria, Belgium, Spain, Finland, France, Greece, Ireland, Italy, Netherlands, Portugal, Canada and USA. Dependent variable is 10-year government bond yield spread relative to Germany. REX is real exchange rate. DREX is the change is real exchange rate. VOLIND is volatility stock market return. FL90 is the average value of financial liberalization index over the 1990s. D is a dummy variable equals one for the year 2007 to 2013. SUR denote fixed effects panel estimation with Seemingly Unrelated Regression which control for heteroskedasticity and contemporaneous correlation. 2SLS denote two-stage least squares fixed effects panel estimates which account for endogeneity. The instruments used in the 2SLS estimations are the lagged values of the independent variables.

Table 4.5

Variable	Coefficient	Std. Error	t-Statistic	P-value
	OLS			
C	0.0811	0.0368	2.2031	0.0277
$DREX_{it}$	-4.0228	1.6883	-2.3827	0.0173
$VOLIND_{it-1}$	-1.3142	0.5527	-2.3778	0.0175
$SPREAD_{it-1}$	0.9600	0.0066	144.4677	0.0000
$D*FL00_{it}$	0.0044	0.0017	2.5320	0.0114
$Adj\text{-}R_2$	0.9393			
	SUR			
C	0.0811	0.0483	1.6797	0.0932
$DREX_{it}$	-4.0228	2.3258	-1.7296	0.0839
$VOLIND_{it-1}$	-1.3142	0.6625	-1.9837	0.0474
$SPREAD_{it-1}$	0.9600	0.0190	50.5427	0.0000
$D*FL00_{it}$	0.0044	0.0019	2.3308	0.0199
$Adj\text{-}R_2$	0.9393			
	2SLS			
C	0.0751	0.0383	1.9582	0.0504
$DREX_{it}$	15.2515	9.3684	1.6280	0.1037
$VOLIND_{it-1}$	-1.6683	0.5881	-2.8366	0.0046
$SPREAD_{it-1}$	0.9690	0.0073	131.8716	0.0000
$D*FL00_{it}$	0.0052	0.0019	2.7309	0.0064
$Adj\text{-}R_2$	0.9349			

Regression models are estimated over the time period 2000m1 to 2013m12. The panel members include Austria, Belgium, Spain, Finland, France, Greece, Ireland, Italy, Netherlands, Portugal, Canada and USA. Dependent variable is 10-year government bond yield spread relative to Germany. REX is real exchange rate. DREX is the change is real exchange rate. VOLIND is volatility stock market return. FL00 is the average value of financial liberalization index over the 2000s. D is a dummy variable equals one for the year 2007 to 2013. SUR denote fixed effects panel estimation with Seemingly Unrelated Regression which control for heteroskedasticity and contemporaneous correlation. 2SLS denote two-stage least squares fixed effects panel estimates which account for endogeneity. The instruments used in the 2SLS estimations are the lagged values of the independent variables.

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Chapter 5 Conclusion

The topic of CEO compensation, performance and risk has attracted considerable public and academic attention. Agency theory says the problem arises from the conflicts of interest existing between shareholders and executives. Researchers have been looking for evidence whether there is a strong link between CEO compensation and firm performance. In Chapter one, we explore this relationship in the banking industry because there are increasing criticism from the public that bankers are often taking huge amount of compensation and rewards despite poor performances and excessive risk taking, which even led to failure of banks that ended up being bailed out by the tax payer. Another strand of the literature attempts to quantify and explain risk taking behaviour at commercial banks. Incentive payment are designed to increase the CEO's risk-taking incentives, so that executives might not reject the variance-increasing positive net present value (NPV) projects, and adopt low risk-return strategies. Thus it can align the interest between executives and shareholders. However it is also criticized that the incentive payment encourages the banks to take excessive risk, which is considered contributes to the financial crisis.

We explore the link between the CEO compensation and performance, and also the link between CEO compensation and risk using fixed-effect panel estimation. In addition, we put these two relationships together and understand it in a systematic way. We specified 4 equations and estimate it in a system using 3SLS system estimation. This system estimation method also account for endogeneity. We use a two-factor market model from the literature, which allow us to decompose total risks into idiosyncratic (firm) risk and systematic (market) risk. Together with Beta, we employed 4 different measures of risks in our study. Research has been conducting their research in this area using US sample data due to data availability. We contribute to the existing literature by using European sample banks including UK. Our sample consists of 63 banks across 15 countries for the time period 1992 to 2010. There is no “click and download” data base for CEO compensation of European banks. The data was hand collected from annual reports. Enormous effort was made to compile the data.

