Studies in International Finance and Corporate Remuneration

by

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Abstract

This thesis makes four different contributions to the literature on international finance and corporate governance. Firstly, it examines the forward exchange rate bias and the forward premium puzzle, using weekly and daily data from thirty-one developed and emerging economies during 1999-2010. The forward-spot relationship is analysed through both a time series and a panel construction. Secondly, it empirically investigates the relationship between the exchange rate and the term structure of interest rates, as proposed by Lim and Ogaki (e.g. Fama 1984; Lim and Ogaki 2004), using data from sixteen emerging economies during 1993-2011. Thirdly, it examines the impact of the term structure of the interest rates on security risk in G7 countries and it tests the stability of this relation during pre- and post-financial crisis periods. Fourthly, this dissertation explores the link between a director's pay and corporate performance using a panel data set of FTSE 350 companies during 2004-2009.

The empirical results demonstrate a robust cointegrating forward-spot relationship and support the forward rate unbiasedness with high frequency data; however, the forward premium puzzle remains in most sample economies. The term structure of interest rates plays an important role in exchange rate determination and the cointegrating relationship is stable despite the presence of a number of exchange rate regime changes for the emerging economies. In this study the short rate is considered as a proxy for economic uncertainty and the yield spread is considered as a proxy for business condition. The findings show statistically significant effects of the short rate and yield spread on the security risk for G7 economies, implying that interest rate policy may be important in reducing market volatility. Lastly, positive and significant relationships are identified between corporate performance and a directors' pay in both levels and first difference regression specifications, and through both directions. However, this link has broken down since recent financial crisis.

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Chapter 1 **Introduction**

1.1. Background and the Motivations for this Research

Over the past twenty years the question of how to test the predictive power of forward exchange rates and the forecast ability of term structure of interest rates on future exchange rates in the exchange market has been of considerable interest to many people in academia, governments, and the financial industry. The forward rate is expected to forecast the future exchange rate in both levels and returns. Previous empirical studies have found with regard to the forward-spot relation in levels that there is consistent evidence showing that the forward rates are biasd in forecasting the corresponding future spot exchange rates. Moreover, for the same relation in returns, negative relations are often found in empricial research between the forward premium and the depreciation of the exchange rates.

The efficient markets hypothesis plays an important role in understanding the forward-spot relation. It states that if the foreign exchange market is competitive and frictionless without taxes, transaction costs, or other costs, that the investors are rational and risk neutral, and all information is fairly available, then the expected returns will be zero, which means that no speculations will have taken place. Thus, under this efficient market hypothesis, the forward exchange rate should be an unbiased predictor of the corresponding future spot exchange rate because it contains all of the information about the expected future exchange rate, as Lin (1999), Lin et al. (2002), and others have pointed out. Frenkel (1976) examines this forward-spot relation through regression $\ln S_{t+k} = \kappa + \gamma \ln F_t + u_{t+k}$ and obtains results with γ close to one. However, Tauchen (2001) demonstrates that this unbiased hypothesis is rejected much more emphatically recently than that in earlier works and suggests that this might be because of the limitations in the econometric and statistical methodologies that were used in prior studies. It has been proved by previous research that the forward rate bias in the foreign exchange markets persists, especially in the 1980s and the 1990s. Hence, it is interesting in this study to see if it is still present in the last two decades while the foreign market has become much more open. It is also interesting to analyse whether the improved econometric and statistical procedures could help to solve the bias in this forward-spot relation.

The forward premium puzzle, on the other hand, refers to the negative relationship between the forward rate and the corresponding future exchange rate in returns. Fama (1984) shows that, although the forward rate seems to be a reasonable predictor of future spot exchange rate, it somehow fails to forecast the exchange rate returns. Engel (1996) supports Fama's findings and points out that it has been difficult to reconcile the forward premium puzzle with economic theory. Numerous economic studies have paid attention to this puzzle and they have tried to explain it rationally. One of the famous interpretations for this empirical presence of the negative coefficient in forward-spot regression in returns is that there is a time-varying risk premium. Besides this most natural explanation, there are also some other alternative interpretations for this forward premium puzzle that takes into account of peso problems, irrational economic agents, segmented markets and trading frictions. However, as argued by Hodick (1987) and Engel (1996), none of these interpretations have been fully accepted. Therefore, the forward premium anomaly has become one of the most considerable unsolved puzzles in economics and it has prompted a number of studies, such as those of Macklem (1991), Backus et al. (1996) and Bekaert et al. (1997), that have constructed economic models to capture the characteristic of this empirically negative relation between forward rate and future exchange rate in returns. Some alternative studies view this puzzle mainly as a statistical phenomenon and they have also argued that the relative small sample size in the previous studies meant that they could not produce convincing conclusions. Hence, it is worthwhile in this study to figure out whether the forward rates continues to be a biased forecast of the future spot rates in both levels and returns with a relatively large sample size, as well as with improved econometric methods and statistical procedures.

Interest rate parity also introduces a relationship between exchange rate and interest rates in the domestic and foreign markets. Dornbusch (1976) suggests that a rise in the interest rate leads to domestic currency appreciation by developing a theory of exchange rate movements under perfect capital mobility. The relationship between exchange rate and interest rates has since been analysed in many studies. For example, Isard (1995) and many other studies show that the uncovered interest parity under risk neutrality is rejected with short-horizon data. However, Meredith and Chinn (1998) find the stylised fact that the forward premium anomaly seems not exist in long-horizon data. There are also many other empirical studies which show evidence that the uncovered interest parity holds much better in the long-run. For example, Edison and Pauls (1993) provide cointegration results suggesting that long-term interest rate differentials play a more important role than the short-term interest rate differentials in the real exchange rate determination, especially in the long-run. Hence, it is natural to analyse the impact of the term structure of interest rates in the exchange rate determination. Byeon and Ogaki (1999) use Canonical Cointegrating Regression (CCR) to study the relationship between exchange rate and the term structure of interest rates for several developed economies. Their study showed statistically significant but opposite effects of the short-term interest differential and the long-term interest rate differential on the real exchange rate.

Lim and Ogaki (2004) later constructed an economic model that is consistent with the short-run and long-run stylised facts, and which helps to explain the forward premium anomaly. The idea behind their model is the concept of indirect complementarity due to the structure of interest risk under the assumption of risk aversion. Specifically, when the domestic short-term interest rate increases, investors with a short-term investment horizon holding long-term bonds suffer a capital loss. Meanwhile, investors with foreign bonds also face a capital loss as a result of domestic currency appreciation. Hence, as long as the domestic currency appreciation is associated with an increase in the domestic short-term interest rate the investors will try to avoid holding both domestic long-term and foreign bonds, which makes these two assets strong substitutes. In addition, it is well known that domestic short-term and long-term bonds are also strong substitutes, and a substitute of a substitute is an indirect complement. Thus, the domestic short-term bonds and the foreign bond can be considered as indirect complements. In their research, Lim and Ogaki (2004) show that when the direct substitutability between the short-term bonds and the foreign bonds dominates the indirect complementarity then the relationship between the exchange rate and the interest rate differentials is consistent with conventional wisdom. However, if the indirect complementarity dominates the direct substitutability then this relationship will become at odds. Most emerging economies have changed their exchange rate regimes since the 1990s and, consequently, the behaviour of the interest rates might not be consistent. Therefore, the term structure of interest rates has become another main focus when analysing the determination of the exchange rate. Additionally, the empirical evidence is rather limited for emerging economies in this area; hence, it is interesting to examine the relationship between exchange rate and the term structure of interest rates, especially for emerging market.

The term structure of interest rates is not only important in exchange rate determination but also plays a significant role in forecasting stock and bond returns. Campbell (1987) states that the term structure of interest rates predicts stock returns and shows the importance of the nominal interest rates uncertainty in pricing both short-term and long-term assets. Campbell and Shiller (1991a) find evidence to show that the long rate tends to fall and the short rate tends to rise when the yield spread between the long- and short-term interest rates is relatively high. Cochrane and Piazzesi (2005) demonstrates that a return-forecasting factor (i.e. a tent-shaped combination of forward rates) is countercyclical and could help to predict stock returns.

Standard asset pricing models state that the expected excess return on an asset can be expressed as the product of the asset's systematic risk and the price of the risk in equilibrium. Fama and French (1989a) produce evidence to show that common components exist in the time variation of bond and stock expected returns. Campbell and Cochrane (1999) establish consumption based models using external habit information and suggest that the time variation in the expected excess returns on bond is partially explained by a time-varying aggregate price of risk. More recently, Wachter (2006) emphasises that there is a positive forecasting relation between the yield spread and future excess returns of bonds which is generated by the external habit preferences. Hence, it is natural to ask whether the bond risk is also time-varying and if this time variation can be interpreted by the short-term interest rates and yield spread. Viceira (2007b) provides a similar analysis on bond risk, but only for the US bond market. It is interesting to extend this study by investigating the relationship between bond risk and the nominal term structure of interest rates for other countries in the G7, as well as under panel construction.

In order to measure the bond and stock risk the realised second moments of bond returns are taken into consideration; this measure has been used in various studies, such as those by Barsky (1989), Shiller and Beltratti (1992), and Campbell and Ammer (1993b). More recently, Anderson et al. (2003) point out that the use of realised volatility constructed from high-frequency intraday returns permits the use of traditional time series procedures for modelling and forecasting. Barndorff-Nielsen and Shephard (2004) theoretically discuss the foundation for the application of the realised second moments in modelling these dynamics. They have also empirically examined the relationship between the time variation in the second moments of bond returns and the time variation in the term structure of interest rates. Boyd et al. (2005) study the unconditional co-movement of bond and stock returns by looking at the realised covariance of bond returns with stock returns, as well as the realised bond CAPM beta, and they provide evidence that a business cycle component exists in the variation of the second moments of stock returns. This research project intends to study how the term structure of interest rates forecasts the bond risk, which is measured as the realized covariance of bond returns with stock returns, as well as the bond CAPM beta, and it extends Viceira's (2007b) work to G7 economies and econometrically improves it by applying panel construction into the analysis.

Lastly, this study also examines the relationship between executive compensation and a firm's performance because this is another hot research topic that currently attracts worldwide attention and media interest. For example, in the US a CNN Money report with the title *"CEO pay: Sky high gets even higher"* showed that the average pay ratio of CEO-to-worker leaps from year to year. Bebchuk and Grinstein (2005) point out that according to the research of Harvard University on pay of the top five executives across a large set of public companies the earnings of those executives amounted to approximately 10% of their companies' earnings during 2001 to 2003, which was almost double of what was during the period of 1993 to 1995. In the U.K., the generous executive pay package and its increase has led to growing public anger in the past two decades. The average pay ratio of CEO-to-employee has increased from 47-to-1 to 128-to-1 over a decade, whereas management guru Peter Drucker proposed that this ratio should be no larger than 20-to-1 in the U.K. However, in comparison to the U.S. empirical studies on directors' remuneration and firm performance were rather limited in the U.K. until the 1990s, when several important reports were produced (e.g. Cadbury, 1992; Greenbury, 1995; and Hampel, 1998). All of these reports play an important part in the disclosure of directors' remuneration, and since their publication, research on executive compensation has started to become easier and it has attracted considerable attention.

Empirically, Conyon (1997) takes a sample of top director remuneration packages within 213 large U.K. companies, recorded from 1988 to 1993, in order to estimate the innovations of corporate governance, and finds a positive relationship between director remuneration and shareholder return. Conyon and Murphy (2000) investigate CEO pay and incentives for both U.S. and U.K. firms. Gregg et al. (2005) find an asymmetric relationship between executive cash compensation and corporate performance with relatively high and low corporate returns, and suggest that overall there is weak relationship between pay and performance. Additionally, Ozkan (2007) uses a hand-collected data set of 390 non-financial companies and identified a significantly positive relation between corporate performance and CEO cash compensation; however, there was an insignificant relation for CEO total pay. Meanwhile, Girma et al. (2007) report that there is weak link between CEO compensation and performance for U.K. firms over the period 1981-1996. From these previous studies one could observe that the evidence relating directors' remuneration and corporate performance in the U.K. is mixed. This is a motivation in this study to reconsider this pay-performance relationship for the large U.K. companies, where the focus will not only be on CEO pay but also on the pay of the highest paid director and of the total board. Meanwhile, it is also interesting to see if the firm's performance, on the other hand, has a significant effect on determining the directors' compensation packages.

1.2. Objectives of this Study

The context of this study is embedded in a large volume of literature analysing the exchange rates, term structure of interest rates, as well as security risk and corporate finance on executive compensation. This study contributes to the literature by conducting four empirical investigations. The more specific objectives of this study are as follows:

i. To test the existence of both forward rate biasedness and forward premium puzzle in both developed and emerging markets. They are two of the most important anomalies in international finance and the empirical studies in this area were far from conclusive.

ii. To examine the relationship between the exchange rate and the term structure of interest rates for emerging economies. As previous studies focused mainly on developed economies, the evidence for emerging economies in this area was limited, especially for the last two decades during which many of the sample emerging economies had changed their exchange regimes.

iii. To find out whether the bond and stock risk is time-varying and explained by the short-term interest rates and yield spread, which are the variables correlated with the time variation in bond and stock excess returns, respectively. Once these relationships are identified, it could help the monetary authority to control the volatilities of the security market through interest rate policies.

iv. To analyse the effects of corporate performance on determining the directors' remuneration and also to evaluate the impact of the directors' pay on firm performance for large U.K. companies. This pay-performance relationship has attract considerable attention, expecially after the recent financial crisis when most of these large firms faced sharp decreases in their returns without the same significant changes taking place in their executives' pay packages. Hence, it is important and interesting to identify the positive pay-performance relationship and to examine the differences in this relationship before and after the recent crisis.

1.3. Outline and the Contributions of this Study

This study includes four main empirical analyses, which are to be found in Chapters 2 to 5. The organisation of this study, together with a brief description of the main contribution of each chapter, follows:

Chapter 2 studies the relationship between forward rate and the corresponding future exchange rate in both levels and returns. The predictive power of forward exchange rate has been one of the most considerable interests in international finance and economics. According to the efficient market hypothesis, as the forword rate contains relevant information about the expected future spot exchange rate, it should be an unbiased predictor of the corresponding future exchange rate. However, consistent empirical evidence has shown that not only the forward rate was biased in forecasting of the future exchange rate but also the forward premium was negatively correlated with the depreciation of the exchange rate. Since most of those empicial literatures were based on the information from 1980s and 1990s, it is interesting to see whether this is still the case in last decade when the foreign exchange market has become much more open and whether the improved econometric methodologies and statistic procedures could help to solve these puzzles. Chapter 2 improves the existing literature in several ways. Firstly, unlike previous works which test either for forward rate unbiasedness or forward premium anomaly, this study examines the forward-spot relation with regressions in both levels and returns using information from thirty-one economies. Secondly, most of the previous empirical wisdom regarding this relation is based on the evidence obtained from individual developed economy or a group of developed economies, such as the G7. Compared with developed economies, emerging economies have some different characteristics and they have been playing a more and more important role in the global currency market. Thus, in Chapter 2 the major emerging economies are included, and more individual developed economies are taken into account than that in previous studies. The evidence from an additional twenty individual emerging economies provides more valuable information in understanding the forward-spot relationship. Thirdly, it is usually argued that the existence of the forward premium puzzle might happen because of poor econometric and statistical techniques. In Chapter 2 a number of improved methodologies are applied to test for the forward-spot cointegration and to analyse the forward premium regressions. Lastly, the panel constructions are implemented respectively for the sample of the developed and emerging economies, which provides a more complete picture of forward rate unbiasedness and which gives additional evidence on the forward premium puzzle.

In Chapter 3, an empirical investigation on the relationship between the exchange rate and the term structure of interest rates is pursued for emerging markets. It focuses on emerging economies because they have significantly different characteristics compated to the developed economies and the empirical literature was rather limited. Meanwhile, many emerging coutries moved from their long-standing currency crawling pegs towards floating exchange rate regimes in the late 1990s, it is interesting to study this relationship between the exchange rate and the term structure of interest rates and check its consistency while the policy changes. Lim and Ogaki (2004) provide a theoretical model suggesting that the short term interest rate differential has an opposite effect from that of conventional wisdom when the indirect complementarity dominates the direct substitutability; however, their empirical evidence is mainly drawn from analyses of developed economies. Chapter 3 extends the previous literature by focusing on the effects of the three-month real interest rate differential and the normalised one-period interest rate differential on the real exchange rate in emerging economies. Moreover, the previous works have used different econometric techniques, mainly for time series analysis. In Chapter 3 a wide range of panel data techniques is applied to investigate this relation between the exchange rate and term structure of interest rates. Additionally, since most emerging economies abandoned their long-standing currency crawling pegs and adopted floating exchange rate regime in 1990s (especially after the 1997 Asian financial crisis and the Russian financial crisis of 1998), the stability of this relationship is considered through a series of tests of structural breaks.

Chapter 4 pays attention to the forecasting power of the term structure of interest rates in the bond and stock markets. It is important and interesting to investigate if the bond and stock market could be controlled through interest rate policy where the short rate proxies for economic uncertainty and the yield spread procies for business conditions. Various studies in the previous literature have focused on the relationship between bond and stock returns, and the term structure of interest rates. This study extends the research in this area by examining whether the bond risk is also time-varying and whether this time variation can be also explained by the short-term interest rate and yield spread. Although Viceira (2007) provides a similar analysis on bond risk, it was only done for the US bond market. This current research project investigates the relationship between bond risk, measured as the realised second moments of bond returns, and the nominal term structure of interest rates for the US and other developed economies in the G7. Furthermore, it treats the G7 economies as a whole with analysis under panel construction. In addition, the effect of the recent financial crisis on the relation between time variation in bond risk and time variation in the term structure of interest rates is also examined in order to confirm the stability throughout the sample period.

Chapter 5 aims to examine the relationship between the directors' emolument and corporate performance for the largest companies in the U.K. The previous literature mainly focused on companies in the U.S., this chapter studies U.K. firms with the most recent data and most improved economectric approaches. A key contribution of his chapter is to evaluate the directors' compensation for the CEO (both cash and total pay), the highest paid director, and the whole board of directors among FTSE 350 firms for the sample period 2004-2009. Differently from the previous studies in this area, this chapter investigates this pay-performance relationship with the most recent data set for both CEO and highest paid director because they are not always the same person in a company. The second contribution is that the fixed effects method is implemented in the panel data estimation with inclusion of both white diagonal and cross-section SUR to control for the observation specific heteroskedasticity and cross-section correlation. Although the panel estimation with fixed effects has been applied in previous studies, few of them have taken into account the techniques to deal with heteroskedasticity and cross-section correlation in estimation. Furthermore, the bootstrapping methodology is applied in this chapter to check the robustness of the findings. In addition, this chapter also takes consideration of the latest financial crisis which began in mid-2007, and investigates its impacts on the corporate pay-performance relationship, which is the third contribution of this chapter.

The last chapter is the conclusion. It provides a synopsis as well as a discussion of the overall findings and implications of this research.

Chapter 2 **Forward Exchange Bias and the Forward Premium Puzzle**

2.1. Introduction

Of considerable interest in the past twenty years has been the test of the predictive power of forward exchange rates, in both levels and returns. For forward-spot relation in levels, consistent empirical evidence has shown that the forward rates are not unbiased forecasts of the corresponding future spot exchange rates in foreign currency markets even with very low trading costs. Meanwhile, for the same relation in returns, a negative relation between the forward premium and the depreciation of the exchange rates is often found in the empirical literature.

The efficient markets hypothesis has played an important role in our understanding of the forward-spot relation. The efficient markets hypothesis 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). Hence, according to the efficient market hypothesis, the forward 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 (e.g. Lin 1999; Lin et al. 2002). In other words, if the two assumptions of rational expectation and risk neutrality are satisfied, then the forward rate should provide an unbiased forecast of the further spot exchange rate. Frenkel (1976) shows evidence that supports this hypothesis through regression $\ln S_{t+k} = \kappa + \gamma \ln F_t + u_{t+k}$, where S and F are spot and forward exchange rate, respectively, and k in the subscripts represents the forward contract length. He finds that γ is close to one. However, Tauchen (2001) suggests that due to limitations in the econometric and statistical methodologies used in prior studies, the unbiasedness hypothesis is found to be rejected much more strongly recently than that in earlier studies.

The forward premium puzzle refers to the negative relation between the return on nominal exchange rate and the forward premium, especially for data up until the early 1990s (Baillie and Bollerslev 2000). One interpretation of the forward premium anomaly is that the forward rate is a biased predictor of the corresponding future spot rate. However, Fama (1984) shows that although the forward rate seems to be a reasonable predictor of further spot exchange rate, it somehow fails to forecast the exchange rate returns. Engel (1996) supports Fama's findings and points out that it has been difficult to reconcile with the economic theory. Furthermore, Barnhart and Szakmary (1991), and Hai, Nelson and Wu (1997) point out that the forward rate unbiasedness regression has no information at the relation between exchange rate depreciation and forward premium, unless the future spot exchange rate and forward rate has an exact 1:1 cointegration relation. However, the assumption of exact 1:1 cointegration relation has been rejected in numerous empirical works (Evans and Lewis (e.g. Evans and Lewis 1995; Luintel and Paudyal 1998; Phillips and McFarland 1997). Maynard (2003) further shows that a very small deviation from 1:1 cointegration can result in substantial bias.

Another interpretation of the empirical presence of the negative slope coefficient in forward-spot regression in returns is that there is a time-varying risk premium. This is known as the most natural explanation that risk premium drives a wedge between expected changes and actual changes of exchange rates, and it results in a prediction with the wrong direction. However, modelling the risk premium is a real challenge. Engel (1999) models the risk with the covariance of consumption and exchange rate in a model with nominal rigidities. There are also some other alternative explanations for the forward premium puzzle that take peso problems, irrational economic agents, segmented markets, and trading frictions into account. However, none of these interpretations has been fully accepted (Engel 1996; Hodrick 1987).

Hence, the forward premium puzzle has prompted numerous studies related to the international asset pricing models, which take into account the effect of consumption risks on the forward prediction bias, to see if they can capture the characteristic of a negative relation when regressing the changes in spot rates on the lagged forward premium (Backus et al. 1996; Bekaert et al. 1997; Macklem 1991). Some other studies view this forward premium puzzle mainly as a statistical phenomenon simply due to the autocorrelation in the forward premium that is particularly persistent. A further problem is that the relatively small sample size used in the previous empirical literature does not in reality tell us that much.

It is argued in previous research that the forward exchange rate bias in the foreign exchange markets has been persistent, especially in the 1980s and 1990s. However, the currency market has recently become much more open. Consequently, this current chapter is motivated to see if this bias is still present in the last decade. Baillie and Bollerslev (2000) and many other papers have pointed out that the so-called forward premium anomaly could be viewed as a statistical artefact from having small sample sizes and a lack of modern econometric methodologies. Consequently, this current chapter will aim to establish if the forward rates continue to be a biased forecast of the future spot rates, both in levels and in returns, by using samples with a large horizon and improved econometric methodologies and statistical procedures.

In this chapter we improve the existing literature in several points. Firstly, unlike the prior literature which has tested either for forward rate biasedness or for forward premium anomaly, we will examine the forward-spot relation with regressions in both levels and returns. Secondly, a number of the previous empirical studies have analysed an individual developed economy or a group of developed economies, such as the G7. Compared with the developed economies the emerging economies have some significantly different characteristics, such as higher average inflation, inflation volatility, and lower per capita income (Bansal and Dahlquist 2000). In addition, the emerging economies have been playing a more and more important role in the global currency market. In this chapter we will extend the literature by including emerging economies as well as the more individual developed economies that were the subject of the previous studies. We will report additional evidence obtained from twenty individual emerging economies, thereby enriching the analysis of the forward-spot relation. Thirdly, it is usually argued that the forward premium puzzle might be caused by the poor econometric and statistical methodologies which have been used in some of the previous studies. In this chapter, several improved econometric methodologies are applied to test for the forward-spot cointegration and to analyse the forward premium regression. We will apply both a Fully Modified OLS and a Dynamic OLS in a time series cointegration analysis, and we will use ARCH/GARCH methodologies to capture the risk premium. In addition, we will also extend the previous literature by using panel data for the samples of developed and emerging economies, respectively. The rolling coefficients are also documented in order to provide a complete picture of the forward-spot relationship.

The rest of this chapter is organised as follows. Section 2.2 provides a brief review of the key works of the previous literature, especially previous empirical studies. Section 2.3 discusses some of the important econometric methodologies that have been applied in testing the forward-spot relationships. The data and the corresponding descriptive statistics are described in detail in Section 2.4. Meanwhile, Section 2.5 presents the models of forward-spot relations, both in levels and returns. Empirical evidence is shown in Section 2.6 for both the forward rate bias and the forward premium anomaly with respect to individual countries as well as their panel. Finally, Section 2.7 concludes this chapter.

2.2. Literature Review

The empirical literature regarding forward rate biasedness relates to the hypothesis of market efficiency. For example, Geweke and Feige (1979) present a joint test and suggest that due to the economic agent's risk aversion and the existence of transaction costs, the foreign exchange markets are not efficient. In the 1980s and 1990s a number of studies focused on testing for the market efficiency hypothesis, and most of them failed to find supportive evidence. This failure was attributed to several factors, such as the existence of risk premium and its negative correlation with expected future spot rate, as well as the lack of appropriate econometric and statistical methodologies. These studies include, Fama (1984), Boothe and Longworth (1986), Hakkio and Rush (1989), Sephton and Larsen (1991), Liu and Maddala (1992).

The forward rate bias puzzle describes a situation where the forward rate does not provide an unbiased forecast of the future spot rate. Numerous studies can be found to test for forward rate unbiasedness hypothesis; however, empirically the results from these studies are inconclusive and conflicting. The earlier studies, such as those of Cornell (1977) and Kohlhagen (1979), support the hypothesis of unbiasedness. However, most of the more recent studies reject this hypothesis, for example, Gregory and McCurdy (1984), Bakshi and Naka (1997), Lin (1999), Lin et al. (2002), Chernenko et al. (2004). Meanwhile, a number of others, such as Edwards (1982), Domowitz and Hakkio (1985), Lin and Chen (1998), report mixed results. There are some limitations in the literature. A number of studies in this area use only one sample period or one time horizon (e.g. one month), such as Barnhart and Szakmary (1991), Lin (1999). Also, many well-cited unbiasedness tests have misspecification issues (e.g. structure homogeneity) and some other arguments arise from the data non-stationarity. Soon after Geweke and McCurdy (1984) addressed the specification error, Chiang (1988) took a stochastic coefficient approach. Furthermore, Lin et al. (2002) introduced a variable mean response model transformed from a logarithmic change specification, which is estimated by a four-step generalised least squares procedure.

Additionally, several recent studies have also examined the presence of common stochastic trends between the forward rate and the corresponding future spot rate, but the empirical results are of conflicts as well. Baillie and Bollerslev (1989) reported the existence of a common trend between the forward and future spot exchange rates for seven currencies. However, Diebold et al. (1994) and Baillie and Bollerslev (1994) argue that the cointegrating relationships in a system of exchange rates are sensitive to a constant term from the cointegration space and when they included a constant term in the model they failed to find the unique cointegrating relationship. In brief, it is often contended that better econometric methodologies and statistical procedures can produce better results in this area.

The forward premium puzzle is closely related to the phenomenon of forward rate bias. A great number of studies link this issue to uncovered interest parity in the sense that the expected currency depreciation is in terms of the domestic and foreign interest rates differential while the covered interest parity holds that capital is perfectly mobile in the foreign exchange market. For a given positive interest differential, higher negative correlations between exchange rate change and interest rate differential imply a higher expected excess return (Bansal and Dahlquist 2000). Froot and Frankel (1989) demonstrate that the variation of the forward premium depends on the expected exchange rate depreciation and, therefore, considerably different results would be obtained with survey-based measures of currency depreciation. Although Chinn and Frankel (2002) find some evidence of the presence of risk premium through examining seventeen different currencies, with a relative broader set of currencies it is difficult to reject the uncovered interest parity hypothesis.

It is accepted that the most natural explanation for the existence of forward premium anomaly is that a risk premium drives a wedge between the expected and actual changes of the exchange rates. The empirical presence of the risk premium and how to model it (both theoretically and empirically) has been widely discussed in recent literature in this area. For example, Hansen and Hodrick (1983) use a latent factor model of asset pricing under frictionless exchange market to rationalise the risk premium from investing in foreign currency deposits. Fama (1984) shows a negative relation between expected currency depreciation and interest rate differential, and suggests that it might be caused by the risk premium, which is more volatile than the expected currency depreciation. Jagannathan and Wang (1996) apply a cross-sectional method and analyse it to see if the systematic risk can account for the cross-sectional heterogeneity in the risk premia. Furthermore, Bansal and Dahlquist (2000) take into account some country specific attributes (such as per capital GNP, sovereign rating, inflation, and inflation volatility) and provide evidence that these attributes seem to be more important in explaining the cross-section of risk premia than the systematic risk. There are some other risk-based explanations relying on the presence of sticky prices in the general equilibrium models. For example, Eichenbaum and Evans (1995) and Backus et al. (1996) illustrate that general equilibrium models with nominal price rigidities and corporation of participation constrains can explain why the forward premium points in the wrong direction for the ex post change of the exchange rate. Another example is Engel (1999), who suggests that the risk exists because of the covariation of consumption and exchange rates in the general equilibrium model with nominal rigidities. Other rigidities have also been used to induce the risk premia in such models. For example, Alvarez et al. (2002) incorporate the "limited participation" of the agents who only enter into arbitrage when the benefits sufficiently exceed costs. More recently, Verdelhan (2006) and Moore and Roche (2006) apply external habit preferences with a combination of multiple costs and/or rigidities, and have provided a more fruitful model to explain the forward premium puzzle.

In most previous studies it has been consistently argued that more improved econometric methodologies and better statistical procedures can play a considerably important role in solving the forward rate bias and forward premium anomaly. Chinn and Meredith (2004) treat interest rates as endogenous variables in an economic sense to account for the divergence in the results reported by McCallum (1994) through both short and long-horizons. Villanueva (2005) illustrates this argument within an improved econometric framework but without clearly demonstrating if these approaches could interpret the presence of a negative relation between forward and corresponding future spot exchange rates. A number of other econometric issues have also been discussed in the literature. Baillie and Bollerslev (2000) provide evidence to show a nonlinear relationship between the change of spot rate and forward discount, and they argue that the forward discount is likely to point in the right direction of the change in spot exchange rate when it is relatively large in absolute value whereas the forward discount would point in the wrong direction when it is relatively small. Baillie and Bollerslev (2000) also suggest that the reason why the nonlinearity exists is because the transaction costs are smaller (or larger) compared to the potential gains. Meanwhile, Bansal and Dahoquist (2000) use a cubic drift to further examine the nonlinearity and state-dependence in the forward premium puzzle. In addition, Maynard (2003) implies that the negative relation between forward and corresponding future spot exchange rates cannot be entirely interpreted through time series analysis.

According to the above discussions of the key literature in this area, the forward-spot relationships in both levels and returns are seen to be far from conclusive. Most of the previous studies have focused on the U.S. dollar against other currencies. In this chapter we will treat the U.K. as the demestic country instead in order to enrich the existing literature. Moreover, previous literature provided evidence on this relationship between the forward and future spot exchange rates mainly for developed economies and especially for 1980s and 1990s. However, the emerging economies have been grown very fast in last decade and the exchange market has become more open to those economies. This chapter uses more recent data to analyse if these puzzles are still present, for both developed and emerging economies for the last ten years. In addition, limitations in econometrics were found in previous research and it has been argued that the lack of the modern econometric techniques might be the reason why these puzzles exist; hence this chapter also extends the existing literature with improved economic methodologies and statistical procedures.

2.3. Methodology

It has been argued that improved econometric methodologies and statistical procedures could help to solve, or at least better explain the empirical puzzles in the forward-spot relationships. In this chapter we will analyse the forward rate unbiasedness and the forward premium anomaly with respect to both time series of individual countries and their panel.

2.3.1. Time-Series Analysis

2.3.1.1 Fully Modified OLS cointegration

It is well known that lots of economic time series are different stationary, and a regression involving the levels of these $I(1)$ series produces misleading results. Phillips (1986) argues that the Wald tests for coefficient significance spuriously show a significant relationship between unrelated series. There are a number of methods in the literature to address cointegration relationships. One of them is Engle and Granger’s (1987) two-step test, which is a single equation approach cointegration test that has been widely implemented to investigate, in particular, the bi-variate cointegration relationship. However, Hamilton (1994) shows that the Ordinary Least Squares (OLS) based estimation of the cointegrating vector converges at a faster rate than is standard. Hamilton (1994) also shows that the OLS estimates have an asymptotic distribution that is generally non-Gaussian, exhibit asymptotic bias, and are a function of non-scalar nuisance parameters. Thus, a static OLS is not recommended because the conventional testing procedures are not valid unless it is substantially modified.

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. To examine the cointegration relationship between $Y_t \sim I(1)$ and $X_t \sim I(1)$, one could specify the following regression:

(2.3.1) $$Y_t = \kappa + \lambda X_t + \varepsilon_t$$

The resulting Fully Modified OLS (FMOLS) estimator employs preliminary estimates of the symmetric and one-side long-run covariance matrices of the residuals. It is asymptotically unbiased and has fully efficient mixture normal asymptotics, allowing for standard Wald tests using asymptotic χ^2 statistical inference.

2.3.1.2 Dynamic OLS/GLS Cointegration

In order to see how sensitive the results with different econometric methodologies are it is intended that the dynamic OLS/GLS (DOLS/DGLS) (Saikkonen 1991; Stock and Watson 1993) will also be applied as an alternative method of cointegration test. The dynamic OLS/GLS (DOLS/DGLS) is also a single equation estimator of cointegration relationship. Hence, similar to the Engle-Granger approach, this approach does not address the problem of multi-cointegration but it is improved in the sense that it can handle unbalanced regression when variables are of different orders of integration. Furthermore, the obtained standard errors from the cointegrating regression are valid for hypothesis testing through Wald statistics. Moreover, the DOLS/DGLS estimator of the cointegrating vector is found to be preferable to a range of other asymptotic estimator when the sample size is relatively shorter (Stock and Watson 1993). It is asymptotically equivalent to Johansen (1988) estimator of cointegration when variables in the system are $I(1)$ and there is a single cointegrating vector (Arghyrou and Luintel 2007). The DOLS regression associated with Y_t and X_t is given by:

(2.3.2) $$Y_t = \alpha + \beta X_t + \sum_{t=-k,k\neq 0}^{k} \gamma_k \Delta X_{t-k} + u_t \ ,$$

Where Y_t and X_t denote the corresponding variables respectively as specified under FMOLS framework and u_t is a random error term. DGLS is required in order to control for residual autocorrelation. One can define the order of difference for the lead and lag terms based on the order of integration of the corresponding regressor (Stock and Watson 1993). For instance, if a regressor is $I(2)$ then the lead and lag terms must be differenced twice (i.e., $\Delta(\Delta x_t)$). The lead and lag differences of the regressors in the DOLS estimator are used to control for any endogenous feedback and the nuisance parameters. There is no unique method to determine the order of lead and lag. Normally, the order of lead and lag is set according to the data frequency, thus, in this chapter we set a fourth order lead and lag for the weekly data set and a fifth order lead and lag for the daily data.

A more general covariance estimator, which is proposed by Newey and West (1987), can be applied to control the presence of both heteroskedasticity and autocorrelation of unknown form. The HAC coefficient covariance estimator can be written as:

(2.3.3) $$\hat{\Sigma}_{NW} = (X'X)^{-1} T\hat{\Omega}(X'X)^{-1}$$

Where $\hat{\Omega}$ is any of the long-run covariance matrix (LRCOV). It can be used to calculate the HAC robust standard errors (Newey and West 1987), employed in unit root (Phillips and Perron 1988) and cointegration analysis (Phillips and Hansen 1990b). Newey and West (1987) suggest a nonparametric kernel method to calculate systematic LRCOV with an automatic bandwidth selection methods for kernel estimators (Andrews 1991; Newey and West 1994).[1]

[1] Further details are provided in Appendix I at the end of this chapter.

2.3.1.3 ARCH/GARCH/TGARCH

In econometrics, especially financial econometrics, AutoRegressive Conditional Heteroskedasticity (ARCH) models (Engle 1982) are commonly applied to analyse observed financial time series because they are able to capture the stylised features of real world volatility. One major contribution of the ARCH approach is that it captures the time-varying volatility clustering (i.e. large changes are followed by future large changes and periods of small changes are followed by future small changes). If an AutoRegressive Moving Average Model (ARMA model) is assumed for the error variance, the model is a Generalised Autoregressive Conditional Heteroskedasticity (GARCH) model (Bollerslev 1986).

To model a time series with an ARCH process, one could define the error terms ε_t in terms of a stochastic piece z_t and a time-dependent standard deviation σ such that:

(2.3.4) $$\varepsilon_t = \sigma_t z_t$$

Where $z_t \sim i.i.d.N(0,1)$. Thus, the series σ_t^2 in ARCH(q) model is:

(2.3.5) $$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + ... + \alpha_q \varepsilon_{t-q}^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2$$

And the specification of GARCH(p, q) model is given by:

(2.3.6) $$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + ... + \alpha_q \varepsilon_{t-q}^2 + \beta_1 \sigma_{t-1}^2 + ... + \beta_p \sigma_{t-p}^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-i}^2$$

Where p is the order of the GARCH terms σ^2 and q refers as the order of the ARCH terms ε^2.

The Lagrange Multiplier (LM) test can be used to test for ARCH effects, the test statistic is:

(2.3.7) $$LM = (T - q)R^2 \sim \chi_{1-\alpha}^2(q)$$

In order to detect the ARCH effects, models will be estimated in terms of mean and variance simultaneously by the maximum likelihood estimator.

The Threshold ARCH/GARCH (TARCH/TGARCH) model which was introduced by Zakoian (1994) is similar to GJR ARCH/GARCH (Glosten et al. 1993b) and it is used to model asymmetry in the ARCH process. In contrast to the standard ARCH and GARCH models which treat good news $(\varepsilon_{t-1} > 0)$ and bad news $(\varepsilon_{t-1} \leq 0)$ symmetrically, the specification of TGARCH model is given by:

(2.3.8) $$\sigma_t = \kappa + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 d_{t-1} \varepsilon_{t-1}^2 + e_t \qquad T-ARCH$$

(2.3.9) $$\sigma_t = \kappa + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 d_{t-1} \varepsilon_{t-1}^2 + \theta \sigma_{t-1} + e_t \qquad T-GARCH$$

Where,

$$d = \begin{cases} 1 & \varepsilon_t < 0 \qquad bad \quad news \\ 0 & \varepsilon_t \geq 0 \qquad good \quad news \end{cases}$$

Hence, the α_2 is known as the symmetry as leverage terms. If α_2 is positive and significant then that implies that 'bad news' increases the conditional variance (volatility).

2.3.2. Panel Data Analysis

2.3.2.1 Panel Unit Root Test

In getting the full picture of the forward-spot cointegration relationship panel analysis is also provided, starting with the unit root tests. There are numerous convenient methods to test unit root under a panel framework, such as: the Fisher-type ADF tests (Breitung 2000; Im et al. 2003; Levin et al. 2002), the Fisher-PP tests (Choi 2001; Maddala and Wu 1999), and the LM tests (Hadri 2000). The panel unit root tests are simply multiple-series unit root tests that have been applied to panel data structures, but these tests are known to have higher power than the unit root tests based on individual time series and they have become more popular in recent literature.

The unit root test is made on the basis of whether or not there are restrictions on the autoregressive process across cross-sections or series. Consider the following AR(1) process for panel data:

(2.3.10) $$y_{it} = \rho_i y_{it-1} + X_{it}\delta_i + \varepsilon_{it}$$

Where X_{it} represent the exogenous variables, including any fixed effects or individual trends; $i = 1,2,...,N$ describes cross-section units or series, and $t = 1,2,...,T$ denotes the time periods; and ε_{it} are those errors that are assumed to be mutually independent idiosyncratic disturbances. Hence, if $|\rho_i| < 1$, then y_{it} is said to be weakly (trend-) stationary. On the other hand, if $|\rho_i| = 1$ then y_{it} contains a unit root. Some unit root tests assume that the coefficient ρ_i is constant across cross-sections (such as the Levin, Lin Chu (LLC), Breitung, and Hadri tests) while others allow ρ_i to vary freely for different i (such as the Im, Pesaran, and Shin (IPS), Fisher-ADF and Fisher-PP tests). The details of these tests are provided in Appendix III at the end of this chapter.

The Table 2-1 in Appendix I at the end of this chapter summarises the basic characteristics of the panel unit root tests that are used in this chapter.

2.3.2.2 Panel Estimation with Fixed Effects

Panel data sets combine time series and cross sections, and are commonly used in economics because they capture variations in the data and provide more powerful tests. The panel model with period and cross-section specific effects can be specified as:

(2.3.11) $$y_{it} = \alpha_i + \gamma_t + \beta' X_{it} + \varepsilon_{it}$$

Where α_i captures the specific effects that are variant across different cross-sections but constant across time, and γ_t refers to time effects which are invariant across different sections. The fixed effects structure with cross-section SUR allows for the exploitation of the contemporaneous residuals across cross-sections which makes the estimates more efficient. More specifically, it can be shown as:

(2.3.12) $$E\left(\varepsilon_{it}\varepsilon_{jt} \middle| X_t *\right) = \sigma_{ij}$$

(2.3.13) $$E\left(\varepsilon_{is}\varepsilon_{jt} \middle| X_t *\right) = 0$$

For all *i*, *j*,*s* and *t* with $s \neq t$. The contemporaneous covariances do not vary over *t*.

Using the period specific residual vectors, we may rewrite this assumption as:

(2.3.14) $$E\left(\varepsilon_t \varepsilon_t' \middle| X_t *\right) = \Omega_M$$

For all *t*, where,

(2.3.15) $$\Omega_M = \begin{pmatrix} \sigma_{11} & \sigma_{12} & \cdots & \sigma_{1M} \\ \sigma_{12} & \sigma_{22} & & \vdots \\ & & \ddots & \\ \sigma_{M1} & \cdots & & \sigma_{MM} \end{pmatrix}$$

Therefore, the cross-section SUR which is weighted least squares on this specification (sometimes referred to as the Parks estimator) is simply the feasible GLS estimator for systems where the residuals are both cross-sectionally heteroskedastic and contemporaneously correlated. The residuals are employed from first stage estimates to form an estimate of Ω_M , and then in the second stage a feasible GLS is performed.

2.3.2.3 Panel Cointegration

In recent literature, one of the extensive interests of panel data focuses on the cointegration tests. Similar to time series cointegration analysis, the most commonly used panel cointegration methods include the Engle-Granger (1987) based two-step tests (such as the Pedroni (1999), Pedroni (2004) and Kao (1999) tests) and the Fisher-type test using Johansen methodology (such as Maddala and Wu (1999)). The Engle-Granger (1987) two-steps cointegration test is based on an examination of the residuals of a spurious regression. Under the Engle-Granger framework it is assumed that the variables in the regression are all $I(1)$, then if the residuals are $I(0)$ the variables are cointegrated. Pedroni (1999), Pedroni (2004) and Kao (1999) extended the Engle-Granger construction to test for cointegrations involving panel data. Maddala and Wu (1999) use Fisher's combined results from individual independent tests to propose an alternative approach to test for cointegration in the panel data. The panel cointegration details are provided in Appendix IV at the end of this chapter for Pedroni, Kao and Maddala and Wu, respectively.

Furthermore, the dynamic OLS/GLS can also be applied to panel data constructions. Consider the following panel setting with fixed effects:

(2.3.16) $$Y_{it} = \alpha_i + \gamma_t + \beta' X_{it} + \sum_{t=-k,k\neq 0}^{k} \gamma_{ik} \Delta X_{it-k} + u_{it}$$

In this case, similarly to the time series DOLS/DGLS, the order of difference for the lead and lag terms are specified according to the order of integration of X_{it} , which is used to control for any endogenous feedback and the nuisance parameters. To be consistent with the corresponding time series cointegration analysis, in this chapter we will set the fourth and fifth order lead and lag for these weekly and daily panel data, respectively. Newey and West’s (1987) HAC is also used to control the presence of both heteroskedasticity and autocorrelation of unknown form under the panel framework.

2.4. Data and Sample Countries

Firstly, in this chapter we re-examines the relationship between $F_{t,l}$ and S_{t+l} of Sterling in comparison with the currencies of most of the major developed economies as well as several emerging economies. The existing literature has mainly studied the U.S. dollar in comparison with other currencies. To extend this understanding, we focus on the pound Sterling instead of the U.S. Dollar. To be consistent with the previous analysis, the exchange rate is denoted as S_t at time *t* in this chapter, which is equal to the domestic currency, British pound, per unit of certain foreign currency. The FTSE group assigns the market status of countries as Developed, Advanced Emerging, and Secondary Emerging based on their economic size, wealth, and the quality, depth, and breadth of their markets. In this chapter the sample of developed economies comprises FTSE standard developed countries. For the sake of simplicity the countries of the European Union will be considered to be one economy. Therefore, this analysis consists of eleven economies, which are: Australia, Canada, the European Union, Hong Kong, Israel, Japan, New Zealand, Norway, Singapore, Switzerland and the United States. South Korea is excluded because of a data limitation. Meanwhile, the sample of emerging economies contains twenty countries from both FTSE Advanced and Secondary markets, which are: Brazil, Hungary, Mexico, Poland, South Africa, Taiwan, Chile, China, Colombia, Czech Republic, India, Indonesia, Malaysia, Morocco, Pakistan, Philippines, Russia, Thailand, Turkey and the United Arab Emirates (UAE). The most recent weekly and daily data are obtained from *Datastream* and the sample consists of observations from January 1st, 1999 (when the European euro started to circulate) to November 3rd, 2010. The forward rates are one month forward rates directly obtained from *Datastream,* which are matched with corresponding future spot rates. For instance, the current forward rate is supposed to forecast the spot exchange rate four weeks ahead for weekly data. Bank holidays are excluded. The descriptive statistics and some univariate properties of weekly and daily data are documented in Table 2-2 and Table 2-3 in Appendix I at the end of this chapter.

The mean and standard deviations of the changes of spot and forward exchange rates are reported, respectively, for weekly as well as daily data sets. The standard deviations are relatively large even with daily frequency, indicating that the exchange markets are volatile across time. The results of the logarithms of both weekly and daily exchange rates which are based on augmented Dickey-Fuller (ADF) tests are also reported in Table 2-2 and Table 2-3, respectively. This shows that all of the spot exchange rates are first difference stationary, or $I(1)$. The corresponding weekly and daily forward rates also have qualitatively similar results of $I(1)$. Thus, the logarithmic growth rates of the spot and forward rates are stationary, which is consistent with the results in the previous literature.

The results of panel unit root tests are shown below in Table 2-4 and Table 2-5 in Appendix I at the end of this chapter for weekly and daily data, respectively. The results of the logarithms of panel weekly and daily spot and forward exchange rates which are based on different test methods show that all of the spot exchange rates are first difference stationary, or $I(1)$. The corresponding forward rates also have qualitatively similar results of $I(1)$. Note that the Hadri test has the null of stationarity, while others all have the null hypothesis of unit root. Consistent with the time series test results, the logarithmic growth rates of the spot and forward rates are stationary for both samples of developed economies and emerging economies. These panel unit root tests results of both weekly and daily exchange rates demonstrate the robustness of the corresponding results for time series analysis, which is also consistent with evidence shown in the previous studies.

2.5. Modelling Framework

2.5.1. Forward Rate Unbiasedness

Generally, the hypothesis of the unbiased forward rate is examined through estimation of the following equation:

(2.5.1) $$\ln S_{t+l} = \kappa + \lambda \ln F_{t,l} + \varepsilon_{t+l}$$

Where 'ln' represents the natural logarithm. Under rational expectations, the unbiasedness of the forward rate for the future spot rate needs the intercept coefficient $\kappa = 0$ and the slope coefficient $\lambda = 1$, and at the meantime, ε_{t+l} to be a white-noise.

The traditional OLS based estimates are not reliable unless the statistic regression forms a valid Engle-Grange cointegrating vector (Engle and Granger 1987). This happens because both the spot and the forward nominal exchange rates are first order integrated so that the regressions suffer from a non-standard distribution due to the non-stationary data. However, the Engle-Granger cointegrating vector is not reliable for traditional Wald type coefficient tests. Thus, to investigate the cointegration as well as the unbiasedness relationship between S_{t+l} and $F_{t,l}$, Equation (2.5.1) is estimated as an FMOLS cointegrating regression and the stationarity of cointegrating vector is tested for each single developed or emerging economy. Moreover, to find out whether $F_{t,l}$ is an unbiased predictor of S_{t+l}, the restrictions of a zero intercept coefficient and a slope coefficient of unity are jointly tested with FMOLS cointegrating vector. The Dickey and Fuller (1979) critical values of unit root tests are suitable for testing the stationarity of FMOLS cointegrating vector and the Wald statistics is adopted to evaluate coefficient restrictions of unbiasedness.

The DOLS is adopted as an alternative estimator of a cointegration relationship in order to address the sensitivity of the cointegrating relationship among econometric methodologies. Both Saikkonen (1992), and Stock and Watson (1993) have advocated the DOLS approach to constructing an asymptotically efficient estimator which eliminates the feedback in the cointegrating system. This method involves augmenting the cointegrating regression with leads and lags of differenced regressor so that the resulting cointegrating equation error term is orthogonal to the entire history of the stochastic regressor innovations. Moreover, by applying DOLS with HAC (Newey-West) the corresponding standard errors are reliable to test the null hypotheses of unbiasedness through Wald statistics, which is χ^2 distributed. In addition, the results from DOLS with HAC (Newey-West) proves the robustness of the cointegrating relationship between S_{t+l} and $F_{t,l}$.

The DOLS model for testing the cointegration relationship between S_{t+l} and $F_{t,l}$ is given by:

(2.5.2) $$\ln S_{t+l} = \alpha + \beta \ln F_{t,l} + \sum_{t=-k,k\neq 0}^{k} \gamma_k \Delta \ln F_{t,l-k} + u_{t+l}$$

In view of the data frequencies, in this chapter we will set fourth and fifth orders leads and lags for weekly and daily data, respectively. Moreover, to get robust cointegration estimation results a HAC (Newey-West) approach is applied to control for both heteroskedasticity and autocorrelation. Under a panel estimation framework, the model can be specified as follows in order to control for the fix effects across time and sections:

(2.5.3) $$\ln S_{i,t+l} = \delta_i + \phi_t + \beta \ln F_{i,t,l} + \sum_{t=-k,k\neq 0}^{k} \gamma_{i,k} \Delta \ln F_{i,t,l-k} + u_{i,t+l}$$

2.5.2. The Forward Premium Puzzle

The forward premium puzzle, which is closely related to the phenomenon of the forward rate biasness, suggests that the forward premium usually points in the wrong direction for the ex post movement in the spot exchange rate. In this section some new evidence associated with this puzzle will be documented with the most recent data set. Firstly, the forward premium puzzle is analysed through various time-series regressions and the results are interpreted separately. Then, a panel data analysis is applied thereby providing a full picture of the forward-spot relationship in returns. Our results are not subject to small sample bias.

The percentage change in the spot exchange rate is defined as $(\ln S_{t+l} - \ln S_t)$ and the corresponding forward premium is written as $(\ln F_{t,l} - \ln S_t)$ where $F_{t,l}$ is defined as the forward exchange rate. By adding and subtracting $\ln S_{t+l} / \ln S_t$ from the forward premium and taking conditional expectations, one can easily observe that the forward premium can be simply expressed in terms of the expected depreciation in the exchange rate and the risk premium on the forward contract, which is:

(2.5.4) $$\frac{\ln F_t - \ln S_t}{\ln S_t} = E\left[\frac{\ln S_{t+l} - \ln S_t}{\ln S_t} \middle| \zeta_t\right] + E\left[\frac{\ln F_t - \ln S_{t+l}}{\ln S_t} \middle| \zeta_t\right]$$

Where ζ_t is defined as the information available at time *t*. Since the forward premium, the expected depreciation of the currency, and the forward risk premium are highly related one could easily restrict one of them given sufficient information of the other two counterparts. Thus, the expected currency depreciation is usually measured by regressing the change in spot exchange rate on the forward premium as follows:

(2.5.5) $$\ln S_{t+l} - \ln S_t = \alpha_l + \beta_l (\ln F_{t,l} - \ln S_t) + \varepsilon_{t+l,l}$$

Where $\varepsilon_{t+l,l}$ is an error term. l is the sampling frequency associated with the maturity time of the forward contract. For instance, for weekly data on one-month forward contract, then $l = 4$. According to the Uncovered Interest Rate Parity (UIP), $\alpha_l = 0$ and $\beta_l = 1$. Hence, this widely used regression is well-known in examining the forward premium puzzle and violations of UIP. The empirical regularity related to the forward premium anomaly is a concern because of the fact that β_l is invariably found not only to be significantly less than one but it is also often found to be negative, especially for the 1980s (see, for example, Fama (1984), Hodrick and Srivastawa (1986), Baillie (1989), Engel (1996)).

In order to further characterise the persistence of the forward premium puzzle, a state-dependent linear projection specified as below is taken into consideration in this chapter. This projection is firstly used in Bansal (1997) and then applied in Baillie and Bollerslev (2000).