Our evidence supports a positive link between CEO compensation and performance. However this relationship is mainly attributed to bonus and performance. The relationship between salary and performance is not as strong. We also find bank size, market to book ratio and CEO tenure have positive effect on CEO salary. We find a negative relationship between CEO bonus and risk. This evidence is strong because the relationship is shown to be negative for all the 4 risk measures. We also examine the stability of our solution by looking at the dynamic properties of the system. We solve for the system and proved that our solution is stable. We also programmed a simulation using estimated parameters, and provide a steady-state solution. We argued that there may not be a behavioural relationship between risk and bonus. Potential positive movement of risk and bonus might be caused by other factors. Our results challenge the conventional view that bonus can induce risk taking.

In the second study we reconsider the market efficiency hypothesis (forward rate unbiasedness) and the forward premium puzzle. Market efficiency hypothesis implies the rejection of the joint hypothesis of zero intercept and slope of unity in the regression of spot exchange rate on forward exchange rate. The presence of the forward premium puzzle shows a negative slope coefficient in the regression of the spot rate return on forward premium. We conduct an extensive investigation using daily exchange rate and forward rate from 1990 to 2013. Our sample contains 31 economies, of which 11 are developed economies and 20 are emerging economies. Our selection of countries cover whether it’s a liquid or less liquid market, strict capital controlled or open free market, large or small economies, developed or developing economies. We aim to find a whether there is a common theme in these wide selection countries.

The main contribution of this study is that we look at this problem in different time horizons. The previous literature only studies this subject using one time horizon; often 1 month or 3 months. . In this study, we obtained forward rates cover 9 time horizons: 1 day, 1week, 1 month, 2 months, 3 months, 6 months, 9 months, 1 year and 2 years. This allows us to examine the problem vertically by comparing different countries, and also horizontally by comparing different time horizons. We thoroughly examine the data in both levels and first differences. We look at the mean and variance of the spot and forward rate, spot rate return, forward premium and also their movement in different time horizon. We use the ADF unit root test to test the stationarity of the spot rate, forward rate, spot rate return and forward premium for each economy. We use the FMOLS and DOLS estimator which eliminate the problems caused by the long run correlation between the cointegrating equation and stochastic regressors innovations.

We find that the variance of spot return is much greater than the variance of forward premium. The variances of the spot return and forward premium increases in longer time horizons. The ratio of the spot return to forward premium variance decreases when the time horizon becomes longer, implying the variance of the forward premium increase at a larger scale compared to the variance of the spot return. Comparing developed economies with emerging economies, we find the exchange rates changes are more volatile in the emerging economies, and also there is greater dispersion in the exchange rate volatility of emerging economies. Our main result suggests that the forward rate unbiasedness holds in the short horizon but not in the longer horizon. The forward rate started to lose its predictive power when the time to maturity is longer than a month. We still find a forward premium puzzle in both short horizons and long horizons, and it does not seem to disappear over the long horizon. When comparing the emerging economies with developed economies, we find that the prediction bias is worse in emerging economies because of their less liquidity and higher risk premium. We argue that exchange rate is similar to the liquidity of the term structure of interest rates. The prediction bias in longer time horizon is due to the inability of measuring the increasing risk premium.

Lastly we study the financial liberalization and the recent financial crisis. We empirically examine whether financial liberalization has a role in explaining crisis. Most existing literature use 0-1 dummies to capture both financial liberalization and financial crisis. The drawback of 0-1 dummy is that it cannot capture the severity of the crisis and the degree of financial liberalization. We use a financial liberalization measure from the IMF, which is an index range from 0 to 21 constructed using 7 different dimensions. They are credit controls and excessively high reserve requirement, interest rate controls, entry barriers, state ownership in the banking sector, financial account restriction, prudential regulations and supervision of the banking sector, and securities market policy. Our proxy for crisis is the 10-year government bond yield spread relative to Germany, because bond yield increase sharply in most of the EMU countries since crisis happened in 2007 except Germany. The existing literature has been using dummy variable. We contribute to the literature by using a new index for financial liberalization and proxy for financial crisis.

Our evidence suggests that there is no contemporaneous relationship between financial liberalization and the recent crisis, but the past liberalization has influence on present crisis. Although it is believed that financial liberalization can spur economic growth, we argue that a fully financial liberalized banking system might not be the best option for developed economies because it makes them vulnerable to crisis. We suggest re-regulation is needed after deregulation.