(2.5.6) $$\ln S_{t+l} - \ln S_t = \alpha_l + \beta_l^+ (\ln F_{t,l} - \ln S_t)^+ + \beta_l^- (\ln F_{t,l} - \ln S_t)^- + \varepsilon_{t+l,l}$$

Where,

(2.5.7) $$(\ln F_{t,l} - \ln S_t)^+ = \begin{cases} \ln F_{t,l} - \ln S_t & if \ \ln F_{t,l} - \ln S_t > 0 \\ 0 & if \ \ln F_{t,l} - \ln S_t \le 0 \end{cases}$$

Or,

(2.5.8) $$(\ln F_{t,l} - \ln S_t)^- = \begin{cases} \ln F_{t,l} - \ln S_t & if \ \ln F_{t,l} - \ln S_t \le 0 \\ 0 & if \ \ln F_{t,l} - \ln S_t > 0 \end{cases}$$

The forward premium is split into two states, positive and negative, $(\ln F_{t,l} - \ln S_t)^+$ and $(\ln F_{t,l} - \ln S_t)^-$, with an arbitrary zero forward premium. Furthermore, following Baillie and Bollerslev (2000), a cubic regression is also estimated in order to check for robustness by eliciting any state-dependence in this forward premium puzzle. The equation is specified as:

(2.5.9)

$$\ln S_{t+l} - \ln S_t = \alpha_l + \beta_l (\ln F_{t,l} - \ln S_t) + \gamma_l (\ln F_{t,l} - \ln S_t)^2 + \eta_l (\ln F_{t,l} - \ln S_t)^3 + \varepsilon_{t+l,l}$$

There are several reasons for the presence of the forward premium puzzle, the most widely accepted explanation is that a time-varying risk premium exists which drives a wedge between the expected and actual exchange rates changes. There are different surveys provided in the literature to model the time-varying risk premium. Using the consumption based risk premium approach, Baillie and Bollerslev (2000) provide a model with the existence of a significant time-dependent risk premium (see Appendix

V for further detail):

(2.5.10) $$E_t\left(\ln S_{t+l} - \ln S_t\right) = \left(\ln F_{t,l} - \ln S_t\right) + \rho_{t,l}$$

As pointed out by Fama (1984), a negative slope coefficient in the forward premium regression indicates a negative sample covariance between expected currency appreciation and risk premium, $Cov\left[E_t\left(\ln S_{t+l} - \ln S_t\right)\rho_{t,l}\right] < 0$, as well as a high variability of the risk premium, $Var\left(\rho_{t,l}\right) > Var\left[E_t\left(\ln S_{t+l} - \ln S_t\right)\right]$. Hence, a reasonable explanation for an extraordinary forward premium anomaly is that either the size and/or volatility of the empirical risk premium are surprisingly large, or some fundamental deficiencies exist in the econometric analysis. In order to capture the effects of a time-dependent risk premium on the relation between currency depreciation and forward premium, a $ARCH(q)/GARCH(p,q)$ model is specified in the following form:

(2.5.11) $$\ln S_{t+l} - \ln S_t = \alpha_l + \beta_l\left(\ln F_{t,l} - \ln S_t\right) + \delta_l h_t + e_t$$

(2.5.12) $$h_t = \mu_l + \sum_{i=1}^{q} \eta_i e_{t-i}^2 + \varepsilon_t \qquad ARCH(q)$$

(2.5.13) $$h_t = \mu_l + \sum_{i=1}^{q} \eta_i e_{t-i}^2 + \sum_{i=1}^{p} \kappa_i h_{t-i} + \varepsilon_t \qquad GARCH(p,q)$$

It is well known that the exchange markets become more volatile when the news is bad than when the news is good. In contrast to the standard ARCH/GARCH models that treat good news $\left(e_{t-1} > 0\right)$ and bad news $\left(e_{t-1} \le 0\right)$ symmetrically, the TARCH/TGARCH models allow for the potential different effects of good and bad news (shocks) on conditional variance.

(2.5.14) $$h_t = \mu_l + \sum_{i=1}^{q} \eta_i e_{t-i}^2 + \sum_{i=1}^{q} \theta_i d_{t-i} e_{t-i}^2 + \varepsilon_t \qquad T-ARCH$$

(2.5.15) $$h_t = \mu_l + \sum_{i=1}^{q} \eta_i e_{t-i}^2 + \sum_{i=1}^{q} \theta_i d_{t-i} e_{t-i}^2 + \sum_{i=1}^{p} \kappa_i h_{t-i} + \varepsilon_t \qquad T-GARCH$$

Where,

$$d = \begin{cases} 1 & e_t < 0 \quad \textit{bad} \quad \textit{news} \\ 0 & e_t \geq 0 \quad \textit{good} \quad \textit{news} \end{cases}$$

If θ_i is positive and significant then this implies that 'bad news' increases the conditional variance (volatility).

In order to control for the bias arising from sampling with short horizon, the panel data series for the different categories (i.e. all, developed, emerging economies, respectively) are analysed. The panel model of Equation (2.5.5) with period and cross-sectional fixed effects is specified below:

(2.5.16) $$\ln S_{i,t+l} - \ln S_{i,t} = \mu_i + \phi_t + \beta_{i,t}\left(\ln F_{i,t,l} - \ln S_{i,t}\right) + \varepsilon_{i,t+l,l}$$

Where μ_i and ϕ_t capture the fixed effects for cross-section and period, respectively. Cross-section SUR is used to control for possible heteroskedasticity and serial correlation in the variance-covariance matrix to report robust coefficient estimates and standard errors. Similarly, Equations (2.5.6) and (2.5.9) are also estimated under panel framework.

Additionally, the rolling regressions method is applied here to check for changes in the regression coefficients over time in order to assess the model's stability. Many research projects have used this econometric procedure to estimate the same equation multiple times with either a growing sample or a partially overlapping sample. In this chapter, in order to assess the stability of the slope coefficient, we estimate the forward premium regression with a certain number of observations taken from the whole sample and keep reestimating the same regression using the same amount of obervations but with dropping the first observation and adding another following observation to the previous subsample until the last observation is included. More specifically, the two-year rolling regressions are estimated for the weekly data under panel framework. The first estimate is obtained using 104×11 obervations for developed economies, 104×20 observations for emerging economies and 104×31 observations for the whole sample, respectively, beginning at the first week of January

1999 and running through to the last week in December 2000. Then, the next estimation uses data from the second week of January 1999 to the first week in January 2001. This proceeds until the final estimate is obtained by using data from the first week of November 2008 to the last week of October 2010. In addition, the rolling regression method is applied with the panel model of forward premium anomaly for daily data. Similarly, two-year rolling regressions are implemented for the daily data set with the first slope coefficient estimate obtained using 521×11 obervations for developed economies, 521×20 observations for emerging economies and 521×31 observations for the whole sample, respectively, beginning on the first working day in 1999 to the last working day in 2001, then the second slope coefficient estimate is yield using observations from the second working day in 1999 to the first working day in 2002, which also includes 521×11 obervations for developed economies, 521×20 observations for emerging economies and 521×31 observations for the whole sample, respectively. It keeps rolling until the last estimate is obtained using the first working day in November 2008 to the last working day in October 2010. Thus the same amoumt of observations are included in every single regression estimation and a series of slope coefficient estimates (with two-year sample) are obtained for weekly and daily data, respectively.

2.6. Empirical Results

2.6.1. Forward Rate Unbiasedness

Equation (2.5.1) is estimated to analyse the cointegration relationship between S_{t+l} and $F_{t,l}$ through a FMOLS cointegrating regression. The unbiasedness hypothesis of zero intercept and slope coefficient of unity is also tested with a FMOLS cointegrating vector. The results obtained from analyses with weekly and daily data respectively are provided in Table 2-6 and Table 2-7 in Appendix I at the end of this chapter.

The null hypothesis of non-stationarity is rejected in all cases according to the ADF tests on the FMOLS cointegrating residuals. This indicates that S_{t+l} and $F_{t,l}$ are cointegrated. It can also be seen that the overwhelming majority of the estimated intercept and slope coefficients are very close to zero and unity, respectively. The results of the Wald coefficient restrictions tests are reported in the last columns in Table 2-6 and Table 2-7 for both weekly and daily data. At weekly frequency, the unbiasedness of joint zero intercept and slope of unity within the forward-spot relation is rejected for most economies, except for: Israel and Norway in the developed markets; and, Chile, Czech Republic, Indonesia, Malaysia and Turkey in the emerging markets. Although the joint coefficient restrictions are rejected in most cases, sixteen out of thirty-one countries accept zero intercept as well as slope of unity under single coefficient restriction tests. In the analysis of the daily data, the results show that there is not enough evidence to comfortably reject the null hypothesis of unbiasedness. The only exception here is Mexico, however, the joint hypothesis of zero intercept and slope of unity is only statistically rejected at the 10% level. Quite a few empirical works with results rejecting the unbiasedness can be found in previous literature as discussed earlier; however, very few of them have checked their results using daily frequency data. The capital mobility is low with daily frequency data and the results in our study provide new evidence on the relationship between S_{t+l} and $F_{t,l}$, indicating that the forward rate is an unbiased predictor of the future spot exchange rate in high frequency.

In order to check the robustness of the findings to test methods, this cointegrating relationship between S_{t+l} and $F_{t,l}$ is also analysed using DOLS. The DOLS estimator is asymptotically equivalent to Johansen's (1988) 'maximum-likelihood' based estimator of cointegrating vectors when variables in the system are $I(1)$ and there is a single cointegrating vector. HAC (Newey-West) is applied to control for both heteroskedasticity and autocorrelation in the cointegration tests. The results are presented in Table 2-8 and Table 2-9 in Appendix I at the end of this chapter.

The choice of a DOLS estimator associates with the first order integration and univariate properties of the data. The results of the ADF tests on the error correction terms indicate that the null hypothesis of non-cointegration between S_{t+l} and F_t is rejected at the 5% significance level across all pairs, which gives the same conclusion of cointegration as those suggested by the FMOLS cointegration test. The conclusion could be made that there is a significant and robust long-run relationship between the forward and future spot exchange rates. Most of the intercept coefficients are not statistically different from zero and all of the slope coefficients are positively signed as expected, they are statistically highly significant and close to unity. The fourth columns of Table 2-8 and Table 2-9 contain the Wald test statistics under the null hypothesis of a zero intercept. The null is statistically rejected for nineteen out of thirty-one economies at 5% level with weekly data, while it is only rejected for three countries at 5% level and four other countries at 10% level with daily data. The results of single restriction of slope of unity show similar patterns. The results of the more important test from the point of view of the unbiasedness hypothesis of both zero intercept and slope of unity are reported in the final columns of Table 2-8 and Table 2-9 for weekly and daily data analysis, respectively. The joint hypothesis of unbiasedness is rejected for most economies with weekly data (except for Norway, Chile, and Indonesia) at the 5% significance level. However, the rejection of the unbiasedness hypothesis can be found in only six economies at the 5% level and another three economies at the 10% level, with daily data frequency. Thus, we conclude that a robust cointegrating relation exists between S_{t+l} and F_t, and, moreover, the biasedness of the forward rate might not be as bad as reported in the empirical literature with high frequency data where the null hypothesis of unbiasedness is hard to reject for most of these sample economies. The results imply that the forecasting ability of the forward exchange rate on the future spot exchange rate is stronger than we thought before with daily frequency data.

Furthermore, the cointegration relation between spot and forward exchange rates is estimated under panel construction. The results of Pedroni and Kao cointegration tests are reported in Table 2-10 and Table 2-11 in Appendix I at the end of this chapter. In both tables the results reject the null of non-cointegrated panels, with weekly and daily samples, respectively. The results are similar for all sample economies, developed economies and emerging economies. This implies that the spot and forward exchange rates are cointegrated under panel construction and the robust long-run relationships between the forward and future spot exchange rates are present for both developed and emerging economies in last decade. In order to check the robustness of this panel cointegration relation and test for the unbiasedness hypothesis, the DOLS/DGLS panel cointegration test is also applied. The results obtained from DOLS/DGLS panel cointegration tests are reported in Table 2-12 and Table 2-13 in Appendix I at the end of this chapter. The findings of cointegration are found to be robust to test methods.

The Levin, Lin and Chu panel unit root test on the panel cointegrating residuals rejects the null of the unit root in favor of stationarity. This implies that the spot and forward exchange rates are cointegrated in panel framework for the sample of all economies, developed economies, and emerging economies and this long-run relationship is not sensitive among econometric approaches. These results are consistent with those from the Pedroni and Kao panel cointegration tests which were reported earlier. Thus, for both time series and panel data analyses, there is evidence of the existence of a cointegration relation between spot and forward exchange rates. The Wald test statistics and *p*-values are reported for each coefficient restrictions. The unbiasedness hypothesis is strongly rejected for all three subsamples, although the face values of the corresponding coefficients seem as such. Therefore, with the evidence obtained from both time series and panel data analyses, one can make a robust conclusion that there is a robust long-run relationship between the spot and forward exchange rates. Furthermore, the forward rate unbiasedness appears for quite a few currencies, especially with high frequency data, although it is rejected under panel data analysis.

2.6.2. The Forward Premium Puzzle

A negative slope coefficient is often found in the forward premium regression (2.5.5) and it is widely known as the forward premium anomaly, which indicates the presence of a large time-variation in the risk premium. If we define the expected depreciation of the domestic currency as d_t and the forward risk premium as p_t, then the forward premium is equal to $d_t + p_t$. Thus, the slope coefficient of regressing d_t on $(d_t + p_t)$ is equal to $Cov(d_t, d_t + p_t)/Var(d_t + p_t)$. We take a part of the table from Bansal and Dahlquist (2000) as Table 2-14 in Appendix I at the end of this chapter, which gives the implication for the slope coefficient in the forward premium regression.

As discussed in the previous section, the slope coefficient should be equal to unity when the uncovered interest rate parity holds. However, the unit slope coefficient is rarely found in the empirical analysis. If the variance of the forward risk premium is greater than the variance of the currency depreciation, then a negative slope coefficient will be found in the forward premium regression, which is known as the forward premium puzzle and will be empirically examined in this study.

Table 2-15 and Table 2-16 in Appendix I at the end of this chapter report the results of regressions specified in Equations (2.5.7), (2.5.8) and (2.5.11) and corresponding Wald test statistics of Equations (2.5.8) and (2.5.11), respectively, for every single currency in the sample. The HAC (Newey-West) covariance matrix is used in all regressions to control for any possible heteroskedasticity and serial correlation. The evidence shows that the slope coefficient is much more likely to be negative for developed economies than emerging economies, which indicates that the forward premium puzzle is more often found in the developed coutries. More specifically, the analysis using weekly data shows that the forward premium puzzle is present in seven out of eleven developed countries, while it exists in half of the emerging economies in the sample. The results from the analysis using highly frequent daily data seem to be improved, in which case the slope coefficients for Hong Kong, Japan, United States, Brazil, Colombia, and United Arab Emirates become positive in regressions. Nevertheless, the time-series regression results suggest that the slope coefficient estimates are not significant for most cases because of the relatively large standard errors, and few of the coefficients are close to one taken at face value. Furthermore, taken into account of the discrete-state dummy, quite a few countries have their slope coefficients across the two states opposite in sign but two-thirds are insignificantly different from each other. These results are slightly different from the evidence provided by Bansal (1997), and Bansal and Dahlquist (2000). Moreover, the results from the cubic equation specification Equation (2.5.11) are reported in the last columns for time-series analysis with weekly and daily data, respectively. The non-linear terms are statistically significantly different from zero simultaneously for more than half of these economies. This implies that there are non-linear relations between the exchange rate changes and the forward premium in a few developed and emerging markets. Since the standard time-series regression analysis cannot address the risk terms in understanding the phenomenon of the forward premium puzzle, we turn to implement the analysis using ARCH/GARCH/TGARCH models to capture the volatility clustering in the exchange markets.

It is well known that the time series of financial variables often show volatility clustering. ARCH/GARCH models are useful in modelling changes in volatility over time. Taking the U.S. and India as representative developed and emerging economies, respectively, the plots of weekly exchange rate changes appear to be very volatile. It can be observed that large changes are followed by future large changes and periods of small changes are followed by future small changes (i.e. there is evidence of time-varying volatility as well as volatility clustering).

Figure 2-1: Exchange rate changes and forward premium in the U.S.

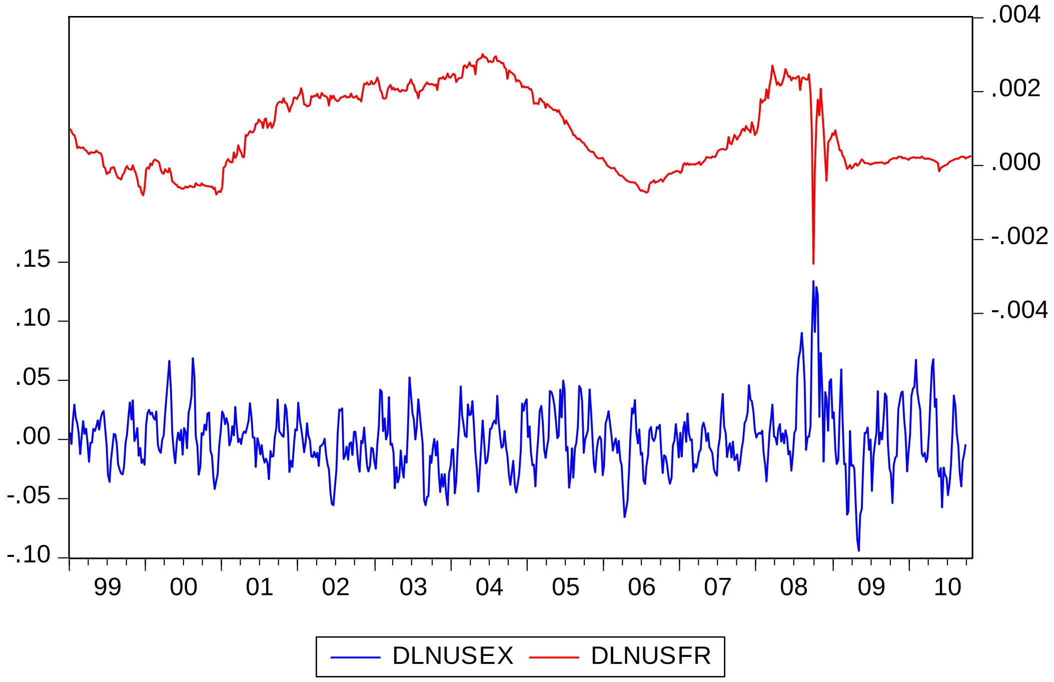
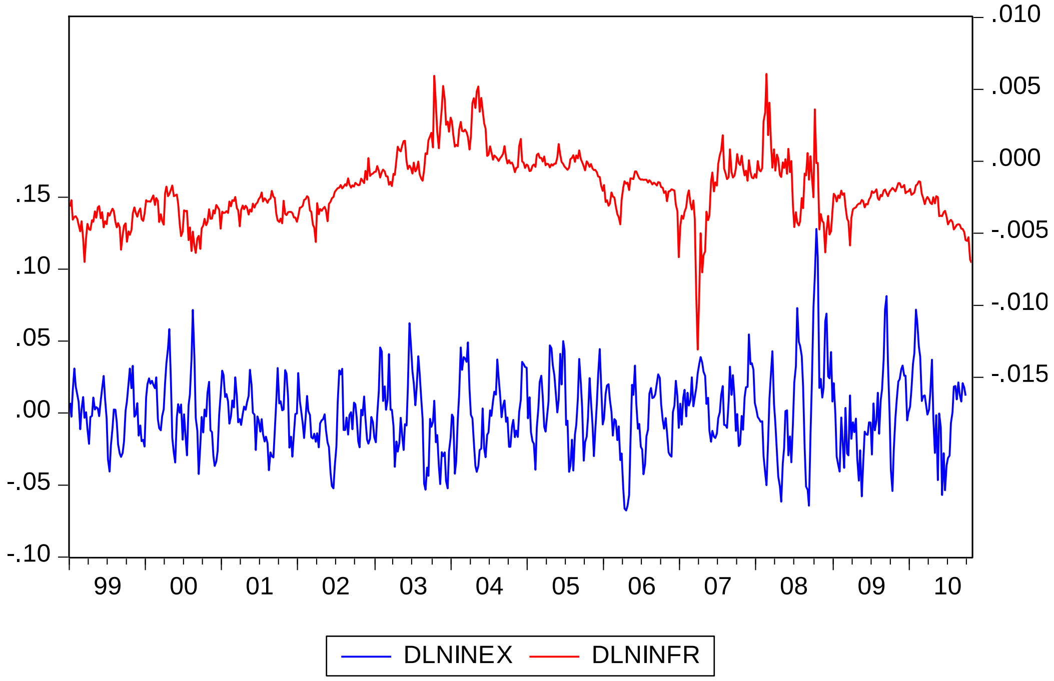


Figure 2-2: Exchange rate changes and forward premium in India



To identify the existence of ARCH effects, the Lagrange Multiplier test, which was proposed by Engle (1982), is used here and the results are reported in the second column in Table 2-17 and Table 2-18 for both weekly and daily data, respectively. Once the ARCH effects are identified, we will apply ARCH/GARCH/TGARCH models as specified in the previous section in order to re-estimate the relation between currency depreciation and the forward premium. The corresponding results are reported in Table 2-17 and Table 2-18 in Appendix I at the end of this chapter.

The ARCH-LM test results show that the ARCH effects exist in standard relation between exchange rate changes and forward premium for all of the sample economies, either with weekly data or daily observations. Based on these test results, ARCH/GARCH models are applied further to re-examine this forward premium puzzle for every individual currency, respectively. The *p*-value of the Wald coefficient tests are reported in Table 2-17 and Table 2-18, following the slope coefficient estimates and corresponding standard deviations. The results show that the ARCH/GARCH term is statistically significant for all regressions using daily data, which implies that the risk factor plays an important role in forecasting the future spot rate in the foreign market. Although the empirical forward premium puzzle cannot be solved by taking into account the risk factors, most of the slope coefficients are statistically significant in regressions controlling the time-varying risk premium. Thses results indicate that the risk premium should be taken into consideration when forcasting the future exchange rate using the forward exchange rate. However, the risk premium might not take the whole responsibility for the presence of the forward premium puzzle. Moreover, the TGARCH methodology is used to detect the difference in this relation in response to good and bad news. It turns out that quite a few economies (with *p*-value in the last columns less than 5%) perform significantly differently to bad news than to good news. However, the results from the regressions with weekly and daily data frequencies are not quite consistent with each other, more significant difference of the effect from good news and bad news appears with higher data frequency. Hence, we will next turn to run the standard forward premium regression under a panel framework, the results are shown in Table 2-19 and Table 2-20 in Appendix I at the end of this chapter for weekly and daily data, respectively.

In order to show a complete picture of the relationship between currency depreciation and forward premium an alternative focus should be given to the evidence obtained from using panel data series, which are reported in Table 2-19 and Table 2-20. The sample is split into two subsamples: one for the developed economies, and the other for the emerging economies. All of the developed economies have complete data from January 1999 to December 2010; except for Israel, which has data from March 2004 to December 2010. However, for the emerging economies the data are not quite balanced. Twelve out twenty economies have complete data while among the remaining eight economies the shortest sample period is from March 2004 to December 2010.

In the panel data analysis, the fixed effects (for both periods and cross-sections) are taken into account in the regression estimation. It can be seen that the slope coefficient estimate is negative for each subsample with weekly data, but positive for all economies and emerging subsample with daily data. Moreover, Table 2-19 and Table 2-20 also present the panel estimation results from the discrete-state dummy regression. The slopes across the two regimes are opposite in sign in all cases with both weekly and daily data, and most of them are statistically significant. The Wald statistics for the equality of the slopes across two states is sharply rejected, except for the developed economies with weekly data. This is consistent with our time series analysis and the empirical results which are provided by Bansal (1997) and Bansal and Dahlquist (2000) that shows that the forward premium puzzle occurs when $(\ln ft - \ln ex) > 0$. The last column documents the results from cubic regression specification. The evidence here shows non-lineararity in the relation between changes in forward and future spot exchange rates with both data frequencies.

Additionally, a rolling regressions analysis is applied to check the stability of the slope coefficient estimate. The slope coefficient estimates from rolling regressions are coefficients obtained with shorter time spans iterated multiple times. Figure 2.3 depicts the estimates of β from 514 2-year rolling panel regression of forward premium using weekly and daily data, respectively. The panel rolling regressions are estimated for the developed economies, the emerging economies, and the whole sample. Within each subsample, the first estimate is obtained using 104×11 obervations for developed economies, 104×20 observations for emerging economies and 104×31 observations for the whole sample, respectively; beginning at the first week of January 1999 and running through to the last week in December 2000. Then the next estimation uses data from the second week of January 1999 and runs to the first week of January 2001. The final estimate is obtained by using data from the first week of November 2008 and which runs to the last week of October 2010. In addition, the rolling procedure is implemented with daily data, but with each single slope coefficient estimate obtained using 521×11 obervations for developed economies, 521×20 observations for emerging economies and 521×31 observations for the whole sample, respectively.

Figure 2-3: Slope coefficients from rolling regressions

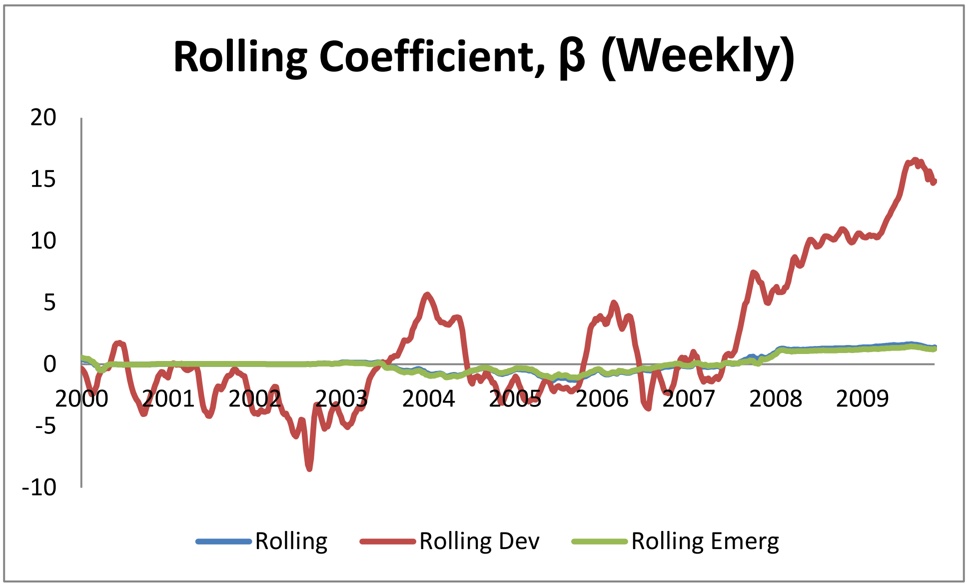
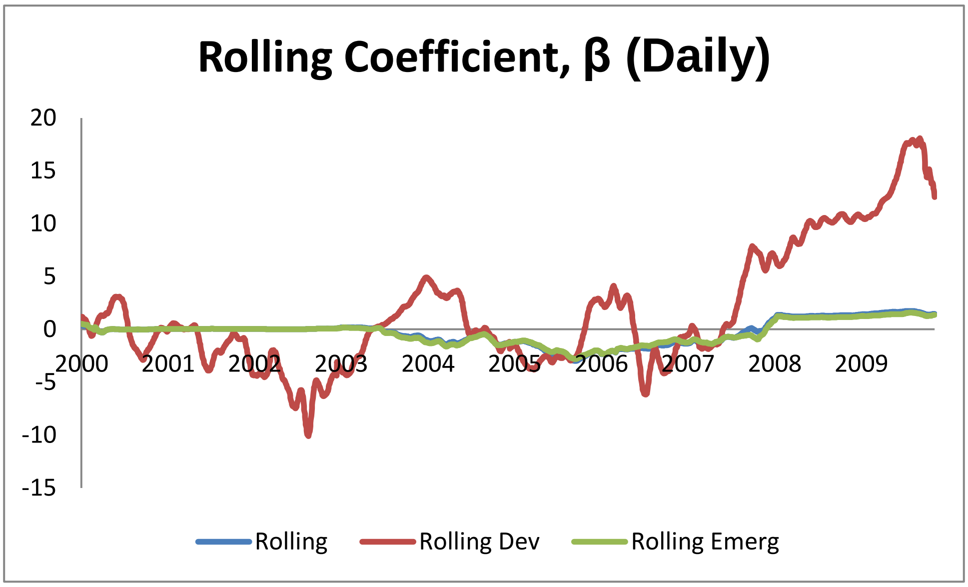


Figure 2-4: Slope coefficients from rolling regressions



All of these slope coefficients obtained from rolling regressions within each respective subsample fluctuate up and down around zero. However, they appear to more extreme, especially for the developed economies, when considering the results obtained with shorter time span and more recent observations. The forward premium puzzle with a negative slope coefficient occurs only in the middle of the first decade of the twenty-first century for the emerging economies, while the sequence of estimated β for the developed economies varies considerably over the sample period. Compared with the emerging economies, the slope coefficient from the forward premium regression for the developed economies exhibits more substantial variation. However, it is worth noticing that many of the more recent slopes are actually positive for both developed and emerging economies, implying that the forward premium has played a better role in forecasting the future currency depreciation in emerging economies compared with their counterparts and this forecasting ability improved in recent years.

2.7. Conclusion

In this chapter we have reconsidered two important anomalies in international finance and economics, which are the forward rate biasedness and forward premium puzzle. The forward rate biasedness is the rejection of the joint hypothesis of zero intercept and slope of unity in regressions of logarithm of spot exchange rate of forward exchange rate. The forward premium puzzle describes the negative slope coefficients which have invariably been reported in the regressions of the changes in the logarithm of the spot rate on the forward premium throughout the literature. However, it has been suggested that both the forward rate biasedness and the forward premium puzzle could be resolved by using better econometric methods and statistical procedures. In this chapter we have adopted FMOLS and DOLS methodologies to analyse time series cointegrating forward-spot relation and GARCH group methods to examine the forward-spot relation in returns. Furthermore, because Maynard (2003) pointed out that the negative coefficient in forward premium regression cannot be fully explained using time series characteristics of the variables we have incorporated panel data constructions in our empirical study.

Unlike the prior literature which has tested either for forward rate unbiasedness or forward premium puzzle, in this chapter we examine this forward-spot relation with regressions in both levels and returns using information from thirty-one developed and emerging economies. The empirical results from the regressions in levels demonstrate a robust long-run relationship between the forward and corresponding future spot exchange rates, which is consistent with previous literature. This chapter extends those literatures by confirming the robustness of this forward-spot cointegration relationship through different cointegration tests, and by using data in both weekly and daily frequencies. The forward rate unbiasedness hypothesis is also examined for individual economies with time series, as well as their panels. The joint hypothesis of zero intercept and slope of unity is not rejected in time series analysis for most economies with daily frquecy data. This result indicates that the forward rate has been an unbiased predictor of the future spot exchange rate in most developed and emerging economies over last decade and it is not sensitive to econometric approaches. This is one of the main interesting findings and contributions in this chapter. However, this unbiasedness forward-spot relation could not be identified with panel data of the developed and emerging groups.

Much of the previous empirical wisdom regarding the forward-spot relationship is based on evidence obtained from an individual developed economy or a group of developed economies, such as the G7. Compared with developed economies, emerging economies have a number of different characteristics and they play a much more important role in the exchange market. Hence, in this chapter we have extended the previous literature by paying more attention to the emerging economies and found that the forward premium anomaly is not a pervasive phenomenon: it seems to occur more often in developed economies. We have also adopted GARCH type models to capture the volatility clustering in the exchange rate, which might help to address the risk premium in the forward-spot relationship in returns. The results show the presence of significant ARCH/GARTH effects while regressing the currency depreciation on the corresponding forward premium. Although this does not solve the forward premium anomaly, the slope coefficients estimated in regressions of the changes in the logarithm of the spot rate on the forward premium become more statistically significant controls for the risk factors. It suggests that the risk factor should be taken into consideration when forecasting the future spot exchange rate with the corresponding forward exchange rate. The standard forward premium regressions are estimated for each individual economy with both time series and their panels to achieve a complete picture and fully understand this forward-spot relationship which has rarely found in previous studies. The rolling slope coefficients within panel framework are also provided for developed and emerging economies. The results show that with shorter samples the standard forward premium regression specifications generate slope coefficient estimates that are widely dispersed, especially for the developed economies, and many of the slopes estimated using more recent data are actually positive, with some of them significantly greater than one for both developed and emerging economies.

Appendix I

Table 2-1: Summary of panel unit root (UR) tests

Test	Null Hypothesis	Alternative Hypothesis	Possible Deterministic Component	Autocorrelation Correction Method
Levin, Lin and Chu	Unit Root	No Unit Root	None, F, T	Lags
Breitung	Unit Root	No Unit Root	None, F, T	Lags
IPS	Unit Root	Some cross-sections without UR	F, T	Lags
Fisher-ADF	Unit Root	Some cross-sections without UR	None, F, T	Lags
Fisher-PP	Unit Root	Some cross-sections without UR	None, F, T	Kernel
Hadri	No Unit Root	Unit Root	F, T	Kernel

None – no exogenous variables; F – fixed effect; T – individual effect and individual trend.

Table 2-2: Descriptive statistics and the stationarity of weekly exchange rates

Currency	Spot rates				Forward rates			
	Mean	S.D.	ADF 1st diff.	ADF level	Mean	S.D.	ADF 1st diff.	ADF level
AUD	0.00082	0.01558	-25.8460***	-0.05039	0.00081	0.01556	-25.9083***	-0.06223
CAD	0.00072	0.01411	-24.3704***	-0.87331	0.00071	0.01409	-24.4069***	-0.88009
EUR	0.00033	0.1056	-22.5145***	-0.31087	0.00033	0.01056	-22.5229***	-0.32151
HKD	0.00007	0.01330	-25.1049***	-1.43697	0.00007	0.01327	-25.0601***	-1.44094
ILS	0.00105	0.01512	-20.0549***	-0.51479	0.00105	0.01509	-20.0309***	-0.51786
JPY	0.00058	0.01805	-25.8857***	-0.54247	0.00058	0.01804	-25.9081***	-0.56059
NZD	0.00061	0.01648	-25.6585***	-0.86495	0.00060	0.01647	-25.6822***	-0.86633
NOK	0.00454	0.01262	-24.3774***	-0.80176	0.00045	0.01262	-24.4474***	-0.81291
SGD	0.00048	0.01155	-25.2520***	-0.12929	0.00047	0.01152	-25.2071***	-0.13918
CHF	0.00060	0.01268	-24.3015***	0.20033	0.00060	0.01267	-24.2811***	0.18747
USD	0.00007	0.01343	-25.0722***	-1.4572	0.00007	0.01341	-25.0127***	-1.45863
BRL	0.00197	0.02099	-17.4941***	-1.0706	0.00195	0.02096	-17.3849***	-1.01157
HUF	0.00018	0.01598	-25.0040***	-1.67731	0.00019	0.01599	-25.0167***	-1.66703
MXP	-0.00031	0.01678	-25.1972***	-1.20697	-0.00028	0.01693	-25.0485***	-1.21691
PLZ	0.00062	0.01651	-22.0279***	-0.85593	0.00063	0.01655	-22.1216***	-0.86910
ZAR	-0.00023	0.02209	-25.3813***	-2.21464	-0.00022	0.02214	-25.4437***	2.19779
TWD	0.00015	0.01238	-25.0622***	-1.23696	0.00014	0.01244	-24.7943***	-1.26754
CLP	0.00112	0.01796	-17.1867***	-1.26949	0.00111	0.01799	-17.1542***	-1.27672
CNY	0.00025	0.014154	-21.2238***	-0.59377	0.00025	0.01396	-21.1483***	-0.58753
COP	0.00151	0.02184	-18.3817***	-1.10935	0.001513	0.021954	-18.3721***	-1.10933
CZK	0.00090	0.01340	-22.8396***	0.33722	0.000901	0.013402	-22.9051***	0.32448
INR	-0.000002	0.01264	-23.8382***	-1.90434	-0.000008	0.012652	-23.8278***	-1.94129
IDR	-0.00013	0.02153	-12.2713***	-2.09485	-0.00010	0.01868	-22.9245***	-1.83829
MYR	0.00098	0.01516	-24.9005***	-2.48227	0.00978	0.01513	-24.9051***	-2.51392
MAD	0.00072	0.01047	-17.2163***	-0.61756	0.00071	0.01042	-17.2439***	-0.62326

Currency	Spot rates				Forward rates			
	Mean	S.D.	ADF 1st diff.	ADF level	Mean	S.D.	ADF 1st diff.	ADF level
PKR	-0.00076	0.01656	-19.9044***	-1.62318	-0.00079	0.01655	-19.8670***	-1.59147
PHP	-0.00014	0.01490	-25.2712***	-1.45671	-0.00013	0.01503	-25.3331***	-1.44971
RUR	0.00022	0.01326	-17.3499***	-2.24166	0.00021	0.01298	-18.2286***	-2.34073
THB	0.00038	0.01416	-26.6564***	-0.48110	0.00037	0.01418	-26.5248***	-0.49112
TRL	-0.00237	0.02577	-23.7101***	-3.86667	-0.00228	0.03716	-24.2710***	-2.75705
AED	0.00007	0.01342	-25.0725***	-1.45702	0.000068	0.01335	-24.9764***	-1.45694

Variables are expressed in natural logarithms. Changes refer to the first difference of natural logarithms of exchange rates. * indicates significance at 10% (or better), ** represents significance at 5% (or better), and * denotes significance at 1% level (or better). Currencies included in the sample are Australian Dollar (AUD), Canadian Dollar (CAD), Euro (EUR), Hong Kong Dollar (HKD), Israeli New Shekel (ILS), Japanese Yen (JPY), New Zealand Dollar (NZD), Norwegian Krone (NOK), Singapore Dollar (SGD), Swiss Franc (CHF), US Dollar (USD), Brazil Real (BRL), Hungarian Forint (HUF), Mexico Peso (MXP), Polish Zloty (PLZ), South African Rand (ZAR), New Taiwan Dollar (TWD), Chile Peso (CLP), Chinese Yuan (CNY), Colombia Peso (COP), Czech Koruna (CZK), Indian Rupee (INR), Indonesian Rupiah (IDR), Malaysian Ringgit (MYR), Morocco Dirham (MAD), Pakistan Rupee (PKR), Philippine Peso (PHP), Russian Ruble (RUR), Thailand Baht (THB), Turkish Lira (TRL) and United Arab Emirates Dirham (AED).**

Table 2-3: Descriptive statistics and the stationarity of daily exchange rates

	Spot rates				Forward rates			
	Mean	S.D.	ADF 1st diff.	ADF level	Mean	S.D.	ADF 1st diff.	ADF level
AUD	0.00017	0.00745	-55.9191***	-0.30985	0.00017	0.00745	-55.9240***	-0.30985
CAD	0.00015	0.00641	-54.7534***	-0.97512	0.00015	0.00641	-54.7961***	-0.97512
EUR	6.8E-05	0.00502	-53.1951***	-0.44617	6.8E-05	0.00502	-53.1753***	-0.44617
HKD	1.1E-05	0.00597	-52.6777***	-1.54708	1.1E-05	0.00596	-52.7351***	-1.54708
ILS	0.00020	0.00716	-39.3541***	-0.62408	0.00020	0.00715	-39.3524***	-0.62408
JPY	0.00012	0.00840	-53.1168***	-0.71854	0.00012	0.00841	-53.1134***	-0.71854
NZD	0.00014	0.00759	-53.4700***	-0.86691	0.00014	0.00759	-53.4649***	-0.86691
NOK	9.7E-05	0.00607	-53.0143***	-1.08497	9.7E-05	0.00607	-53.0203***	-1.08497
SGD	9.1E-05	0.00540	-54.0446***	-0.29103	9.0E-05	0.00540	-34.5186***	-0.29103
CHF	0.00012	0.00589	-54.6265***	0.02682	0.00012	0.00589	-54.5737***	0.02682
USD	1.1E-05	0.00599	-52.5913***	-1.56205	1.1E-05	0.00598	-52.6107***	-1.56205
BRL	0.00039	0.01006	-43.0894***	-1.17459	0.00038	0.01006	-42.9265***	-1.17459
HUF	4.4E-05	0.00714	-51.8415***	-1.81169	4.6E-05	0.00714	-51.8257***	-1.81169
MXP	-6.0E-05	0.00779	-54.0660***	-1.23447	-5.2E-05	0.00785	-53.9596***	-1.23447
PLZ	0.00012	0.00729	-53.4748***	-0.95252	0.00012	0.00729	-46.0025***	-0.95252
ZAR	-4.1E-05	0.01004	-53.6975***	-2.17774	-3.9E-05	0.01005	-53.6420***	-2.17774
TWD	3.0E-05	0.00596	-57.4342***	-1.38211	3.0E-05	0.00602	-58.0283***	-1.38211
CLP	0.00021	0.00809	-37.8426***	-1.50010	0.00021	0.00808	-37.6548***	-1.50010
CNY	4.0E-05	0.00635	-45.568***	-0.69831	4.1E-05	0.00629	-46.1343***	-0.69831
COP	0.00029	0.0090	-38.5080***	-1.17184	0.00029	0.00902	-38.6256*	-1.17184
CZK	0.00019	0.00624	-54.1364***	0.24611	0.00019	0.00624	-54.1370***	0.24611
INR	-2.8E-06	0.00596	-55.3459***	-2.03471	-3.4E-06	0.00597	-55.2728***	-2.03471
IDR	-2.6E-05	0.01007	-34.4493***	-2.11635	-1.9E-05	0.00906	-34.2120***	-2.11635
MYR	0.00019	0.00690	-54.8547***	-2.57394	0.00019	0.00690	-54.8625***	-2.57394
MAD	0.00014	0.00498	-39.3416***	-0.72034	0.00014	0.00497	-39.3816***	-0.72034

	Spot rates				Forward rates			
	Mean	**S.D.**	**ADF 1st diff.**	**ADF level**	**Mean**	**S.D.**	**ADF 1st diff.**	**ADF level**
PKR	-0.00016	0.00732	-39.7945***	-1.57379	-0.00017	0.00731	-39.7961***	-1.57379
PHP	-1.8E-05	0.00692	-55.5282***	-1.37439	-1.5E-05	0.00698	-55.3366***	-1.37439
RUR	2.6E-05	0.00644	-38.1174***	-2.659568	2.3E-05	0.00662	-38.3726***	-2.65957
THB	7.6E-05	0.00669	-54.5157***	-0.66226	7.6E-05	0.00672	-54.7686***	-0.66226
TRL	-0.00047	0.01304	-43.3847***	-3.7122***	-0.00045	0.01688	-56.0684***	-3.7122***
AED	1.1E-05	0.00599	-52.6157***	-1.56200	1.1E-05	0.00598	-52.631***	-1.56200

Variables are expressed in natural logarithms. Changes refer to the first difference of natural logarithms of exchange rates. * indicates significant at 10% (or better), ** represents significance at 5% (or better), and * denotes significance at 1% level (or better).**

Table 2-4: Panel Unit Root Tests for the stationarity of weekly exchange rates

Economy	Exchange rate	Levin, Lin, Chu	Breitung	Im, Pesaran, Shin	Fisher-ADF	Fisher-PP	Hadri
All Economies	$\ln ex$ level	1.0662	1.1189	2.4275	2.4848	2.6757	57.916**
		[0.8568]	[0.8684]	[0.9924]	[0.9935]	[0.9963]	[0.0000]
	$\ln ex$ 1st diff.	-169.31**	-85.617**	-137.52**	-69.619**	-70.103**	1.4244*
		[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0772]
	$\ln fr$ level	1.9334	0.5581	2.6682	2.7334	2.9051	58.253**
		[0.9734]	[0.7116]	[0.9962]	[0.9969]	[0.9982]	[0.0000]
	$\ln fr$ 1st diff.	-171.24**	-88.002**	-140.04**	-70.176**	-70.127**	1.0367
		[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.1499]
Developed Economies	$\ln ex$ level	3.1854	0.6339	3.5416	3.5697	3.9492	36.562**
		[0.9993]	[0.7369]	[0.9998]	[0.9998]	[1.0000]	[0.0000]
	$\ln ex$ 1st diff.	-107.5***	-49.10***	-88.48***	-42.37***	-42.29***	0.958
		[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.1689]
	$\ln fr$ level	3.158	0.614	3.510	3.541	3.922	36.60***
		[0.9992]	[0.7302]	[0.9998]	[0.9998]	[1.0000]	[0.0000]
	$\ln fr$ 1st diff.	-106.7***	-49.22***	-88.49***	-42.37***	-42.29***	0.947
		[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.1718]
Emerging Economies	$\ln ex$ level	-1.059	0.922	0.396	0.446	0.402	44.99***
		[0.1449]	[0.8218]	[0.6538]	[0.6723]	[0.6563]	[0.0000]
	$\ln ex$ 1st diff.	-130.8***	-71.42***	-105.6***	-55.25***	-55.91***	1.063*
		[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.1440]
	$\ln fr$ level	-0.019	0.227	0.719	0.777	0.708	45.38***
		[0.4923]	[0.5897]	[0.7640]	[0.7813]	[0.7606]	[0.0000]
	$\ln fr$ 1st diff.	-133.8***	-74.63***	-108.7***	-55.95***	-55.95***	0.588
		[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.2782]

The results report both test statistics and *p*-value (within brackets) for each unit root test. Breitung test includes both individual and trend effects while the rest include constant only but the results are robust when including constant and trend and/or none. Lag length selection based on Schwarz Information Criterion (SIC) of maximum lags. Newey-west bandwidth selection and Parzen kernel applied in the cases that spectral estimation required. * represents significance at 10% level, ** stands for significance at 5% level and * indicates significance at 1% level.**

Table 2-5: Panel Unit Root Tests for the stationarity of daily exchange rates

Economy	Exchange rate	Levin, Lin, Chu	Breitung	Im, Pesaran, Shin	Fisher-ADF	Fisher-PP	Hadri
All Economies	$\ln ex$ level	0.865	0.219	1.731	1.830	2.288	184.6***
		[0.8064]	[0.5866]	[0.9583]	[0.9664]	[0.9889]	[0.0000]
	$\ln ex$ 1st diff.	-380.5***	-187.3***	-311.3***	-27.18***	-25.438**	1.346*
		[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0892]
	$\ln fr$ level	1.510	-0.288	1.922	2.033	2.557	185.3***
		[0.9344]	[0.3867]	[0.9727]	[0.9785]	[0.9947]	[0.0000]
	$\ln fr$ 1st diff.	-378.5***	-190.4***	-308.47**	-28.47***	-25.39***	0.526
		[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.2996]
Developed Economies	$\ln ex$ level	2.815	0.038	3.011	3.097	3.447	119.0***
		[0.9976]	[0.5151]	[0.9987]	[0.9990]	[0.9997]	[0.0000]
	$\ln ex$ 1st diff.	-238.8***	-118.1***	-196.9***	-13.52***	-13.42***	0.377
		[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.3529]
	$\ln fr$ level	2.783	0.014	2.977	3.066	3.434	119.2***
		[0.9973]	[0.5054]	[0.9985]	[0.9989]	[0.9997]	[0.0000]
	$\ln fr$ 1st diff.	-232.1***	-118.3***	-189.8***	-16.01***	-13.42***	0.365
		[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.3574]
Emerging Economies	$\ln ex$ level	-1.041	0.242	-0.074	41.24	39.33	141.6***
		[0.1490]	[0.5958]	[0.4704]	[0.4163]	[0.5001]	[0.0000]
	$\ln ex$ 1st diff.	-296.3***	-145.5***	-241.6***	788.9***	648.1***	1.395*
		[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0814]
	$\ln fr$ level	-0.258	-0.375	0.187	36.22	32.75	142.4***
		[0.3981]	[0.3538]	[0.5741]	[0.6411]	[0.7852]	[0.0000]
	$\ln fr$ 1st diff.	-299.0***	-149.1***	-243.2***	779.7***	643.1***	0.383
		[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.3508]

The results report both test statistics and *p*-value (within brackets) for each unit root test. The Breitung test includes both individual and trend effects while the rest include constant only; however, the results are robust when including constant and trend and/or none. The lag length selection is based on the Schwarz Information Criterion (SIC) of maximum lags. Newey-west bandwidth selection and Parzen kernel applied in the cases that spectral estimation required. * represents significance at 10% level, ** stands for significance at 5% level and * indicates significance at 1% level.**

Table 2-6: FMOLS Cointegration tests between S_{t+l} and $F_{t,l}$ with weekly data

Currency	Cointegrating Vector	ADF(10)	$\alpha=0$	$\beta=1$	$\alpha=0\cap\beta=1$
AUD	$AUS_{t+4}=0.008887+1.009115AUF_t$ $(0.002065)\ (0.002339)$	-7.1957***	18.519***	15.190***	24.393***
CAD	$CAS_{t+4}=0.002266+1.003945CAF_t$ $(0.002143)\ (0.002791)$	-6.5851***	1.1177	1.9983	6.7300**
EUR	$EUS_{t+4}=0.000964+1.005276EUF_t$ $(0.000528)\ (0.001404)$	-6.6937**	3.3282*	14.119***	44.920***
HKD	$HKS_{t+4}=0.008564+1.003840HKF_t$ $(0.007563)\ (0.002946)$	-5.4552***	1.2824	1.6995	17.003***
ILS	$ILS_{t+4}=0.009228+1.004668ILF_t$ $(0.007777)\ (0.003908)$	-4.8403***	1.4077	1.4267	1.4308
JPY	$JPS_{t+4}=0.039219+1.008150JPF_t$ $(0.010340)\ (0.001983)$	-4.9607***	14.386***	16.893***	135.44***
NZD	$NZS_{t+4}=0.007722+1.005900NZF_t$ $(0.002577)\ (0.002459)$	-6.2965***	8.9759***	5.7549***	31.019***
NOK	$NOS_{t+4}=0.005076+1.001987NOF_t$ $(0.006612)\ (0.002694)$	-7.0970***	0.5892	0.5441	1.0543
SGD	$SGS_{t+4}=0.006102+1.008115SGF_t$ $(0.001866)\ (0.001865)$	-6.1037***	10.691***	18.926***	110.55***
CHF	$CHS_{t+4}=0.003066+1.006832CHF_t$ $(0.001601)\ (0.002004)$	-6.1688***	3.6673*	11.622***	85.817***
USD	$USS_{t+4}=-0.000418+1.000979USF_t$ $(0.001560)\ (0.002969)$	-5.53833***	0.07168	0.10872	7.81941**
BRL	$BRS_{t+4}=-0.001606+0.992340BRF_t$ $(0.007433)\ (0.005530)$	-5.74777***	0.04671	1.91888	57.4223***
HUF	$HUS_{t+4}=0.007584+1.000514HUF_t$ $(0.026003)\ (0.004399)$	-7.8665***	0.0851	0.0137	103.42***
MXP	$MXS_{t+4}=0.042333+1.012840MXF_t$ $(0.007652)\ (0.002641)$	-6.9049***	30.603***	23.644***	152.69***
PLZ	$PLS_{t+4}=0.005338+1.002293PLF_t$ $(0.005383)\ (0.003129)$	-5.8639***	0.9835	0.5369	10.471***
ZAR	$ZAS_{t+4}=-0.000718+0.997656ZAF_t$ $(0.012870)\ (0.005087)$	-6.5395***	0.0031	0.2122	48.733***
TWD	$TWS_{t+4}=0.056768+1.014670TWF_t$ $(0.012331)\ (0.003080)$	-6.0400***	21.193***	22.693***	59.205***
CLP	$CLS_{t+4}=0.040462+1.005978CLF_t$ $(0.048312)\ (0.007029)$	-5.17010**	0.70142	0.72326	1.37247
CNY	$CNS_{t+4}=0.037948+1.015864CNF_t$ $(0.006341)\ (0.002449)$	-4.5403***	35.817***	41.956***	119.52***
COP	$COS_{t+4}=0.035541+1.004045COF_t$ $(0.054011)\ (0.006535)$	-5.9718***	0.4330	0.3831	4.7431*

Currency	Cointegrating Vector	ADF(10)	$\alpha = 0$	$\beta = 1$	$\alpha = 0 \cap \beta = 1$
CZK	$CZS_{t+4} = -0.000203 + 0.999974 CZF_t$ $(0.006413)\quad(0.001700)$	-7.5877***	0.0010	0.0002	0.0726
INR	$INS_{t+4} = 0.055806 + 1.012438 INF_t$ $(0.024289)\quad(0.005610)$	-6.8530***	5.2788**	4.9166**	23.240***
IDR	$IDS_{t+4} = 0.059036 + 1.006057 IDF_t$ $(0.187969)\quad(0.019502)$	-7.0698***	0.0986	0.0965	0.1603
MYR	$MYS_{t+4} = 0.006344 + 1.003601 MYF_t$ $(0.010250)\quad(0.005615)$	-5.6813***	0.3831	0.4114	0.5122
MAD	$MAS_{t+4} = 0.058952 + 1.021128 MAF_t$ $(0.012096)\quad(0.004469)$	-4.5247***	23.754***	22.353***	36.794**
PKR	$PKS_{t+4} = -0.147470 + 0.0968503 PKF_t$ $(0.042095)\quad(0.008797)$	-4.0230***	12.273***	12.818***	27.589***
PHP	$PHS_{t+4} = 0.030530 + 1.006296 PHF_t$ $(0.010833)\quad(0.002459)$	-5.8843***	7.9421***	6.5535**	57.771***
RUR	$RUS_{t+4} = 0.236899 + 1.059825 RUF_t$ $(0.089545)\quad(0.022925)$	-6.6093***	6.0001***	6.8098***	13.971***
THB	$THS_{t+4} = 0.037058 + 1.008880 THF_t$ $(0.009276)\quad(0.002230)$	-6.0646***	15.960***	15.856***	16.133***
TRL	$TRS_{t+4} = 0.022886 + 1.023362 TRF_t$ $(0.074001)\quad(0.092144)$	-2.9168**	0.0957	0.0643	0.0957
AED	$AES_{t+4} = 0.006383 + 1.004603 AEF_t$ $(0.005577)\quad(0.003968)$	-5.5127***	1.3100	1.7541	10.152***

ADF critical value at the 5% significance level is -3.34. Since the ADF *t*-ratios are highly robust to higher order augmentation (1-25) only the results based on a uniform augmentation (i.e. 10) reported here. The hypotheses $\alpha = 0$, $\beta = 1$ and $\alpha = 0 \cap \beta = 1$ are tested and the results are reported, respectively. * denotes significance at 10% (or better), ** indicates significance at 5% (or better) and * stands for significance at 1% level (or better). All Wald test statistics are χ^2 distributed.**

Table 2-7: FMOLS Cointegration tests between S_{t+l} and $F_{t,l}$ with daily data

Currency	Cointegrating Vector	ADF(10)	$\alpha=0$	$\beta=1$	$\alpha=0\cap\beta=1$
AUD	$AUS_{t+21}=0.007447+1.007744AUF_t$ $(0.013978)\quad(0.015830)$	-10.583***	0.2839	0.2393	0.3483
CAD	$CAS_{t+21}=0.000961+1.002523CAF_t$ $(0.012723)\quad(0.016567)$	-11.841***	0.0057	0.0232	0.2537
EUR	$EUS_{t+21}=0.000201+1.003476EUF_t$ $(0.004703)\quad(0.012506)$	-10.258***	0.0018	0.0772	0.5711
HKD	$HKS_{t+21}=0.005928+1.002814HKF_t$ $(0.036871)\quad(0.014361)$	-9.0773***	0.0259	0.0384	0.6912
ILS	$ILS_{t+21}=0.005716+1.002687ILF_t$ $(0.032851)\quad(0.016507)$	-7.7524***	0.0303	0.0265	0.0513
JPY	$JPS_{t+21}=0.028499+1.006112JPF_t$ $(0.073778)\quad(0.014148)$	-9.2024***	0.1492	0.1866	2.6597
NZD	$NZS_{t+21}=0.002642+1.002251NZF_t$ $(0.017345)\quad(0.016567)$	-11.148***	0.0232	0.0186	0.0386
NOK	$NOS_{t+21}=0.004346+1.001772NOF_t$ $(0.039139)\quad(0.015949)$	-10.317***	0.0123	0.0123	0.0123
SGD	$SGS_{t+21}=0.004265+1.006273SGF_t$ $(0.013044)\quad(0.013042)$	-10.305***	0.1069	0.2314	2.1117
CHF	$CHS_{t+21}=0.000798+1.001522CHF_t$ $(0.009770)\quad(0.012203)$	-10.761***	0.0067	0.0156	0.0755
USD	$USS_{t+21}=-0.000957+0.999950USF_t$ $(0.007634)\quad(0.014528)$	-9.2192***	0.0157	0.00001	0.3320
BRL	$BRS_{t+21}=-0.003393+0.992661BRF_t$ $(0.023827)\quad(0.017725)$	-9.4332***	0.0203	0.1714	3.1386
HUF	$HUS_{t+21}=-0.028505+0.994476HUF_t$ $(0.117465)\quad(0.019873)$	-9.9027***	0.0589	0.0773	4.2763
MXP	$MXS_{t+21}=0.038700+1.011581MXF_t$ $(0.038926)\quad(0.013431)$	-10.899***	0.9884	0.7435	5.7788*
PLZ	$PLS_{t+21}=-0.001233+0.998662PLF_t$ $(0.027689)\quad(0.016096)$	-8.1139***	0.0020	0.0069	0.2193
ZAR	$ZAS_{t+21}=-0.016148+0.991647ZAF_t$ $(0.049573)\quad(0.019600)$	-10.321***	0.1061	0.1816	3.1258
TWD	$TWS_{t+21}=0.010656+1.002775TWF_t$ $(0.058636)\quad(0.014639)$	-9.9585***	0.0330	0.0359	0.1227
CLP	$CLS_{t+21}=0.025438+1.003667CLF_t$ $(0.204182)\quad(0.029707)$	-7.8665***	0.0155	0.0152	0.0205
CNY	$CNS_{t+21}=0.034891+1.014664CNF_t$ $(0.035708)\quad(0.013794)$	-7.4557***	0.9548	1.1300	3.4974
COP	$COS_{t+21}=0.032049+1.003593COF_t$ $(0.196082)\quad(0.023726)$	-7.4694***	0.0267	0.0229	0.4313

Currency	Cointegrating Vector	ADF(10)	$\alpha = 0$	$\beta = 1$	$\alpha = 0 \cap \beta = 1$
CZK	$CZS_{t+21} = -0.005766 + 0.998679 CZF_t$ $(0.028162) \quad (0.007468)$	-10.542***	0.0419	0.0313	0.2477
INR	$INS_{t+21} = 0.048786 + 1.010825 INF_t$ $(0.089502) \quad (0.020672)$	-10.069***	0.2971	0.2742	1.5888
IDR	$IDS_{t+21} = 0.111698 + 1.011538 IDF_t$ $(0.275389) \quad (0.028571)$	-8.5017***	0.1645	0.1631	0.1800
MYR	$MYS_{t+21} = 0.007557 + 1.004366 MYF_t$ $(0.029331) \quad (0.016064)$	-9.7814***	0.0664	0.0739	0.1152
MAD	$MAS_{t+21} = 0.053924 + 1.019324 MAF_t$ $(0.050171) \quad (0.018538)$	-7.8377***	1.1552	1.0866	1.7972
PKR	$PKS_{t+21} = -0.159290 + 0.965970 PKF_t$ $(0.127754) \quad (0.026700)$	-7.2035***	1.5546	1.6245	3.5406
PHP	$PHS_{t+21} = 0.020172 + 1.003977 PHF_t$ $(0.049177) \quad (0.011165)$	-9.1865***	0.1683	0.1269	2.3584
RUR	$RUS_{t+21} = 0.256623 + 1.064922 RUF_t$ $(0.164592) \quad (0.042139)$	-6.6201***	2.4310	2.3737	4.2771
THB	$THS_{t+21} = 0.020048 + 1.004828 THF_t$ $(0.061634) \quad (0.014817)$	-9.1885***	0.1058	0.1062	0.1064
TRL	$TRS_{t+21} = 0.037663 + 1.043113 TRF_t$ $(0.083018) \quad (0.103423)$	-3.1037***	0.2058	0.1738	0.2125
AED	$AES_{t+21} = 0.004304 + 1.002919 AEF_t$ $(0.026577) \quad (0.014620)$	-9.1962***	0.0262	0.0399	0.4152

ADF critical value at the 5% significance level is -3.34. Since the ADF *t*-ratios are highly robust to higher order augmentation (1-25) only the results based on a uniform augmentation (i.e. 10) reported here. The hypotheses $\alpha = 0$, $\beta = 1$ and $\alpha = 0 \cap \beta = 1$ are tested and the results are reported, respectively. * indicates significance at 10% (or better) and ** indicates significance at 5% (or better), * represents significance at 1% (or better), respectively. All Wald test statistics are χ^2 distributed with degree of freedom one and two, respectively.**

Table 2-8: DOLS Cointegration tests between S_{t+l} and $F_{t,l}$ with weekly data

Currency	Cointegrating Vector	ADF(10)	$\alpha=0$	$\beta=1$	$\alpha=0 \cap \beta=1$
AUD	$AUS_{t+4}=0.006862+1.006736AUF_t$ $(0.000410)\quad(0.000503)$	-7.15449***	280.152***	179.249***	592.276***
CAD	$CAS_{t+4}=0.001123+1.002598CAF_t$ $(0.000477)\quad(0.000664)$	-6.57388***	5.54222**	15.3345***	75.7388***
EUR	$EUS_{t+4}=-0.000046+1.003169EUF_t$ $(0.000272)\quad(0.000864)$	-6.67739***	0.02830	13.4533***	102.824***
HKD	$HKS_{t+4}=0.009711+1.004282HKF_t$ $(0.003852)\quad(0.001519)$	-5.45526***	6.35498**	7.94302***	44.4291***
ILS	$ILS_{t+4}=0.003401+1.001910ILF_t$ $(0.001417)\quad(0.000759)$	-4.82748***	5.75862**	6.33629**	8.79669**
JPY	$JPS_{t+4}=0.030147+1.006451JPF_t$ $(0.007267)\quad(0.001367)$	-4.95235***	17.2094***	22.2607***	1085.24***
NZD	$NZS_{t+4}=0.006435+1.004698NZF_t$ $(0.000853)\quad(0.000822)$	-6.28702***	56.8923**	32.6970***	182.781***
NOK	$NOS_{t+4}=0.005346+1.002113NOF_t$ $(0.004337)\quad(0.001824)$	-7.09787***	1.51927	1.34208	3.20335
SGD	$SGS_{t+4}=0.004544+1.006659SGF_t$ $(0.001176)\quad(0.001172)$	-6.08798***	14.9312***	32.2562***	229.923***
CHF	$CHS_{t+4}=0.001855+1.005526CHF_t$ $(0.000603)\quad(0.000797)$	-6.15028***	9.46765***	48.0396***	434.404***
USD	$USS_{t+4}=-0.000127+1.001499USF_t$ $(0.000779)\quad(0.001523)$	-5.53845***	0.02652	0.96771	23.8690***
BRL	$BRS_{t+4}=-0.002356+0.992702BRF_t$ $(0.001896)\quad(0.001429)$	-5.74474***	1.54416	26.0958***	231.072***
HUF	$HUS_{t+4}=-0.008183+0.997903HUF_t$ $(0.013201)\quad(0.002233)$	-7.86182***	0.38419	0.88137	151.088***
MXP	$MXS_{t+4}=0.038918+1.011789MXF_t$ $(0.009738)\quad(0.003243)$	-6.90584***	15.9734***	13.2132***	104.402***
PLZ	$PLS_{t+4}=0.001704+1.000324PLF_t$ $(0.001992)\quad(0.001207)$	-5.85861***	0.73183	0.07182	20.9806***
ZAR	$ZAS_{t+4}=-0.007760+0.994994ZAF_t$ $(0.005480)\quad(0.002148)$	-6.54464***	2.00557	5.43363**	292.352***
TWD	$TWS_{t+4}=0.053472+1.013885TWF_t$ $(0.012171)\quad(0.003028)$	-6.03877***	19.3027***	21.0234***	93.6623***
CLP	$CLS_{t+4}=0.016605+1.002453CLF_t$ $(0.015383)\quad(0.002310)$	-5.16836***	1.09918	1.12832	1.73952
CNY	$CNS_{t+4}=0.036221+1.015184CNF_t$ $(0.004592)\quad(0.001823)$	-4.53798***	62.2085***	69.3902***	106.313***
COP	$COS_{t+4}=0.022326+1.002442COF_t$ $(0.022986)\quad(0.002758)$	-5.96787***	0.94335	0.78390	32.6043***

Currency	**Cointegrating Vector**	**ADF(10)**	$\alpha=0$	$\beta=1$	$\alpha=0\cap\beta=1$
CZK	$CZS_{t+4}=-0.000059+1.000208CZF_t$ $(0.003437)\quad(0.000910)$	-7.59130***	0.00029	0.05234	15.2104***
INR	$INS_{t+4}=0.057708+1.012890INF_t$ $(0.016267)\quad(0.003796)$	-6.85296***	12.5847***	11.5339***	128.109***
IDR	$IDS_{t+4}=-0.034570+0.996425IDF_t$ $(0.151926)\quad(0.015459)$	-7.06900***	0.05178	0.05349	0.32158
MYR	$MYS_{t+4}=0.013557+1.007746MYF_t$ $(0.002440)\quad(0.001364)$	-5.69681***	30.8721***	32.2437***	37.8756***
MAD	$MAS_{t+4}=0.054698+1.019683MAF_t$ $(0.008663)\quad(0.003162)$	-4.52201***	39.8671***	38.7564***	46.3365**
PKR	$PKS_{t+4}=-0.117141+0.974746PKF_t$ $(0.024671)\quad(0.005171)$	-4.02691***	22.5442***	23.8491***	62.9481***
PHP	$PHS_{t+4}=0.029216+1.006024PHF_t$ $(0.005872)\quad(0.001315)$	-5.88511***	24.7536***	20.9754***	115.897***
RUR	$RUS_{t+4}=0.332771+1.084423RUF_t$ $(0.183785)\quad(0.046759)$	-6.58874***	3.27844*	3.25970*	4.85640*
THB	$THS_{t+4}=0.020542+1.004961THF_t$ $(0.008897)\quad(0.002171)$	-6.03185***	5.33059***	5.22288**	6.08316**
TRL	$TRS_{t+4}=-0.126609+0.854266TRF_t$ $(0.092230)\quad(0.097132)$	-3.15312**	1.88445	2.25112	6.10722**
AED	$AES_{t+4}=0.007082+1.004435AEF_t$ $(0.004140)\quad(0.002331)$	-5.51275***	2.92581*	3.61935*	18.8326***

ADF critical value at the 5% significance level is -3.34. Since the ADF *t*-ratios are highly robust to higher order augmentation (1-25) only the results based on a uniform augmentation (i.e. 10) reported here. The hypotheses $\alpha=0$, $\beta=1$ and $\alpha=0\cap\beta=1$ are tested and the results are reported, respectively. * indicates significance at 10% (or better), ** indicates significance at 5% (or better) and * indicates significance at 1% (or better), respectively. All Wald test statistics are χ^2 distributed with degree of freedom one and two, respectively.**

Table 2-9: DOLS Cointegration tests between S_{t+l} and $F_{t,l}$ with daily data

Currency	Cointegrating Vector	ADF(10)	$\alpha = 0$	$\beta = 1$	$\alpha = 0 \cap \beta = 1$
AUD	$AUS_{t+21} = 0.011201 + 1.008785 AUF_t$ (0.013282) (0.014643)	-10.591***	0.7111	0.3599	3.8130
CAD	$CAS_{t+21} = -0.003196 + 0.993586 CAF_t$ (0.011021) (0.014091)	-11.789***	0.0841	0.2072	1.4690
EUR	$EUS_{t+21} = -0.000158 + 0.999308 EUF_t$ (0.005614) (0.013976)	-10.236***	0.0008	0.0025	0.0112
HKD	$HKS_{t+21} = -0.048497 + 0.981508 HKF_t$ (0.031711) (0.012381)	-9.0241***	2.3388	2.2308	2.7772
ILS	$ILS_{t+21} = -0.001611 + 0.997619 ILF_t$ (0.031671) (0.015574)	-7.7335***	0.0026	0.0234	2.3150
JPY	$JPS_{t+21} = -0.012242 + 0.997938 JPF_t$ (0.073965) (0.014089)	-9.1632***	0.0274	0.0214	0.4857
NZD	$NZS_{t+21} = -0.006263 + 0.991643 NZF_t$ (0.013927) (0.013345)	-11.089***	0.2022	0.3922	2.0725
NOK	$NOS_{t+21} = -0.020534 + 0.990897 NOF_t$ (0.037586) (0.015094)	-10.270***	0.2985	0.3637	2.5717
SGD	$SGS_{t+21} = 0.005208 + 1.005725 SGF_t$ (0.013253) (0.012854)	-10.302***	0.1544	0.1984	0.4826
CHF	$CHS_{t+21} = 0.007960 + 1.007966 CHF_t$ (0.010324) (0.012327)	-10.813***	0.5945	0.4177	1.4432
USD	$USS_{t+21} = -0.011788 + 0.978404 USF_t$ (0.006526) (0.012430)	-9.1644***	3.2632*	3.0186*	3.2658
BRL	$BRS_{t+21} = -0.017924 + 0.976105 BRF_t$ (0.020759) (0.015401)	-9.4133***	0.7456	2.4074	19.512***
HUF	$HUS_{t+21} = -0.200582 + 0.965225 HUF_t$ (0.147082) (0.024721)	-9.8053***	1.8598	1.9788	18.003***
MXP	$MXS_{t+21} = -0.004161 + 0.997156 MXF_t$ (0.033036) (0.011231)	-10.857***	0.0159	0.0641	4.3660
PLZ	$PLS_{t+21} = -0.024551 + 0.983923 PLF_t$ (0.033349) (0.018773)	-8.0655***	0.5420	0.7335	4.5649
ZAR	$ZAS_{t+21} = -0.115442 + 0.952576 ZAF_t$ (0.041178) (0.016673)	-10.234***	7.8595***	8.0908***	8.4471**
TWD	$TWS_{t+21} = -0.060988 + 0.984776 TWF_t$ (0.047143) (0.0011735)	-9.9007***	1.6736	1.6831	1.6925
CLP	$CLS_{t+21} = -0.168936 + 0.974948 CLF_t$ (0.146590) (0.021304)	-7.7968***	1.3281	1.3829	2.7506
CNY	$CNS_{t+21} = 0.009132 + 1.004419 CNF_t$ (0.009132) (0.039422)	-7.4239***	0.0537	0.0880	2.0494
COP	$COS_{t+21} = -0.138661 + 0.982387 COF_t$ (0.150674) (0.018166)	-7.4175***	0.8469	0.9401	5.7937**

Currency	Cointegrating Vector	ADF(10)	$\alpha = 0$	$\beta = 1$	$\alpha = 0 \cap \beta = 1$
CZK	$CZS_{t+21} = 0.008108 + 1.001488 CZF_t$ $(0.032071) \quad (0.008369)$	-10.563***	0.0639	0.0316	2.7048
INR	$INS_{t+21} = -0.128089 + 0.969980 INF_t$ $(0.071103) \quad (0.016518)$	-9.9655***	3.2453*	3.3028*	3.8132
IDR	$IDS_{t+21} = -0.382518 + 0.960299 IDF_t$ $(0.228505) \quad (0.023467)$	-8.4156***	2.8023*	2.8621*	4.9316*
MYR	$MYS_{t+21} = -0.059390 + 0.965921 MYF_t$ $(0.035414) \quad (0.019704)$	-9.7741***	2.8125*	2.9913*	4.0135
MAD	$MAS_{t+21} = 0.026435 + 1.008388 MAF_t$ $(0.049177) \quad (0.017794)$	-7.8033***	0.2890	0.2222	6.4878**
PKR	$PKS_{t+21} = -0.335147 + 0.929752 PKF_t$ $(0.125347) \quad (0.026413)$	-7.1499***	7.1490**	7.0733***	7.7945**
PHP	$PHS_{t+21} = -0.050088 + 0.988094 PHF_t$ $(0.043609) \quad (0.009862)$	-9.1604***	1.3193	1.4573	3.4052
RUR	$RUS_{t+21} = -0.098227 + 0.973929 RUF_t$ $(0.215019) \quad (0.054838)$	-6.4603***	0.2087	0.2260	4.6792*
THB	$THS_{t+21} = 0.002468 + 1.000298 THF_t$ $(0.059058) \quad (0.014088)$	-9.1644***	0.0018	0.0005	0.5981
TRL	$TRS_{t+21} = -0.137266 + 0.845379 TRF_t$ $(0.062303) \quad (0.065656)$	-3.2857**	4.8540**	5.5461**	8.5744**
AED	$AES_{t+21} = -0.034869 + 0.981201 AEF_t$ $(0.022594) \quad (0.012447)$	-9.1412***	2.3818	2.2811	2.5437

ADF critical value at the 5% significance level is -3.34. Since the ADF *t*-ratios are highly robust to higher order augmentation (1-25) only the results based on a uniform augmentation (i.e. 10) reported here. The hypotheses $\alpha = 0$, $\beta = 1$ and $\alpha = 0 \cap \beta = 1$ are tested and the results are reported, respectively. * indicates significance at 10% (or better), ** indicates significance at 5% (or better) and * indicates significance at 1% (or better), respectively. All Wald test statistics are χ^2 distributed with degree of freedom one and two, respectively.**

Table 2-10: Panel cointegration for weekly data

Economy	Test	No Intercept or Trend	Individual Intercept	Individual Intercept and Individual Trend
All Economies	**Pedroni**	-88.63113***	-67.90634***	-88.63113***
		[0.0000]	[0.0000]	[0.0000]
	Kao		-10.35146***	
			[0.0000]	
Developed Economies	**Pedroni**	-65.60129***	-57.94933***	-51.40137***
		[0.0000]	[0.0000]	[0.0000]
	Kao		-7.687700***	
			[0.0000]	
Emerging Economies	**Pedroni**	-62.77741***	-54.59534***	-47.06893***
		[0.0000]	[0.0000]	[0.0000]
	Kao		-6.081128***	
			[0.0000]	

The null hypothesis of no cointegration tested using both Pedroni and Kao tests. Panel rho-statistics and *p*-values (within brackets) reported for Pedroni tests, while panel ADF test statistics and *p*-value (within brackets) reported for Kao tests. d.f. corrected Dickey-Fuller residual variances used. Lag length selection based on Schwarz information criterion (SIC) with a max lag of 16. Newey-West bandwidth selection and Parzen kernel applied. * represents significance at 10% level (or better)， denotes significance at 5% level (or better) and *** stands for significance at 1% level (or better).**

Table 2-11: Panel cointegration for daily data

Economy	Test	No Intercept or Trend	Individual Intercept	Individual Intercept and Individual Trend
All Economies	**Pedroni**	-137.9735***	-125.1185***	-105.1600***
		[0.0000]	[0.0000]	[0.0000]
	Kao		-17.94994***	
			[0.0000]	
Developed Economies	**Pedroni**	-126.9814***	-111.0822***	-95.12833***
		[0.0000]	[0.0000]	[0.0000]
	Kao		-18.27960***	
			[0.0000]	
Emerging Economies	**Pedroni**	-88.27325***	-80.47931***	-66.86064***
		[0.0000]	[0.0000]	[0.0000]
	Kao		-10.95509***	
			[0.0000]	

The null hypothesis of no cointegration tested using both Pedroni and Kao tests. Panel rho-statistics and *p*-values (within brackets) reported for Pedroni tests, while panel ADF test statistics and *p*-value (within brackets) reported for Kao tests. d.f. corrected Dickey-Fuller residual variances used. Lag length selection based on Schwarz information criterion (SIC) with a max lag of 16. Newey-West bandwidth selection and Parzen kernel applied. * represents significance at 10% level (or better), ** denotes significance at 5% (or better) and * stands for significance at 1% level (or better).**

Table 2-12: DOLS/DGLS panel cointegration for weekly data

Economy	Cointegrating vector	Liven, Lin and Chu	$\alpha=0$	$\beta=1$	$\alpha=0\cap\beta=1$
All Economies	$\ln EX_{i,t+4} = -0.163092 + 0.945132 \ln FR_{i,t}$ $(0.018336) \quad (0.006179)$	-15.485*** [0.0000]	79.1147*** [0.0000]	78.8433*** [0.0000]	116.509*** [0.0000]
Developed Economies	$\ln EX_{i,t+4} = -0.012558 + 0.991465 \ln FR_{i,t}$ $(0.004743) \quad (0.003020)$	-11.233*** [0.0000]	7.01175*** [0.0081]	7.98829*** [0.0047]	26.1676*** [0.0000]
Emerging Economies	$\ln EX_{i,t+4} = -0.262710 + 0.9316071 \ln FR_{i,t}$ $(0.028973) \quad (0.007543)$	-11.467*** [0.0000]	82.2161*** [0.0000]	82.2080*** [0.0000]	82.2994*** [0.0000]

DOLS/DGLS based panel cointegrating vector reported. The corresponding standard errors are reported in parenthesis beneath the coefficient estimates. The Liven, Lin and Chu unit root test applied to the residuals and *t*-statistic and *p*-value (within brackets) reported. Wald test statistics are χ^2 distributed with coefficient restrictions. The hypotheses $\alpha=0$, $\beta=1$ and $\alpha=0\cap\beta=1$ are tested and the results are reported, respectively. * represents significance at 10% level (or better), ** denotes significance at 5% level (or better) and * stands for significance at 1% level (or better).**

Table 2-13: DOLS/DGLS panel cointegration for daily data

Economy	Cointegrating vector	Liven, Lin and Chu	$\alpha=0$	$\beta=1$	$\alpha=0\cap\beta=1$
All Economies	$\ln EX_{i,t+21} = -218970 + 0.926017 \ln FR_{i,t}$ $(0.008741) \quad (0.002945)$	-8.5872*** [0.0000]	627.592*** [0.0000]	630.987*** [0.0000]	1180.33*** [0.0000]
Developed Economies	$\ln EX_{i,t+4} = -0.031217 + 0.979703 \ln FR_{i,t}$ $(0.003697) \quad (0.002344)$	-22.344*** [0.0000]	71.2843*** [0.0000]	74.9631*** [0.0000]	1185.03*** [0.0000]
Emerging Economies	$\ln EX_{i,t+4} = -0.335391 + 0.912569 \ln FR_{i,t}$ $(0.013537) \quad (0.003524)$	-6.5586*** [0.0000]	613.840*** [0.0000]	615.512*** [0.0000]	781.804*** [0.0000]

DOLS/DGLS based panel cointegrating vector reported. The corresponding standard errors are reported in parenthesis beneath the coefficient estimates. The Liven, Lin and Chu unit root test applied to the residuals and *t*-statistic and *p*-value (within brackets) reported. Wald test statistics are χ^2 distributed with coefficient restrictions. The hypotheses $\alpha=0$, $\beta=1$ and $\alpha=0\cap\beta=1$ are tested and the results are reported, respectively. * represents significance at 10% level (or better), ** denotes significance at 5% level (or better) and * indicates significance at 1% level (or better).**

Table 2-14: Implications of the forward premium regression

Case		$\beta_l = \dfrac{Cov(d, d+p)}{Var(d+p)}$	$Var(p)$ and $Var(d)$	$Cov(d,p)$
I	UIP holds	= 1	$Var(d) > Var(p) = 0$	$Cov(d,p) = 0$
II	Forward premium puzzle	< 0	$Var(p) > \lvert Cov(d,p)\rvert > Var(d)$	$Cov(d,p) < 0$

Table 2-15: Forward premium regressions for weekly individual currencies

	Standard Regression		State-dependent Regressions					
	β_l	$SE(\beta_l)$	β_l^+	$SE(\beta_l^+)$	β_l^-	$SE(\beta_l^-)$	**Wald[a]**	**Wald[b]**
AUD	-1.668293	(2.197720)	10.53580	(9.795939)	-2.675148	(2.614909)	[0.2381]	[0.2187]
CAD	3.764998	(2.765245)	2.697637	(2.871547)	40.73557	(22.66754)	[0.1039]	[0.0082]
EUR	-2.949988	(2.481661)	-0.970986	(2.001127)	-66.84694	(55.57890)	[0.2395]	[0.2220]
HKD	-0.274635	(1.533656)	0.133526	(1.710382)	-6.020495	(14.19427)	[0.6792]	[0.5987]
ILS	2.430125	(4.056591)	13.20642	(5.641080)	-21.05569	(6.591431)	[0.0008]	[0.0132]
JPY	-0.078261	(1.916444)	-	-	-	-	-	[0.2153]
NZD	0.074285	(2.006352)	-3.133600	(7.594002)	0.612921	(2.872583)	[0.6960]	[0.0176]
NOK	-0.287618	(0.897005)	1.064355	(2.287079)	-1.654934	(2.197319)	[0.5089]	[0.6242]
SGD	0.027291	(1.578744)	0.496944	(1.621413)	-12.76872	(23.51594)	[0.5798]	[0.0286]
CHF	-2.622531	(1.674875)	-	-	-	-	-	[0.1718]
USD	-0.391068	(1.824968)	0.224563	(2.293350)	-5.460071	(14.84268)	[0.7252]	[0.0987]
BRL	-0.552721	(1.109150)	3.956976	(5.534260)	-0.644125	(1.184492)	[0.4636]	[0.0029]
HUF	0.294609	(0.866611)	-	-	-	-	-	[0.0290]
MXP	-1.402588	(0.466335)	-	-	-	-	-	[0.3007]
PLZ	3.076579	(1.616203)	0.897825	(6.316552)	3.500722	(2.202913)	[0.7333]	[0.9292]
ZAR	-3.734457	(1.554624)	-	-	-	-	-	[0.1952]
TWD	0.621394	(0.546443)	0.679708	(0.692541)	0.501006	(1.293478)	[0.9118]	[0.5342]
CLP	-1.644884	(2.546650)	4.170893	(3.251435)	-6.490521	(2.962303)	[0.0323]	[0.0007]
CNY	-0.359722	(1.027857)	1.421321	(0.643555)	-6.817858	(2.287280)	[0.0005]	[0.0047]
COP	-2.083723	(1.823453)	12.12868	(9.319366)	-3.268063	(2.073537)	[0.1321]	[0.1833]
CZK	2.239894	(1.748067)	-0.735609	(2.318866)	9.775305	(6.845558)	[0.2125]	[0.0444]
INR	-1.366524	(0.800403)	-3.572993	(1.935446)	-0.612907	(1.034958)	[0.2283]	[0.1259]
IDR	0.359994	(0.173375)	0.331155	(0.241341)	0.414590	(0.221153)	[0.8055]	[0.0338]
MYR	0.467092	(1.624414)	0.287051	(2.225378)	0.954811	(4.441067)	[0.9060]	[0.7030]
MAD	0.531290	(0.821504)	-1.056964	(3.515045)	0.758907	(1.065344)	[0.6597]	[0.7982]
PKR	0.229783	(0.796921)	-1.971142	(2.127700)	0.577421	(1.000908)	[0.3464]	[0.3932]

	Standard Regression		State-dependent Regressions					
	β_l	$SE(\beta_l)$	β_l^+	$SE(\beta_l^+)$	β_l^-	$SE(\beta_l^-)$	**Wald[a]**	**Wald[b]**
PHP	0.851056	(0.950242)	15.66456	(10.29166)	0.517517	(1.004603)	[0.1559]	[0.0772]
RUR	1.236777	(0.682613)	-2.112768	(2.034568)	1.349197	(0.715695)	[0.1528]	[0.0007]
THB	-0.342735	(1.077043)	-1.723450	(1.878651)	0.159650	(1.600021)	[0.5194]	[0.0139]
TRL	-0.014004	(0.033643)	-0.035650	(0.036149)	0.482529	(0.172702)	[0.0041]	[0.0107]
AED	-0.164253	(1.332711)	1.062560	(1.361062)	-9.663346	(6.457274)	[0.1247]	[0.0205]

This table reports results from estimation of regressions (2.5.5) $\ln S_{t+l} - \ln S_t = \alpha_l + \beta_l(\ln F_{t,l} - \ln S_t) + \varepsilon_{t+l,l}$**, (2.5.6)** $\ln S_{t+l} - \ln S_t = \alpha_l + \beta_l^+(\ln F_{t,l} - \ln S_t)^+ + \beta_l^-(\ln F_{t,l} - \ln S_t)^- + \varepsilon_{t+l,l}$ **and (2.5.9)** $\ln S_{t+l} - \ln S_t = \alpha_l + \beta_l(\ln F_{t,l} - \ln S_t) + \gamma_l(\ln F_{t,l} - \ln S_t)^2 + \eta_l(\ln F_{t,l} - \ln S_t)^3 + \varepsilon_{t+l,l}$**. The standard regression is the regression of percentage change in the exchange rate on the associated forward premium. The plus-minus regression refers to a case when observations of the forward premia are categorized into negative and positive observations. The corresponding standard error is given within parenthesis. The Wald[a] statistic refers to the test of the hypothesis that** $\beta_l^+ = \beta_l^-$**. The Wald[b] statistic refers to the test of the hypothesis that the added terms are zero. P-values from Wald tests are reported within brackets. HAC (Newey-West) covariance matrices are robust to heteroskedasticity and serial correlation.**

Table 2-16: Forward premium regressions for daily individual currencies

	Standard Regression		State-dependent Regressions					
	β_l	$SE(\beta_l)$	β_l^+	$SE(\beta_l^+)$	β_l^-	$SE(\beta_l^-)$	**Wald[a]**	**Wald[b]**
AUD	-2.026882	(1.567068)	8.494450	(6.826307)	-3.008529	(1.838198)	[0.1349]	[0.6709]
CAD	2.929582	(1.913539)	2.563572	(1.989776)	18.34294	(18.45382)	[0.4050]	[0.0420]
EUR	-3.028630	(1.849059)	-1.531778	(1.514393)	-53.92475	(52.22452)	[0.3200]	[0.9145]
HKD	0.177604	(1.069942)	-0.200299	(1.205276)	5.701214	(6.050991)	[0.3678]	[0.5550]
ILS	4.051134	(2.875034)	12.68456	(3.961078)	-17.88011	(6.831541)	[0.0010]	[0.1396]
JPY	0.434898	(1.475289)	-	-	-	-	-	[0.0771]
NZD	-1.749471	(5.929299)	-3.364944	(6.929290)	-1.189737	(8.627303)	[0.8674]	[0.1904]
NOK	-0.403826	(0.717016)	0.786063	(1.757603)	-1.643190	(1.725765)	[0.4443]	[0.0001]
SGD	0.616040	(1.128182)	0.644291	(1.198541)	-0.453171	(14.38138)	[0.9407]	[0.0448]
CHF	-6.922925	(3.586132)	-7.049443	(3.613501)	29.16910	(3.726661)	[0.0000]	[0.0702]
USD	0.228114	(1.284825)	-0.704727	(1.546841)	8.747067	(7.750362)	[0.2665]	[0.1302]
BRL	-0.542814	(0.840737)	5.137957	(4.083717)	-0.618085	(0.878736)	[0.2133]	[0.0001]
HUF	0.339862	(0.638317)	-	-	-	-	-	[0.2784]
MXP	-1.483341	(0.354394)	-	-	-	-	-	[0.1031]
PLZ	3.155290	(1.092927)	-0.772769	(4.335230)	3.942777	(1.567836)	[0.3779]	[0.2469]
ZAR	-3.986464	(1.115118)	-5.550962	(1.715975)	-3.983209	(1.120782)	[0.5724]	[0.2600]
TWD	1.486975	(1.267544)	0.822560	(1.574125)	2.595360	(2.600260)	[0.5864]	[0.8502]
CLP	-1.930320	(1.631843)	4.617137	(2.340675)	-7.453288	(1.951404)	[0.0005]	[0.0000]
CNY	-0.226157	(0.662156)	1.611798	(0.464477)	-7.273854	(1.761677)	[0.0000]	[0.0001]
COP	2.092099	(1.352700)	7.545510	(4.781440)	-2.948001	(1.554940)	[0.0575]	[0.3010]
CZK	2.363472	(1.203210)	-0.881022	(1.586791)	9.976375	(3.992676)	[0.0296]	[0.1332]
INR	-1.451861	(0.589355)	-4.341840	(1.47378)	-0.509177	(0.777628)	[0.0419]	[0.0206]
IDR	0.351412	(0.124395)	0.334295	(0.168957)	0.387419	(0.166812)	[0.8275]	[0.0840]
MYR	0.911563	(1.265265)	0.987964	(1.808032)	0.706242	(3.176597)	[0.9468]	[0.0878]
MAD	0.680199	(0.606124)	-1.762270	(2.473660)	1.029353	(0.776165)	[0.3368]	[0.5494]
PKR	0.304150	(0.530124)	-2.520046	(1.677044)	0.740346	(0.659960)	[0.1087]	[0.0416]

	Standard Regression		State-dependent Regressions					
	β_l	$SE(\beta_l)$	β_l^+	$SE(\beta_l^+)$	β_l^-	$SE(\beta_l^-)$	**Wald**[a]	**Wald**[b]
PHP	0.842425	(0.806721)	20.30653	(9.527355)	0.366683	(0.846778)	[0.0423]	[0.0008]
RUR	1.258867	(0.401713)	-2.130128	(1.320447)	1.369911	(0.418592)	[0.0217]	[0.0029]
THB	-0.407807	(0.717661)	-1.983211	(1.407897)	0.196742	(1.082990)	[0.2982]	[0.7020]
TRL	-0.012299	(0.023435)	-0.033912	(0.024725)	0.565389	(0.129088)	[0.0000]	[0.0001]
AED	0.105048	(0.908628)	0.626183	(1.019930)	-4.208953	(4.589028)	[0.3344]	[0.0187]

This table reports results from estimation of regressions (2.5.5) $\ln S_{t+l} - \ln S_t = \alpha_l + \beta_l(\ln F_{t,l} - \ln S_t) + \varepsilon_{t+l,l}$ **, (2.5.6)** $\ln S_{t+l} - \ln S_t = \alpha_l + \beta_l^+(\ln F_{t,l} - \ln S_t)^+ + \beta_l^-(\ln F_{t,l} - \ln S_t)^- + \varepsilon_{t+l,l}$ **and (2.5.9)** $\ln S_{t+l} - \ln S_t = \alpha_l + \beta_l(\ln F_{t,l} - \ln S_t) + \gamma_l(\ln F_{t,l} - \ln S_t)^2 + \eta_l(\ln F_{t,l} - \ln S_t)^3 + \varepsilon_{t+l,l}$ **.The standard regression is the regression of percentage change in the exchange rate on the associated forward premium. The plus-minus regression refers to a case when observations of the forward premia are categorised into negative and positive observations. The corresponding standard error is given within parenthesis. The Wald[a] statistic refers to the test of the hypothesis that** $\beta_l^+ = \beta_l^-$ **. The Wald[b] statistic refers to the test of the hypothesis that the added terms are zero. P-values from Wald tests are reported within brackets. HAC (Newey-West) covariance matrices are robust to heteroskedasticity and serial correlation.**

Table 2-17: Forward premium regressions for weekly individual currencies

	ARCH-LM Test	GARCH			TGARCH		
	ARCH(8)	β_l	$SE(\beta_l)$	Wald[a]	β_l	$SE(\beta_l)$	Wald[b]
AUD	[0.0000]	1.376425	(0.558408)	[0.0000]	0.511269	(0.454054)	[0.0269]
CAD	[0.0000]	3.905756	(0.927522)	[0.6959]	4.733805	(1.000680)	[0.9581]
EUR	[0.0000]	-1.473396	(0.549750)	[0.5458]	-2.943949	(0.621232)	[0.4319]
HKD	[0.0000]	0.445257	(0.416783)	[0.0000]	0.254440	(0.427364)	[0.5560]
ILS	[0.0000]	3.803390	(1.186661)	[0.0000]	3.539969	(1.209662)	[0.2565]
JPY	[0.0000]	-1.333633	(0.634489)	[0.0000]	-0.413990	(0.404129)	[0.0361]
NZD	[0.0000]	-0.033422	(0.403733)	[0.0000]	-0.451954	(0.804945)	[0.5925]
NOK	[0.0000]	-0.313961	(0.304724)	[0.0000]	-0.143700	(0.288062)	[0.8033]
SGD	[0.0000]	1.053112	(0.403519)	[0.4163]	0.728130	(0.488256)	[0.8434]
CHF	[0.0000]	-0.500211	(0.505704)	[0.0000]	-2.977091	(0.445207)	[0.4352]
USD	[0.0000]	-0.047398	(0.511393)	[0.0001]	-0.220502	(0.501427)	[0.7883]
BRL	[0.0000]	-1.065901	(0.354802)	[0.0000]	-0.867972	(0.393264)	[0.3687]
HUF	[0.0000]	0.443774	(0.201706)	[0.3044]	0.363502	(0.287976)	[0.9996]
MXP	[0.0000]	-1.994491	(0.152612)	[0.9408]	-1.946578	(0.158990)	[0.5471]
PLZ	[0.0000]	1.843276	(0.388035)	[0.1843]	1.776139	(0.396477)	[0.8226]
ZAR	[0.0000]	-1.685568	(0.425032)	[0.0000]	-1.427135	(0.441086)	[0.4406]
TWD	[0.0000]	0.704664	(0.202952)	[0.0000]	0.627941	(0.277112)	[0.9760]
CLP	[0.0000]	-1.092467	(0.358006)	[0.5786]	-1.729286	(0.527719)	[0.9975]
CNY	[0.0000]	1.590525	(0.337127)	[0.0984]	1.664971	(0.204601)	[0.0033]
COP	[0.0000]	-3.670529	(0.392249)	[0.6056]	-4.480197	(0.431756)	[0.9676]
CZK	[0.0000]	1.662768	(0.162023)	[0.0000]	2.110504	(0.588627)	[0.5060]
INR	[0.0000]	-2.203514	(0.255821)	[0.0636]	-1.938253	(0.248975)	[0.5793]
IDR	[0.0000]	0.431685	(0.035221)	[0.0000]	0.355634	(0.039084)	[0.4272]
MYR	[0.0000]	1.965392	(0.585107)	[0.0064]	0.751672	(0.433370)	[0.4262]
MAD	[0.0000]	0.525199	(0.251234)	[0.0013]	0.529968	(0.131133)	[0.9233]

	ARCH-LM Test	GARCH			TGARCH		
	ARCH(8)	β_l	$SE(\beta_l)$	Wald[a]	β_l	$SE(\beta_l)$	Wald[b]
PKR	[0.0000]	0.744422	(0.187054)	[0.8950]	0.765128	(0.198100)	[0.0001]
PHP	[0.0000]	-0.744378	(0.149431)	[0.0000]	-0.390677	(0.332516)	[0.8448]
RUR	[0.0000]	1.190274	(0.163699)	[1.0000]	1.108316	(0.144521)	[0.9586]
THB	[0.0000]	-0.715972	(0.306116)	[0.0595]	-0.347496	(0.502499)	[0.9989]
TRL	[0.0000]	-0.011829	(0.004789)	[0.9975]	0.007416	(0.007900)	[0.9303]
AED	[0.0000]	0.862217	(0.360894)	[0.0000]	0.920023	(0.338685)	[0.3429]

This table report results from regressions (2.5.11) $\ln S_{t+l} - \ln S_t = \alpha_l + \beta_l(\ln F_{t,l} - \ln S_t) + \delta_l h_t + e_t$, (2.5.12) $h_t = \mu_t + \sum_{i=1}^{q} \eta_i e_{t-i}^2 + \varepsilon_t$, (2.5.13) $h_t = \mu_t + \sum_{i=1}^{q} \eta_i e_{t-i}^2 + \sum_{i=1}^{p} \kappa_i h_{t-i} + \varepsilon_t$ and (2.5.14) $h_t = \mu_t + \sum_{i=1}^{q} \eta_i e_{t-i}^2 + \sum_{i=1}^{q} \theta_i d_{t-i} e_{t-i}^2 + \varepsilon_t$. The *p*-value of ARCH –LM tests with lag length = 8 are reported within brackets. The corresponding standard errors from GARCH (8, 8) and TGARCH (8, 8, 8) are reported in parenthesis. The Wald[a] statistic refers to the test of the hypothesis that the coefficients of GARCH terms are equal to zero simultaneously. The Wald[b] statistic refers to the test of the hypothesis that the coefficients for good news and bad news are equal in TGARCH model. P-values from Wald tests are reported within brackets. All estimations are reported with Bollerslev-Wooldridge robust standard errors and covariance.

Table 2-18: Forward premium regressions for daily individual currencies

	ARCH-LM Test	GARCH			TGARCH		
	ARCH(5)	β_l	$SE(\beta_l)$	Wald[a]	β_l	$SE(\beta_l)$	Wald[b]
AUD	[0.0000]	1.683220	(0.198962)	[0.0000]	1.465331	(0.187510)	[0.3869]
CAD	[0.0000]	5.092563	(0.259279)	[0.0000]	3.019965	(0.270160)	[0.0000]
EUR	[0.0000]	-2.986889	(0.438839)	[0.0845]	-0.843731	(0.158116)	[0.1963]
HKD	[0.0000]	-0.605690	(0.099180)	[0.0000]	-0.482024	(0.104763)	[0.3647]
ILS	[0.0000]	6.401000	(0.300180)	[0.0000]	6.754148	(0.272660)	[0.0001]
JPY	[0.0000]	-1.796942	(0.158426)	[0.0000]	-0.225394	(0.177031)	[0.0250]
NZD	[0.0000]	-1.754533	(0.973312)	[0.0000]	-1.783311	(1.112564)	[0.0195]
NOK	[0.0000]	-1.068064	(0.073305)	[0.0000]	-1.074433	(0.078244)	[0.7817]
SGD	[0.0000]	-1.486775	(0.099477)	[0.0000]	-1.559325	(0.102152)	[0.2558]
CHF	[0.0000]	-2.553494	(0.676744)	[0.0000]	-7.037566	(1.071042)	[0.0016]
USD	[0.0000]	-0.823642	(0.121799)	[0.0000]	-0.950937	(0.121610)	[0.2518]
BRL	[0.0000]	-0.511535	(0.116630)	[0.0016]	-0.522390	(0.117331)	[0.3364]
HUF	[0.0000]	0.476272	(0.054904)	[0.0000]	0.861936	(0.065159)	[0.5181]
MXP	[0.0000]	-2.054075	(0.031133)	[0.0000]	-1.845056	(0.064239)	[0.0000]
PLZ	[0.0000]	1.839385	(0.289031)	[0.0000]	2.105150	(0.089376)	[0.7034]
ZAR	[0.0000]	0.179406	(0.113285)	[0.0000]	0.224365	(0.120147)	[0.6140]
TWD	[0.0000]	-0.136644	(0.175473)	[0.0000]	-0.164027	(0.166401)	[0.1270]
CLP	[0.0000]	0.518524	(0.171105)	[0.0000]	0.816171	(0.182359)	[0.0164]
CNY	[0.0000]	1.856012	(0.048337)	[0.0000]	1.616915	(0.046423)	[0.2625]
COP	[0.0000]	-2.491654	(0.127449)	[0.0000]	-2.775851	(0.133213)	[0.5350]
CZK	[0.0000]	1.740064	(0.094259)	[0.0000]	1.974348	(0.104094)	[0.0043]
INR	[0.0000]	-2.535088	(0.066388)	[0.0000]	-2.659891	(0.067748)	[0.0619]
IDR	[0.0000]	0.320252	(0.015926)	[0.0000]	0.306931	(0.014724)	[0.3579]
MYR	[0.0000]	0.614006	(0.136811)	[0.0000]	0.098945	(0.168050)	[0.2516]
MAD	[0.0000]	0.365968	(0.046445)	[0.0000]	0.421426	(0.044471)	[0.4471]

	ARCH-LM Test	GARCH			TGARCH		
	ARCH(5)	β_l	$SE(\beta_l)$	Wald[a]	β_l	$SE(\beta_l)$	Wald[b]
PKR	[0.0000]	0.678582	(0.051003)	[0.0000]	0.672997	(0.051026)	[0.1444]
PHP	[0.0000]	-0.831138	(0.077754)	[0.0000]	-0.838590	(0.076481)	[0.7157]
RUR	[0.0000]	0.865588	(0.044522)	[0.0000]	0.986612	(0.043828)	[0.1111]
THB	[0.0000]	-1.181646	(0.083368)	[0.0000]	-1.168975	(0.079899)	[0.3585]
TRL	[0.0000]	0.007075	(0.001619)	[0.0000]	0.006386	(0.002982)	[0.0155]
AED	[0.0000]	0.355676	(0.085727)	[0.0000]	0.643103	(0.091989)	[0.4304]

This table report results from regressions (2.5.11) $\ln S_{t+l} - \ln S_t = \alpha_l + \beta_l(\ln F_{t,l} - \ln S_t) + \delta_l h_t + e_t$ **, (2.5.12)** $h_t = \mu_t + \sum_{i=1}^{q} \eta_i e_{t-i}^2 + \varepsilon_t$**, (2.5.13)** $h_t = \mu_t + \sum_{i=1}^{q} \eta_i e_{t-i}^2 + \sum_{i=1}^{p} \kappa_i h_{t-i} + \varepsilon_t$ **and (2.5.14)** $h_t = \mu_t + \sum_{i=1}^{q} \eta_i e_{t-i}^2 + \sum_{i=1}^{q} \theta_i d_{t-i} e_{t-i}^2 + \varepsilon_t$**.The *p*-value of ARCH –LM tests with lag length = 5 are reported within brackets. The corresponding standard errors from GARCH (5, 5) and TGARCH (5, 5, 5) are reported in parenthesis. The Wald[a] statistic refers to the test of the hypothesis that the coefficients of GARCH terms are equal to zero simultaneously. The Wald[b] statistic refers to the test of the hypothesis that the coefficients for good news and bad news are equal in TGARCH model. P-values from Wald tests are reported within brackets. All estimations are reported with Bollerslev-Wooldridge robust standard errors and covariance.**

Table 2-19: Panel analysis of forward premium regressions (weekly data)

	Standard regression		State-dependent regressions					
	β_l	$SE(\beta_l)$	β_l^+	$SE(\beta_l^+)$	β_l^-	$SE(\beta_l^-)$	**Wald[a]**	**Wald[b]**
All	-0.001414	(0.011793)	-0.017962	(0.012580)	0.295268	(0.074685)	[0.0001]	[0.0000]
Developed	-0.105865	(0.401700)	-0.155069	(0.540733)	0.000056	(0.823622)	[0.8860]	[0.0092]
Emerging	-0.000924	(0.011887)	-0.016607	(0.012733)	0.276601	(0.076911)	[0.0003]	[0.0000]

This table reports results from panel estimation of regressions (2.5.5) $\ln S_{t+l} - \ln S_t = \alpha_l + \beta_l(\ln F_{t,l} - \ln S_t) + \varepsilon_{t+l,l}$**, (2.5.6)** $\ln S_{t+l} - \ln S_t = \alpha_l + \beta_l^+(\ln F_{t,l} - \ln S_t)^+ + \beta_l^-(\ln F_{t,l} - \ln S_t)^- + \varepsilon_{t+l,l}$ **and (2.5.9)** $\ln S_{t+l} - \ln S_t = \alpha_l + \beta_l(\ln F_{t,l} - \ln S_t) + \gamma_l(\ln F_{t,l} - \ln S_t)^2 + \eta_l(\ln F_{t,l} - \ln S_t)^3 + \varepsilon_{t+l,l}$ **.The standard regression is the regression of percentage change in the exchange rate on the associated forward premium. The plus-minus regression refers to the case when observations of the forward premia are categorized into negative and positive observations. The corresponding standard error is given within parenthesis. The Wald[a] statistic refers to the test of the hypothesis that** $\beta_l^+ = \beta_l^-$ **. The Wald[b] statistic refers to the test of the hypothesis that the added terms are zero. P-values from Wald tests are reported within brackets. HAC (Newey-West) covariance matrices are robust to heteroskedasticity and serial correlation.**

Table 2-20: Panel analysis of forward premium regressions (daily data)

	Standard regression		State-dependent regressions					
	β_l	$SE(\beta_l)$	β_l^+	$SE(\beta_l^+)$	β_l^-	$SE(\beta_l^-)$	**Wald[a]**	**Wald[b]**
All	0.000324	(0.005427)	-0.014987	(0.005729)	0.313889	(0.036072)	[0.0000]	[0.0000]
Developed	-0.040316	(0.185938)	0.401096	(0.255720)	-1.252199	(0.406503)	[0.0023]	[0.0007]
Emerging	0.000868	(0.005464)	-0.013949	(0.005786)	0.300336	(0.037028)	[0.0000]	[0.0000]

This table reports results from panel estimation of regressions (2.5.5) $\ln S_{t+l} - \ln S_t = \alpha_l + \beta_l(\ln F_{t,l} - \ln S_t) + \varepsilon_{t+l,l}$**, (2.5.6)** $\ln S_{t+l} - \ln S_t = \alpha_l + \beta_l^+(\ln F_{t,l} - \ln S_t)^+ + \beta_l^-(\ln F_{t,l} - \ln S_t)^- + \varepsilon_{t+l,l}$ **and (2.5.9)** $\ln S_{t+l} - \ln S_t = \alpha_l + \beta_l(\ln F_{t,l} - \ln S_t) + \gamma_l(\ln F_{t,l} - \ln S_t)^2 + \eta_l(\ln F_{t,l} - \ln S_t)^3 + \varepsilon_{t+l,l}$ **.The standard regression is the regression of percentage change in the exchange rate on the associated forward premium. The plus-minus regression refers to a case when observations of the forward premia are categorised into negative and positive observations. The corresponding standard error is given in parenthesis. The Wald[a] statistic refers to the test of the hypothesis that** $\beta_l^+ = \beta_l^-$ **. The Wald[b] statistic refers to the test of the hypothesis that the added terms are zero. P-values from Wald tests are reported within brackets. HAC (Newey-West) covariance matrices are robust to heteroskedasticity and serial correlation.**

Appendix II: HAC (Newey-West)

Following Andrews (1991) and Hansen's (1992) framework, a sequence of mean-zero random P-vectors $\{V_t(\theta)\}$ may depend on a K-vector of parameters θ, and let $V_t \equiv V_t(\theta_0)$ where θ_0 is the true value of θ. Hence, the LRCOV matrix Ω to be estimated is:

(A.1) $$\Omega = \sum_{j=-\infty}^{\infty} \Gamma(j)$$

Where,

(A.2) $$\Gamma(j) = E\left(V_t V_{t-j}{}'\right) \qquad j \geq 0$$
$$\Gamma(j) = \Gamma(-j)' \qquad j < 0$$

is the antocovariance matrix of V_t at lag j. When V_t is second-order stationary, Ω equals 2π times the spectral density matrix of V_t evaluated at frequency zero (Hansen (1982), Andrews (1991)).

The class of kernel HAC covariance matrix estimators in Andrews (1991) can be written as:

(A.3) $$\hat{\Omega} = \frac{T}{T-K} \sum_{j=-\infty}^{\infty} k(j/b_T) \cdot \hat{\Gamma}(j)$$

Where the sample autocovariances $\hat{\Gamma}(j)$ are given by

(A.4) $$\hat{\Gamma}(j) = \frac{1}{T} \sum_{t=j+1}^{T} \hat{V}_t \hat{V}_{t-j}{}' \qquad j \geq 0$$
$$\hat{\Gamma}(j) = \hat{\Gamma}(-j)' \qquad j < 0$$

k is a symmetric kernel (or lag window) function that, among other conditions, is continuous at the origin and satisfies $|k(x)| \leq 1$ for all x with $k(0) = 1$, and $b_T > 0$ is a bandwidth parameter. The leading $T/(T-K)$ term is an optimal correction for degrees-of-freedom associated with the estimation of the K parameters in θ. There are a large number of kernel functions that satisfy the required conditions. The bandwidth b_T operates in concert with the kernel function to determine the weights for the various sample autocovariances.

To construct an operational nonparametric kernel estimator, a value for the bandwidth b_T must be chosen. Under general conditions (Andrews 1991) the consistency of the kernel estimator requires that b_T is chosen so that $b_T \to \infty$ and $b_T / T \to 0$ as $T \to \infty$. Alternately, Kiefer and Vogelsang (2002) propose setting $b_T = T$ in a testing context.

For the great majority of supported kernels $k(j/b_T) = 0$ for $|j| > b_T$ so that the bandwidth acts indirectly as a lag truncation parameter. However, relating b_T to the corresponding integer lag number of included lag m requires an examination of the properties of the kernel at the endpoints $(|j/b_T| = 1)$. The varying relationship between the bandwidth and the lag-truncation parameter implies that one should examine the kernel function when choosing bandwidth values to match computations that are quoted in lag truncation form. For example, matching the Newey-West's (1987) Bartlett kernel estimator which uses m weighted autocovariance lags requires setting $b_T = m + 1$.

The theoretical results of the relationship between bandwidths and the asymptotic truncated MSE of the kernel estimator provide finer discrimination in the rates at which bandwidths should increase. The optimal bandwidths may be written in the form:

(A.5) $$b_T = \gamma T^{1/(2q+1)}$$

Where γ is a constant, and q is a parameter that depends on the kernel function that you select (Andrews 1991). For the Bartlett kernel $(q = 1) b$ should grow (at most) at the rate $T^{1/3}$. The truncated kernel does not have an optimal rate, but Andrews (1991) reports Monte Carlo simulations which suggest that $T^{1/5}$ works well. Meanwhile, the theoretically useful knowledge of the rate at which bandwidths should increase at $T \to \infty$ does not tell us the optimal bandwidth for a given sample size since the constant γ remains unspecified.

Andrews (1991) and Newey and West (1994) offers two approaches to estimating γ. These techniques can be termed as automatic bandwidth selection methods since they involve estimating the optima bandwidth from the data rather than specifying a value a priori. Both the Andrews and Newey-West estimators for γ may be written as:

(A.6) $$\hat{\gamma}(q) = c_k \hat{\alpha}(q)^{1/(2q+1)}$$

Where q and the constant c_k depend on properties of the selected kernel and $\hat{\alpha}(q)$ is an estimator of $\alpha(q)$, which is a measure of the smoothness of the spectral density at frequency zero that depends on the autocovariances $\Gamma(j)$. Thus:

(A.7) $$\hat{b}_T^* = c_k \left(\hat{\alpha}(q) T\right)^{1/(2q+1)}$$

The q that one uses depends on properties of the selected kernel function.

Newey-West (1994) employ a nonparametric approach to estimating $\alpha(q)$. In contrast to Andrews who computes parametric estimates of the individual $\hat{f}_s^{(q)}$, Newey-West uses a truncated kernel estimator to estimate the $f^{(q)}$ corresponding to aggregate data:

(A.8) $$\hat{\sigma}_j = \frac{1}{T} \sum_{t=j+1}^{T} w' \hat{V}_t \hat{V}_{t-j}{}' w = w' \hat{\Gamma}(j) w$$

The $\hat{\sigma}_j$ may be viewed either as the sample autocovariance of a weighted linear combination of the data using weights w, or as a weighted combination of the sample autocovariances. Next, Newey and West use the $\hat{\sigma}_j$ to compute nonparametric truncated kernel estimators of the Parzen measures of smoothness:

(A.9) $$\hat{f}^{(q)} = \frac{1}{2\pi} \sum_{j=-n}^{n} |j|^q \cdot \hat{\sigma}_j$$

for $q = 1,2$. This expression may be used to obtain the expression for the plug-in optimal bandwidth estimator.

To implement the Newey-West optimal bandwidth selection method we require a value for n, the lag-selection parameter, which governs how many autocovariances to use in forming the nonparametric estimates of $f^{(q)}$. Newey and West show that n should increase at (less than) a rate that depends on the properties of the kernel. For the Bartlett kernel, the rate is $T^{2/9}$. In addition, one must choose a weighted vector w. Although Newey-West (1987) leaves the choice of w open, they follow Andrew's (1991) suggestion of $w_s = 1$ for all but the intercept in their Monte Carlo simulations. Here, the choice is slightly different by setting $w_s = 1$ for al s.

Appendix III: Panel Unit Root Tests

Panel unit root tests are technically similar to unit root tests carried out on single series, but are applied to panel data structure. Several tests (such as Levin, Lin and Chu (2002), Breitung (2000), Fisher-type ADF tests, Im, Pesaran and Shin(2003), and Fisher-PP (Maddala and Wu (1999) and Choi (2001)) tests, and Hadri (2000) LM tests) are used here to test the unit roots and the details of these tests are briefly described below.

Consider the following AR(1) process for panel data:

(A.10) $$y_{it} = \rho_i y_{it-1} + X_{it}\delta_i + \varepsilon_{it}$$

Where X_{it} represent the exogenous variables, including any fixed effects or individual trends; $i = 1,2,...,N$ describes cross-section units or series and $t = 1,2,...,T$ denotes the time periods; and, ε_{it} are errors that assumed to be mutually independent idiosyncratic disturbance. Hence, if $|\rho_i| < 1$ then y_{it} is said to be weakly (trend-) stationary. On the other hand, if $|\rho_i| = 1$ then y_{it} contains a unit root. Some unit root tests assume that the coefficient ρ_i is constant across cross-sections (such as the Levin, Lin Chu (LLC), Breitung, and Hadri tests) while others allow ρ_i to vary freely for different i (such as the Im, Pesaran, and Shin (IPS), Fisher-ADF and Fisher-PP tests).

The Levin, Lin and Chu (LLC), Breitung, and Hadri tests all assume that there is a common unit root process so that $\rho_i = \rho$. The first two tests both employ the following basic ADF specification:

(A.11) $$\Delta y_{it} = \alpha y_{it-1} + \sum_{j=1}^{p_i} \beta_{ij} \Delta y_{it-j} + X'_{it}\delta + \varepsilon_{it}$$

Where the coefficient $\alpha = \rho - 1$, and p_i is the lag order for different terms which varies across cross-sections. The null and alternative hypotheses for the tests are specified as:

$H_0 : \alpha = 0$ Unit root

$H_1 : \alpha < 0$ Stationary

Given the lag orders, Levin, Lin and Chu (LLC) derives estimates of α from proxies for Δy_{it} and y_{it} through estimation of both Δy_{it}, y_{it-1} on the lag terms Δy_{it-j} (for $j = 1,..., p_i$) and the exogenous variables X_{it}. By denoting the two sets of estimated coefficients from these two regressions by $(\hat{\beta}, \hat{\delta})$ and $(\dot{\beta}, \dot{\delta})$, respectively, $\Delta \bar{y}_{it}$ can be yielded by using the first set of auxiliary estimates, removing the autocorrelations and deterministic components from Δy_{it}:

(A.12) $$\Delta \bar{y}_{it} = \Delta y_{it-1} - \sum_{j=1}^{p_i} \hat{\beta}_{ij} \Delta y_{it-j} - X'_{it} \hat{\delta}$$

Likewise, $\bar{y}_{it-1}$ can be written as:

(A.13) $$\bar{y}_{it-1} = y_{it-1} - \sum_{j=1}^{p_i} \dot{\beta}_{ij} \Delta y_{it-j} - X'_{it} \dot{\delta}$$

These proxies are then standardised by dividing the corresponding estimated standard errors, s_i:

(A.14) $$\Delta \bar{y}_{it} = \left(\Delta \bar{y}_{it} / s_i \right)$$

(A.15) $$\bar{y}_{it-1} = \left(\bar{y}_{it-1} / s_i \right)$$

The estimate of the coefficient α is obtained by estimating the pooled proxy equation:

(A.16) $$\Delta \bar{y}_{it} = \alpha \bar{y}_{it-1} + \eta_{it}$$

The LLC test statistic for the resulting $\hat{\alpha}$ follows an asymptotic normally distribution:

(A.17) $$t_\alpha * = \frac{t_\alpha - \left(N\tilde{T}\right)S_N \hat{\sigma}^{-2} se(\hat{\alpha})\mu_{m,\tilde{T}*}}{\sigma_{m\tilde{T}*}} \to N(0,1)$$

Where t_α is the standard *t*-statistic for $\hat{\alpha} = 0$; $\hat{\sigma}^2$ is the estimated variance of the error term η; $se(\hat{\alpha})$is the standard error of $\hat{\alpha}$; and, $\tilde{T} = T - \left(\sum_i p_i \Big/ N\right) - 1$. S_N is the average standard deviation ratio, which is defined as the mean of the ratios of the long-run standard deviation to the innovations standard deviation for each individual. $\mu_{m\tilde{T}*}$ and $\sigma_{m\tilde{T}*}$ are the adjusted mean and standard deviations, respectively.

The Breitung methodology is different from LLC in two distinct aspects. Firstly, in order to construct the standardized proxies only the autoregressive term is removed, which yields:

(A.18) $$\Delta\tilde{y}_{it} = \left(\Delta y_{it-1} - \sum_{j=1}^{p_i} \hat{\beta}_{ij} \Delta y_{it-j}\right) \Big/ s_i$$

(A.19) $$\tilde{y}_{it-1} = \left(y_{it-1} - \sum_{j=1}^{p_i} \dot{\beta}_{ij} \Delta y_{it-j}\right) \Big/ s_i$$

Where $\hat{\beta}, \dot{\beta}$, and s_i are with same definitions as for LLC. Secondly, the proxies are transformed and detrended through the following equations:

(A.20) $$\Delta y_{it}* = \sqrt{\frac{(T-t)}{(T-t+1)}} \left(\Delta\tilde{y}_{it} - \frac{\Delta\tilde{y}_{it+1} + \ldots + \Delta\tilde{y}_{iT}}{T-t}\right)$$

(A.21) $$y_{it}* = \tilde{y}_{it} - \tilde{y}_{i1} - \frac{t-1}{T-1}\left(\tilde{y}_{iT} - \tilde{y}_{i1}\right)$$

And the persistence parameter α is estimated from the pooled proxy equation:

(A.22) $$\Delta y_{it}* = \alpha y_{it-1} * + v_{it}$$

Under the null hypothesis of unit root, the resulting estimator $\alpha*$ is asymptotically distributed as a standard normal suggested by Breitung. Furthermore, no kernel computations are needed for Breitung, which is in contrast to the LLC which requires kernel techniques to estimate S_N.

The Hadri panel unit root test has a null hypothesis of no unit root in any of the series in the panel, and it is based on the residuals from the individual OLS regressions of y_{it}, for example on a constant or on a constant, and the trend is as follows:

(A.23) $$y_{it} = \delta_i + \eta_i t + \varepsilon_{it}$$

Under homoscedasticity assumption, the *LM* statistic based on the residual estimates $\hat{\varepsilon}$ taken from the individual regressions is:

(A.24) $$LM_1 = \frac{1}{N}\left(\sum_{i=1}^{N} \left(\sum_t S_i(t)^2 / T^2 \right) \Big/ \dot{f}_0 \right)$$

Where $S_i(t)$ are the cumulative sums of the residuals, $S_i(t) = \sum_{s=1}^{t} \hat{\varepsilon}_{is}$ and $\dot{f}_0$ is the average of the individual estimators of the residual spectrum at frequency zero, $\dot{f}_0 = \sum_{i=1}^{N} f_{i0} \Big/ N$. Furthermore, with heteroskedasticity across i:

(A.25) $$LM_2 = \frac{1}{N}\left(\sum_{i=1}^{N} \left(\sum_t S_i(t)^2 / T^2 \right) \Big/ f_{i0} \right)$$

Hadri suggests that under mild assumptions:

(A.26) $$Z = \frac{\sqrt{N}(LM - \xi)}{\zeta} \rightarrow N(0,1)$$

With $\xi = 1/6$ and $\zeta = 1/45$ when the model only includes constants ($\eta_i = 0$ for all i), and $\xi = 1/15$ and $\zeta = 11/6300$ otherwise. However, Hlouskova and Wagner (2006) show that the Hadri test appears to over-reject the null of stationarity and, therefore, may yield results that directly contradict those which are obtained using alternative test statistics.

There are also some tests with individual unit root process (such as the Im, Pesaran and Shin, the Fisher-ADF, and Fisher-PP tests) where p_i may vary across cross-sections. These tests combine individual unit root tests to yield a panel-specific result.

Im, Pesaran and Shin consider a separate ADF regression for different cross-sections:

(A.27) $$\Delta y_{it} = \alpha y_{it-1} + \sum_{j=1}^{p_i} \beta_{ij} \Delta y_{it-j} + X'_{it}\delta + \varepsilon_{it}$$

The null and alternative hypotheses are specified as:

$$H_0 : \alpha_i = 0, \qquad \text{for all } i$$

$$H_1 : \begin{cases} \alpha_i = 0 & for \quad i = 1,2,\ldots,N_1 \\ \alpha_i < 0 & for \quad i = N+1, N+2,\ldots,N \end{cases}$$

The average of the *t*-statistics from individual ADF regressions estimation for α_i, which is defined as $t_{iT_i}(p_i)$ and which is written as:

(A.28) $$\bar{t}_{NT} = \left(\sum_{i=1}^{N} t_{iT_i}(p_i) \right) \Big/ N$$

In general, IPS shows that a properly standardised $\bar{t}_{NT}$ has an asymptotic standard normal distribution:

(A.29) $$W_{\bar{t}_{NT}} = \frac{\sqrt{N}\left(\bar{t}_{NT} - N^{-1} \sum_{i=1}^{N} E(\bar{t}_{NT}(p_i)) \right)}{\sqrt{N^{-1} \sum_{i=1}^{N} Var(\bar{t}_{NT}(p_i))}} \rightarrow N(0,1)$$

In addition, there is an alternative approach which was proposed by Maddala and Wu (1999), as well as Choi that uses Fisher's (1932) results to derive tests that combine the *p*-values from individual unit root tests. If π_i is defined as the *p*-value from any individual unit root test from cross-section i then the asymptotic result under the null of unit root for all *N* cross-sections is:

(A.30) $$-2\sum_{i=1}^{N} \log(\pi_i) \rightarrow \chi^2_{2N}$$

Choi demonstrates that:

(A.31) $$Z = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \Phi^{-1}(\pi_i) \rightarrow N(0,1)$$

Where Φ^{-1} is the inverse of the standard normal cumulative distribution function.

Appendix IV: Panel Cointegration Methodology

Similar to the time series cointegration analysis, the most commonly used panel cointegration methods are split into Engle-Granger (1987) based two-step tests (such as Pedroni (1999), Pedroni (2004) and Kao (1999) tests) as well as the Fisher-type test using Johansen methodology (such as Maddala and Wu (1999)).

The Engle-Granger (1987) two-step cointegration test is based on an examination of the residuals of a spurious regression. Under the Engle-Granger framework, assuming that the variables in the regression are all $I(1)$, then if the residuals are $I(0)$ the variables are cointegrated. Pedroni and Kao extend the Engle-Granger construction to tests involving panel data. Pedroni allows for heterogeneous individual and trend effects across cross-sections in his panel cointegration tests:

(A.32) $$y_{it} = \alpha_i + \delta_i t + \beta_{1i} x_{1i,t} + \beta_{2i} x_{2i,t} + \ldots + \beta_{Mi} x_{Mi,t} + e_{i,t}$$

For $t = 1,\ldots,T$; $i = 1,\ldots,N$; $m = 1,\ldots,M$; where y and x are assumed to be integrated of order one (e.g. $I(1)$). The parameters α_i and δ_i are individual and trend effects which may be set to zero if desired. The residual $e_{i,t}$ should be $I(0)$ if y and x are cointegrated. Thus, in order to test whether $e_{i,t} \sim I(0)$ we will run the following auxiliary regression:

(A.33) $$e_{it} = \rho_i e_{it-1} + u_{it}$$

Or,

(A.34) $$e_{it} = \rho_i e_{it-1} + \sum_{j=1}^{p_i} \psi_{ij} \Delta e_{it-j} + v_{it}$$

for each cross-section. Pedroni provides various methods of constructing statistics for testing for null hypothesis of no cointegration ($\rho_i = 1$). There are two alternative hypotheses: firstly, the homogenous alternative, $(\rho_i = \rho) < 1$ for all i (which Pedroni terms the within-dimension test or panel statistics test); and secondly, the heterogeneous alternative, $\rho_i < 1$ for all i (which is also referred to as the between-dimension or group statistics test).

The Pedroni panel cointegration statistic $\aleph_{N,T}$, and he shows that the standardised statistic is asymptotically normally distributed:

(A.35) $$\frac{\aleph_{N,T} - \mu\sqrt{N}}{\sqrt{v}} \Rightarrow N(0,1)$$

Where μ and v are Monte Carlo generated adjustment terms.

The Kao test is also an Engle-Granger based cointegration test which follows the same basic approach as the Pedroni tests. It differs by specifying cross-section specific intercepts and homogeneous coefficients on the first-stage regressors. For example, consider a bivariate case, which is described in Kao (1999):

(A.36) $$y_{it} = \alpha_i + \beta x_{it} + e_{it}$$

For:

(A.37) $$y_{it} = y_{it-1} + u_{it}$$

(A.38) $$x_{it} = x_{it-1} + \varepsilon_{it}$$

Where $t = 1,...,T$; $i = 1,...,N$. Similarly to Pedroni, Kao obtains the residuals and runs the pooled auxiliary regression:

(A.39) $$e_{it} = \rho e_{it-1} + v_{it}$$

Or:

(A.40) $$e_{it} = \bar{\rho} e_{it-1} + \sum_{j=1}^{p} \psi_j \Delta e_{it-j} + v_{it}$$

Under the null of no cointegration, Kao shows that following the statistics:

(A.41) $$DF_\rho = \frac{T\sqrt{N}(\hat{\rho} - 1) + 3\sqrt{N}}{\sqrt{10.2}}$$

(A.42) $$DF_t = \sqrt{1.25} t_\rho + \sqrt{1.875N}$$

(A.43) $$DF_{\rho}{*} = \frac{\sqrt{N}T\left(\hat{\rho}-1\right)+3\sqrt{N}\,\hat{\sigma}_{v}^{2}/\hat{\sigma}_{0v}^{2}}{\sqrt{3+36\hat{\sigma}_{v}^{4}/\left(5\hat{\sigma}_{0v}^{4}\right)}}$$

(A.44) $$DF_{t}{*} = \frac{t_{\rho}+\sqrt{6N}\,\hat{\sigma}_{v}/\left(2\hat{\sigma}_{0v}\right)}{\sqrt{\hat{\sigma}_{0v}^{2}/\left(2\hat{\sigma}_{v}^{2}\right)+3\hat{\sigma}_{v}^{2}/\left(10\hat{\sigma}_{0v}^{2}\right)}}$$

And for the augmented pooled auxiliary regression, where $p > 0$:

(A.45) $$ADF = \frac{t_{\rho}+\sqrt{6N}\,\hat{\sigma}_{v}/\left(2\hat{\sigma}_{0v}\right)}{\sqrt{\hat{\sigma}_{0v}^{2}/\left(2\hat{\sigma}_{v}^{2}\right)+3\hat{\sigma}_{v}^{2}/\left(10\hat{\sigma}_{0v}^{2}\right)}}$$

Converge to $N(0,1)$ asymptotically, where the estimated variance is $\hat{\sigma}_{v}^{2} = \hat{\sigma}_{u}^{2} - \hat{\sigma}_{u\varepsilon}^{2}\sigma_{\varepsilon}^{-2}$ with estimated long run variance $\hat{\sigma}_{0v}^{2} = \hat{\sigma}_{0u}^{2} - \hat{\sigma}_{0u\varepsilon}^{2}\sigma_{0\varepsilon}^{-2}$. The covariance of $w_{it} = \begin{bmatrix} u_{it} \\ \varepsilon_{it} \end{bmatrix}$ is estimated as:

(A.46) $$\hat{\Sigma} = \begin{bmatrix} \hat{\sigma}_{u}^{2} & \hat{\sigma}_{u\varepsilon} \\ \hat{\sigma}_{u\varepsilon} & \hat{\sigma}_{\varepsilon}^{2} \end{bmatrix} = \frac{1}{NT}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{w}_{it}\hat{w}_{it}{'}$$

And the long run covariance is estimated using the usual kernel estimator:

(A.47) $$\hat{\Omega} = \begin{bmatrix} \hat{\sigma}_{0u}^{2} & \hat{\sigma}_{0u\varepsilon} \\ \hat{\sigma}_{0u\varepsilon} & \hat{\sigma}_{0\varepsilon}^{2} \end{bmatrix} = \frac{1}{N}\sum_{i=1}^{N}\left[\frac{1}{T}\sum_{t=1}^{T}\hat{w}_{it}\hat{w}_{it}{'} + \frac{1}{T}\sum_{\tau=1}^{\infty}\kappa(\tau/b)\sum_{t=\tau+1}^{T}\left(\hat{w}_{it}\hat{w}_{it-\tau}{'} + \hat{w}_{it-\tau}\hat{w}_{it}{'}\right)\right]$$

Where κ is one of the supported kernel functions and b is the bandwidth.

Fisher (1932) derives a combined test that uses the results of the individual independent tests. Maddala and Wu (1999) use Fisher's results to propose an alternative approach to testing for cointegration in panel data by combining the tests from individual cross-sections to obtain at test statistic for the null panel. If π_i is the *p*-value from an individual cointegration test for cross-section i, then under the null hypothesis for the panel:

(A.48) $$-2\sum_{i=1}^{N}\log(\pi_i) \rightarrow \chi_{2N}^{2}$$

Where the χ^2 value is based on MacKinnon, Haug and Michelis (1999) *p*-values for Johansen's cointegration trace test and maximum eigenvalue test.

Appendix V: Economic foundations of forward risk premium

Baillie and Bollerslev (2000) denote the logarithms of the spot and forward exchange rates by the corresponding lower case variables, s_t and $f_{t,l}$, respectively, where the forward contract is signed at time *t* and matured at time *t+l*. The covered interest rate parity (CIP) can be expressed as $\left(f_{t,l} - s_{t+1}\right) = \left(i_{t,l} - i_{t,l}^{*}\right)$, with $i_{t,l}$ being the pound return on an *l*-period risk free pound denominated bond and $i_{t,l}^{*}$ denoting the foreign currency return on a risk free bond denominated in terms of the foreign currency. Associating it with uncovered interest parity (UIP) it yields:

(A.49) $$E_t\left(\Delta s_{t+l}\right) = \left(f_{t,l} - s_{t+1}\right) = \left(i_{t,l} - i_{t,l}^{*}\right)$$

Where $E_t(\cdot)$ denotes the mathematical expectation conditioned on the set of all relevant information at time *t*. Hence the expected rate of appreciation (depreciation) should be equal to the current forward premium, $\left(f_{t,l} - s_{t+1}\right)$.

It is well known that the UIP holds under some joint assumptions, which are: rational expectations, risk neutrality, free capital mobility and the absence of taxes on capital transfers (Baillie and Bollerslev 2000). According to these assumptions, the expected real returns in the forward market is:

(A.50) $$E_t\left[\left(F_{t,l} - S_{t+l}\right)/ P_{t+l}\right] = 0$$

Where P_t denotes the domestic price level, measured by the British pound. A Taylor series expansion of Equation (A.50) to second order terms gives:

(A.51) $$E_t\left(s_{t+l}\right) - f_{t,l} = -\frac{1}{2} Var_t\left(s_{t+1}\right) + Cov_t\left(s_{t+l} p_{t+l}\right)$$

Where p_t is defined as the logarithm of domestic price level. The expression on the right hand side of Equation (A.51) contains two terms of second moment, conditional on the assumptions of rational expectations and risk neutrality. In the previous literature these terms are often referred to as the Jensen inequality term.

Under the consumption-based asset pricing model, the representative investor's real returns can be specified as follows, associated with the current and future consumption streams:

(A.52) $$E_t\{[(F_{t,l} - S_{t+l})/P_{t+l}]U'(C_{t+l})/U'(C_t)\} = 0$$

Where $U'(C_{t+l})/U'(C_t)$ is the marginal rate of substitution. Thus:

(A.53) $$E_t(s_{t+l}) - f_{t,l} = -\frac{1}{2}Var_t(s_{t+1}) + Cov_t(s_{t+l}p_{t+l}) + Cov_t(s_{t+l}q_{t+l})$$

Where q_{t+l} denotes the logarithmic intertemporal marginal rate of substitution. Therefore, compared to Eq. (A.51), the last term is specified as a time-dependent risk premium, which can be used to explain the empirical deviations from UIP.

(A.54) $$\rho_{t,l} = Cov_t(s_{t+l}q_{t+l})$$

Chapter 3 **Exchange Rate and Term Structure of Interest Rates**

3.1. Introduction

In the late 1990s, quite a few emerging countries abandoned their long-standing currency crawling pegs and moved towards floating exchange rate regime, especially after the 1997 Asian financial crisis and the 1998 Russian financial crisis. For instance, Brazil set its currency into an independently floating regime following its own currency crisis in 1999, while Chile (whose exchange rate had been classified as managed floating since 1997) also finally allowed its currency to float in 1999.

There is a widespread consensus that the relationship between the exchange rate and interest rates plays a very important role in policy-making. Dornbusch (1976) developed a theory of exchange rate movements under perfect capital mobility, following which it has been a conventional wisdom that a rising interest rate is associated with the appreciation of domestic currency. This point has been proved in more recent papers which have used a risk neutral investor (e.g. Alexius 1999). Thus, it is natural to make a corollary that the term structure of interest rates might be irrelevant for determining the exchange rate. However, Ogaki and Santaella (1999) and Lim and Ogaki (2004) argue that this conventional wisdom may not be that reliable and they show evidence that the term structure of interest rates plays an important part in the exchange rate determination. In this chapter, we will reconsider Lim and Ogaki's (2004) theory and will empirically extend it by examining the relationship between the exchange rate and the term structure of interest rates for emerging economies.

Isard (1995) and many other recent papers show that the uncovered interest parity under risk neutrality is rejected with short-horizon data. Engel (1996) points out the presence of forward premium anomaly, which is the finding of a negative slope coefficient when one regresses the future exchange rate depreciation on the current forward premium. However, it is difficult to interpret this anomaly from an economic point of view. Mark and Wu (1998) emphasise that it is hard to explain this anomaly with standard consumption-based capital asset pricing model. Another stylised fact has recently found that this forward premium anomaly seems not to exist in long-horizon data (Meredith and Chinn 1998). At the same time, many empirical studies show evidence that the uncovered interest parity holds better in the long-run. Edison and Pauls (1993) provide cointegration results which suggest that the long-term interest rate differentials play a more important role than the short-term interest rate differentials in the real exchange rate determination, especially in the long-run. Baxter (1994) argues that the reason why the prior studies could not find a statistical link between real exchange rates and real interest differentials is because they have focused on high-frequency data. He also shows that there is a positive correlation between real exchange rates and real interest rate differentials, and this relationship is strong at trend and business-cycle frequencies. Eichenbaum and Evans (1997) show that some implications of uncovered interest parity hold in the long-run, although they are not consistent with the stylised facts in the short-run. More recently, Byeon and Ogaki (1999) have used Canonical Cointegrating Regression (CCR) techniques and illustrate statistically significant but opposite effects of the short-term interest rate differential and the long-term interest rate differential on the real exchange rate for several developed countries. However, the evidence for emerging economies is rather limited in the literature.

Lim and Ogaki (2004) provide an economic model that is consistent with these short-run and long-run stylised facts and which is useful to explain the forward premium anomaly. In their model they assume that investors are risk averse with short investment horizons, and a complicated effect of the term structure of interest rates on the exchange rate is derived. The idea behind their model is the concept of indirect complementarity due to the structure of interest risk under the assumption of risk aversion. Specifically, the domestic long-term bonds and the foreign bonds are strong substitutes if domestic currency appreciates with the rise in the domestic short-term interest rate. When the domestic short-term interest rate increases, investors with a short-term investment horizon holding long-term bonds suffer a capital loss. At the same time, investors with foreign bonds also face a capital loss as a result of domestic currency appreciation. In other words, as long as the domestic currency appreciation is associated with an increase in the domestic short-term interest rate then investors will try to avoid holding both the domestic long-term and the foreign bonds, which makes these two assets strong substitutes. Meanwhile, it is well known that domestic short-term and long-term bonds are also strong substitutes, and a substitute of a substitute is an indirect complement and, therefore, the domestic short-term bonds and the foreign bonds can be also considered as strong indirect complements. As a result, only when the direct substitutability between the short-term bonds and the foreign bonds dominate the indirect complementarity is the relationship between the exchange rate and the interest rate differentials consistent with conventional wisdom. If the indirect complementarity dominates the direct substitutability then this relationship will become at odds.

It is well known that the monetary authorities try to manage liquidity through interest rates, as well as achieving their foreign exchange market objectives. Hence, it is interesting to ask if the short-term interest rate has an intuitive effect on the exchange rate. According to the theoretical model of Lim and Ogaki (2004), the one-month interest rate differential has the opposite effect from conventional wisdom by controlling for the effect of the three-month interest rate differential when the indirect complementarity dominates the direct substitutability, and vice versa.

Because the term structure of interest rates describes the different yields to maturity, which is often considered as an important factor in formulating monetary policy, it has motivated a number of theoretical and empirical studies in recent years. In this chapter, an empirical investigation on the relationship between the exchange rate and the term structure of interest rates is pursued for emerging markets. The evidence for emerging economies is found to be rare in the previous literature; consequently, one of the main contributions of this chapter will be to address this gap in our understanding of this problem. In addition, the consistency of the term structure of money markets (one-month and three-month interest rates) on exchange rate determination has recently become another main focus of research and it is taken into account in this investigation. The consistency issue which is related to this relationship between the exchange rate and the term structure of interest rates for emerging economies arises because most of these countries changed their exchange rate regimes during their sample periods. Therefore, the behaviour of these interest rates might not be consistent while, in the meantime, the markets of long-term bonds for some of these emerging economies is not well developed, hence shifts in the yield curves have to be taken into consideration. Another contribution of this chapter is the application of a panel cointegration approach controlling for fixed effects for each individual country and across time. The data and information are found to be relatively limited for individual emerging economy and some countries have short sample periods available; nonetheless, a whole picture of this cointegration relationship between the exchange rate and the term structure of interest rates for emerging market as well as more powerful results can be provided through panel construction of the data

The rest of this chapter is organised as follows. Section 3.2 presents the economic model in detail and provides some recent literature that will inform this issue. Section 3.3 interprets the econometric methodologies that are used to investigate the relationship between the exchange rate and the term structure of interest rates. Data and basic statistics are described in Section 3.4, where VAR is applied to approximate rational expectations. Section 3.5 discusses the empirical model specifications. The results are reported in Section 3.6 and Section 3.7 will conclude this chapter.

3.2. Literature Review

Dornbusch (1976) develops a theory of exchange rate movements under perfect capital mobility, which has been followed by quite a large literature showing that with risk neutral investors an increase in the interest rate would associate with domestic currency appreciation. Driskill and McCafferty (1980) adopt rational expectations under floating exchange rates to analyse exchange speculation in the foreign market. Fukao and Okubo (1984) develop a theoretical model of exchange rate determination and interest rate structure in explaining Japanese secondary bond market yields. Both of these studies constructed and used two-asset models. Byeon and Ogaki (1999) and Lim and Ogaki (2004) extend these two-asset models and construct instead a three-asset model to predict the relationship between the exchange rate and the term structure of interest rates. Their partial equilibrium model is shown to be consistent with the stylised facts for both the short-term and long-term interest rates to determine the exchange rate. It is essential to motivate the empirical investigations to investigate this further.

The forward premium anomaly is a well-known puzzle in the study of economics. Mark and Wu (1998) and Wu (2004) emphasise that it is impossible to explain this anomaly with either a standard consumption-based capital asset pricing model or a dynamic term structure model. However, another stylised fact has recently found that this forward premium anomaly seems not to exist. Mark (1995) finds some implications to show that the uncovered interest parity holds in the long-run. Meredith and Chinn (1998) give similar results with long-horizon data for G-7 countries. Alexius (2001) shows direct evidence that regressions with long-horizon of future currency depreciation on the current interest rate differential yield positive slope coefficient estimates. There is also other indirect evidence to show that the uncovered interest parity holds better in the long-run under the long-run purchasing power parity assumptions. For example, Boughton (1988) elucidates that including the term structure of interest rate differentials could help to improve the performance of asset-market models of exchange rates empirically for developed economies like the U.S., Germany, and Japan. Meanwhile, Edison and Pauls (1993) provide cointegration results suggesting that long-term interest rate differentials play a more important role than the short-term interest rate differentials in the real exchange rate determination, especially in the long run. Baxter (1994) argues that the reason why the prior studies could not find a statistical link between real exchange rates and real interest differentials is because they focus on high-frequency data. He also shows that there is a positive correlation between real exchange rates and real interest differentials, and that this relationship is strongest at trend and business-cycle frequencies. More recently, Byeon and Ogaki (1999) have used Canonical Cointegrating Regression (CCR) techniques and illustrate statistically significant but opposite effects of short-term interest rate differential and long-term interest rate differential on the real exchange rate for several developed countries.

Theoretically, Lim and Ogaki (2004) have constructed an economic model to explain the relationship between exchange rate and the term structure of interest rates which is consistent with the stylized facts for both short-term and long-term interest rates. Their economic model is built on conditional expectations and variances of risky assets. They decompose the effect of domestic short-term interest rate change into the direct risk premium effect (i.e. the effect of change in the risk premium for foreign bonds when the risk premium for domestic long-term bonds is unchanged) and indirect risk premium effect (i.e. effect of change in the risk premium for domestic long-term bonds while the risk premium for foreign bonds is kept constant), respectively, on demand for foreign bonds. They assume that the investors, who are risk averse, have short investment horizons with both domestic and foreign bonds while for investors who are risk neutral there is no indirect risk premium effect. Lim and Ogaki (2004) find a complicated relationship between the exchange rate and the term structure of interest rates. If the indirect complementarity dominates the direct substitutability between domestic one-period bonds and foreign bonds, then the relationship between the exchange rate and the term structure of interest rate differentials will be counterintuitive and at odds with conventional wisdom (Ogaki and Santaella 1999).

More specifically, Lim and Ogaki (2004) assume that the domestic investors are risk averse and invest in short horizon with a Constant Absolute Risk Averse (CARA) utility function, investors are identical and live only for two periods, and there is equal number of investors born in each period. There are three assets in the model: the domestic short-term bonds $\left(=B_{S,t}\right)$, which are risk free; the domestic long-term bonds $\left(=B_{L,t}\right)$; and the foreign bonds $\left(=B_{F,t}\right)$, which are considered as the other two risky assets, respectively. The returns of these assets follow normal distributions and, for the sake of simplicity, the overall price level is assumed to be constant so that the variables can be considered in real terms. The domestic short-term and long-term discount bonds pay one unit of domestic currency in one and two periods, respectively. The foreign short-term and long-term bonds are perfect substitutes, assuming a constant foreign interest rate. Thus, a representative investor with initial wealth $\left(=W_t\right)$ will invest and hold a portfolio of these three assets to get maximal expected utility at the beginning of time t+1 in terms of wealth that defined as W_{t+1}, subject to certain budget constraint. Thus, under rational expectation equilibrium with certain coefficients combinations, Lim and Ogaki (2004) have achieved a unique saddle point solution[2] for the exchange rate which can be expressed as:

(3.2.1) $$s_t = \bar{s} - \left(\frac{1-\lambda}{b}\right)u_t - \left(\frac{1-\lambda}{b}\right)B^s_{F,t-1} - \left(\frac{\lambda}{1-\lambda c}\right)e_t + \lambda(\phi-1)\varepsilon_t$$

Where $\bar{s}$ is long-run equilibrium exchange rate.

Equation (3.2.1), which is the basis of the following empirical study, implies that there are four factors that drive the exchange rate away from its long-run equilibrium.

[2] For model and derivation details, please refer to Lim and Ogaki (2004).

The first one is the trade shock (the second term on the right hand side of Equation (3.2.1)), which increases the current account surplus and appreciates the domestic currency. The second is the cumulative current account balance (the third term on the right hand side of Equation (3.2.1)), which also tends to appreciate the domestic currency. The last two factors are the persistent and temporary shocks in the short-term interest rate, respectively. Persistent rises in the short-term interest rate appreciates the domestic currency, while the temporary interest rate shock ε_t makes the domestic currency depreciate if the indirect complementarity of short-term and foreign bonds exceeds the direct substitutability (the relative magnitude of the indirect risk premium effect, $\phi > 1$). Whether long-term bonds and foreign bonds are substitutes or complements is determined by the sign of ϕ. A positive ϕ indicates positive indirect risk premium effect of the short-term interest rate rise on the demand of the foreign bonds. An intuitive interpretation of this is that as the short-term interest rate increases the investors holding long-term bonds suffer a capital loss because the price of the long-term bonds falls. Since a rise in short-term interest rate decreases the risk premium for holding long-term bonds, the risk averse investors would choose to hold more foreign bonds rather than domestic long-term bonds. Therefore, the rise in the short-term interest rate increases the demand for foreign bonds through the indirect risk premium effect. As argued by Ogaki and Santaella (1999) and Lim and Ogaki (2004) that the term structure of interest rates plays an important part in the exchange rate determination, in this chapter we will reconsider Lim and Ogaki's (2004) theory and we will empirically examine the relationship between the exchange rate and the term structure of interest rates for emerging economies.

In this chapter the empirical models are mainly based on Byeon and Ogaki's (1999) empirical work on the relationship between exchange rate and the term structure of interest rates for several developed economies and on Ogaki and Santaella's (1999) investigation of the same relation for Mexico. For developed economies (such as UK, Germany, Japan, Canada, France, Italy, and Switzerland) similar effects of the term structure of interest rates are obtained on the exchange rate (Byeon and Ogaki, 1999). A risk in the short-term interest rate causes an appreciation in the domestic currency if the long-term interest rate rises in response to the rise in the short-term interest rate; while it leads to domestic currency depreciation if the long-term interest rate does not rise. Mexico is one of the developing countries which adopted a floating exchange rate regime due to the impacts of the Asian financial crisis of 1997 and the Russian financial crisis of 1998. Ogaki and Santaella (1999) use a CCR technique to examine how one-month and three-month Cetes interest rates influence the real exchange rate in Mexico for the periods before and after 1998. They find that the behaviour of the term structure of interest rates does not follow the conventional wisdom, especially during these two crises episodes. They suggest that their results for Mexico might be useful to understand the operation of floating exchange rate regime, however, they have not extended their work to any other developing economy.

It can be seen from the previous literature that the empirical work is mainly focused on the developed economies. Evidence and information from emerging economies still continues to be rather limited in this area. Meanwhile, most of these empirical studies use time series analysis for each individual developed country. The powerful panel cointegrating approach is not widely applied to empirically study Lim and Ogaki's (2004) model. The currencies in most emerging economies were not freely convertible until the late 1990s and the consistency of the relationship between their exchange rates and the term structure of interest rates is rarely found in the previous empirical studies.

3.3. Methodology

3.3.1. Cointegrating Regression

Various economic time series are known as difference stationary. Phillips and Durlauf (1986) show evidence that if the series are I(1) in a regression then the conventional Wald coefficient tests will yield misleading results; for instance, spuriously showing a significant relationship between unrelated series. Engle and Granger (1987) illustrate that two or more I(1) series are cointegrated if the linear combination of those variables are stationary, or I(0), and such cointegrating vectors characterise the long-run relationship between these variables.

Following Phillips and Hansen (1990) and Hansen (1992b), a standard triangular representation of a regression with a single cointegrating vector in terms of n+1 dimensional series vector process (y_t, X_t') can be specified as:

(3.3.1) $$y_t = X_t'\beta + D_{1t}'\gamma_1 + u_1$$

With the deterministic trend regressors, $D_t = (D_{1t}', D_{2t}')'$, and the n stochastic regressors X_t that are governed by the following system of equations:

(3.3.2) $$\begin{aligned} X_t &= \Gamma_{21}'D_{1t} + \Gamma_{22}'D_{2t} + \varepsilon_{2t} \\ \Delta\varepsilon_{2t} &= u_{2t} \end{aligned}$$

Both the cointegrating and regressors equations include the p_1-vector of D_{1t} regressors, while the deterministic trend regressors (i.e. the p_2-vector of D_{2t}) only enter into the regressors equations. The constant term, if present, is assumed to be included in D_{1t}. The innovations, $u_t = (u_{1t}', u_{2t}')'$, are assumed to be strictly stationary with: zero mean, contemporaneous covariance Σ, one-sided long-run covariance Λ, and non-singular long-run covariance Ω. Which is expressed as follows:

$$\Sigma = E(u_t u_t') = \begin{bmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{21} & \sigma_{22} \end{bmatrix}$$

(3.3.3) $$\Lambda = \sum_{j=0}^{\infty} E(u_t u_{t-j}') = \begin{bmatrix} \lambda_{11} & \lambda_{12} \\ \lambda_{21} & \lambda_{22} \end{bmatrix}$$

$$\Omega = \sum_{j=-\infty}^{0} E(u_t u_{t-j}') = \begin{bmatrix} \omega_{11} & \omega_{12} \\ \omega_{21} & \omega_{22} \end{bmatrix} = \Lambda + \Lambda' - \Sigma$$

Thus, y_t and X_t are I(1) and cointegrated but exclude both cointegration amongst elements of X_t and multicointegration (details are provided by Phillips and Hansen (1990a), Hansen (1992b) and Park (1992) with additional alternative specifications).

Hamilton (1994) suggests that the ordinary least squares (static OLS) estimation of the cointegrating vector β is consistent if the series are cointegrated. However, the asymptotic distribution of static OLS estimates is generally non-Gaussian due to the presence of long-run correlation between the cointegrating equation errors and regressor innovations and (ω_{12}), and cross-correlation between the cointegrating equation errors and the regressors (λ_{12}). Thus, the conventional testing procedures are not reliable to conduct inference on the cointegrating vector. Nevertheless, if the number of stochastic regressors n is less than the number of deterministic trends excluded from the cointegrating equation p_2 then static OLS exhibits an asymptotic Gaussian mixture distribution. By defining $m_2 = \max(n - p_2, 0)$, then if $m_2 = 0$ the deterministic trends in the regressors asymptotically dominate the stochastic trend components in the cointegrating equation.

However, apart from these exceptional cases, it is important to construct generally asymptotically efficient estimators which involve data transformation or cointegrating equation specification modifications to mimic the strictly exogenous X_t case.

3.3.2. Canonical Cointegration Regression (CCR)

The long-run relationship involving cointegrated variables have attracted considerable attention recently. Many works have focused on alternative cointegrating estimators and their asymptotic properties that are not affected by endogeneity and serial correlation under certain circumstances. One of these is the so called Canonical Cointegrating Regression (CCR) that was developed by Park (1992). The CCR can be applied to a wide class of cointegrating models. It is constructed so that the least square procedure yields asymptotically efficient estimators as well as Chi-square tests. Several previous studies, such as Phillips and Durlauf (1986), elucidate that the classical least squares estimators are nonstandard and biased for cointegrating regressions. Johansen (1988) uses a system estimation of error correction models to attack the problem of inference in cointegrated models. Park's (1992) single equation CCR procedure yields the same asymptotically efficient estimators and Chi-square tests as Johansen's (1988) system maximum likelihood method.

Park's (1992) CCR employs stationarity transformations of the data to get least squares distribution that are free of non-scalar nuisance parameters and suitable for asymptotic Chi-square testing. In the above equations specifications, $u_t = \left(u_{1t}', u_{2t}'\right)$ is strictly stationary with zero mean and finite covariance matrix Σ. In general cases, Σ is not block-diagonal and the u_t process is weakly dependent, implying that the OLS estimator is not efficient.

Following Park's (1992) advice the first step is to obtain the innovation estimates $\hat{u}_t = \left(\hat{u}_{1t}, \hat{u}_{2t}'\right)'$. The corresponding consistent estimates of the long-run covariance matrices $\hat{\Omega}$ and $\hat{\Lambda}$ are obtained next. The next step is to extract the column of $\hat{\Lambda}$ corresponding to the one-sided covariance matrix of u_t:

(3.3.4) $$\hat{\Lambda}_2 = \begin{bmatrix} \hat{\lambda}_{12} \\ \hat{\lambda}_{22} \end{bmatrix}$$

Hence, the transformed series can be written as:

(3.3.5) $$X_t^* = X_t - \left(\hat{\Sigma}^{-1}\hat{\Lambda}_2\right)' \hat{u}_t$$

(3.3.6) $$y_t^* = y_t - \left(\hat{\Sigma}^{-1}\hat{\Lambda}_2\overline{\beta} + \begin{bmatrix} 0 \\ \hat{\Omega}_{22}^{-1}\hat{\omega}_{21} \end{bmatrix}\right)' \hat{u}_t$$

Where $\overline{\beta}$ are estimates of the cointegrating equation coefficients, which are asymptotically equivalent to the Maximum Likelihood (ML) estimates. These transformations asymptotically eradicate the endogeneity due to the long-run correlation of the cointegrating equation errors and the stochastic regressors innovations, as well as the asymptotic bias caused by the contemporaneous correlation between the regression and stochastic regressor errors. Therefore, CCR estimates are fully efficient and have unbiased asymptotic properties:

(3.3.7) $$\hat{\theta} = \begin{bmatrix} \hat{\beta} \\ \hat{\gamma}_1 \end{bmatrix} = \left(\sum_{t=1}^{T} Z_t^* Z_t^{*\prime}\right)^{-1} \sum_{t=1}^{T} Z_t^* y_t^*$$

Where $Z_t^* = \left(X_t^{*\prime}, D_{1t}'\right)'$.

Since CCR estimators follow asymptotic distributions that can be essentially considered as normal distribution, the corresponding standard errors are valid to test for Wald coefficient restrictions. Defining the scalar estimator as:

(3.3.8) $$\hat{\omega}_{1.2} = \hat{\omega}_{11} - \hat{\omega}_{12}\hat{\Omega}_{22}^{-1}\hat{\omega}_{21}$$

According to Hansen (1992a), the Wald statistic for the null hypothesis $R\theta = r$ can be specified as:

(3.3.9) $$W = \left(R\hat{\theta} - r\right)' \left(RV\left(\hat{\theta}\right)R'\right)^{-1} \left(R\hat{\theta} - r\right)$$

With:

(3.3.10) $$V\left(\hat{\theta}\right) = \hat{\omega}_{1.2}\left(\sum_{t=1}^{T} Z_t Z_t'\right)^{-1}$$

$V(\hat{\theta})$ has an asymptotic χ_g^2-distribution, with g being the number of restrictions imposed by R.

3.3.3. Dynamic OLS/DLS

The CCR cointegration is applied first in this study in order to be consistent with the previous literature. However, the Dynamic Ordinary Least Square (DOLS) estimator is an alternative cointegrating regression estimator which is advocated by Stock and Watson (1993) using the models proposed by Inder (1993). Montalvo (1995) points out that the DOLS estimator performs systematically better than the CCR estimator for small-sample performance.

DOLS is a single equation estimator of cointegration relationships, but it can handle unbalanced regression in which the variables have different orders of integration. The DOLS method augments the cointegrating regression using leads and lags of differences of independent variables to obtain efficient estimates and standard errors that are valid for hypothesis testing through Wald statistics. The DOLS is asymptotically equivalent to Johansen (1988) estimator of cointegration when variables in the system are $I(1)$ and there is a single cointegrating vector (Arghyrou and Luintel 2007). The DOLS cointegrating regression can be specified as:

(3.3.11) $$y_t = X_t'\beta + \sum_{j=-q,\, j\neq 0}^{r} \Delta X_{t+j}'\delta + v_{1t}$$

By augmenting the cointegrating regression with q lags and r leads of ΔX_t, the resulting cointegrating equation error term is orthogonal to the entire history of the stochastic innovations. The leads and lags of ΔX_t eliminate asymptotically any possible bias to endogeneity or serial correlation (Montalvo 1995). Details of DOLS cointegration approach with Newey-West HAC robust standard errors are provided in

Section 2.3.1.2 of Chapter 2.

3.3.4. Panel Cointegrating Regression and Structural Breaks

As pointed out by Montalvo (1995), the DOLS estimator performs systematically better than the CCR estimator for small-sample performance. It can also be applied to panel cointegration constructions. For example, consider the following panel setting with fixed effects:

(3.3.12) $$y_{it} = \alpha_i + \gamma_t + X'_{it}\beta + \sum_{j=-q, j\neq 0}^{r} \Delta X'_{it+j}\delta + u_{it}$$

Similar to the time series DOLS/DGLS, the order of difference for the lead and lag terms are specified according to the order of integration of X_{it}, which are used to control for any endogenous feedback and the nuisance parameters. Newey and West (1987) HAC is also used to control the presence of both heteroskedasticity and autocorrelation of unknown form under the panel framework.

Under the panel DOLS construction, shifts in different regimes can be assessed through the tests of structural breaks in the cointegrating relationship. Break dates are identified using the sequential Wald test (Quintos 1995) with controlling time and cross-sectional fixed effects. The corresponding auxiliary regression for the stability test for panel data can be expressed as:

(3.3.14) $$y_{it} = \alpha_i + \gamma_t + X'_{it}\beta + \sum_{j=-q}^{r} \Delta X'_{it+j}\delta + (DX)'_{it}\eta + u_{it}$$

With:

(3.3.15) $$D = 1 \quad if \quad t = t_b$$

$$= 0 \quad if \quad t \neq t_b$$

Where t_b represents the break date. The null hypothesis of no structural break through the whole sample $\left(H_0 : \eta = 0\right)$ is also tested sequentially over the whole sample period. The test Wald test statistic follows $\chi^2(1)$ distribution.

3.4. Data and Preliminary Considerations

This chapter investigates the effect of the term structure of interest rates on the exchange rate for sixteen emerging economies, which are: Brazil, Hungary, Mexico, Poland, South Africa, Taiwan, Chile, Czech Republic, India, Indonesia, Malaysia, Pakistan, Philippines, Russia, Thailand, and Turkey. These emerging economies are chosen from FTSE advanced and secondary emerging countries. China, Colombia, Morocco, and United Arab Emirates are excluded from this analysis because of the data limitations. The data series are obtained monthly from *Datastream* over March 1993 to March 2011. This is done because the data for the British one-month interest rate are available from March 1993. The United Kingdom is considered as a foreign country and the nominal exchange rate is expressed as the price of the U.K. pound in terms of each currency of the emerging economies, respectively. The consumer price index is used as the price level for each country. Thus, the real exchange rate is measured as the nominal exchange rate, times the U.K. price level, divided by the corresponding domestic price level. The data series of one-month and three-month interest rates are also obtained from *Datastream*. The one-month and three-month interbank rates are used for Hungary, Poland, South Africa, Czech Republic, Indonesia, Pakistan, Russia, Thailand, Turkey and United Arab Emirates. The one- and three-month deposit rates are collected for Taiwan, India, Malaysia and Philippines. While for Mexico the one- and three-month interest rates are the rates of Treasury Bill (CETE) for 28 days and 91 days, respectively. All of the data are not seasonally adjusted. The inflation rate is calculated from the data of the corresponding consumer price index for each country, respectively. Therefore, the real interest rates are equal to the nominal interest rates minus the expected inflation that obtained using a Vector Autoregression (VAR), as well as under perfect foresight assumption. Both of these details are discussed below.

Bansal and Dahlquist (Bansal and Dahlquist 2000) point out that many emerging countries were only accessible for international investors from the early 1990s. The data base used here reflects this point. Thus, for these emerging economies, data are included as and when they become available. Table 3-1 and Table 3-2 in Appendix I at the end of this chapter report the inclusion date and basic descriptive statistics for the sample economies.

The complete sample contains 217 monthly observations over the period March 1993 to March 2011 for Mexico, Taiwan, Malaysia and Thailand; while Russia only has data available from May 1995 to May 1999. Expect for Russia all of these emerging economies have a similar pattern of interest rates and inflation (though with different magnitudes). The reason why Russia's pattern of interest rates and inflation is dissimilar might be the short sample periods which contain more volatile data for the late-1990s. Both exchange rates and interest rates are relatively stable. The mean value of the three-month interest rate is slightly higher than its corresponding one-month interest rate for every country except for Brazil, Hungary, Chile and Indonesia which have a relatively higher one-month interest rate on average.

The real interest rates are needed to model the relationship between the exchange rate and the term structure of interest rates. Thus, the expected inflation estimate has to be constructed. One method to achieve the expectation estimation is through a VAR model. Following Byeon and Ogaki (1999), a VAR of order five for the one-month nominal interest rate, the three-month nominal interest rate, and the inflation rate was estimated for every single economy over the respective sample period in order to obtain the three-period ahead forecast of the inflation rate in each period. Then, the three-month real interest rate specified in the model is calculated as the three-month nominal interest rate minus the corresponding inflation forecast. An alternative approach to achieve the expected inflation is based on the assumption of perfect foresight, which states that individuals are able to make correct and precise predictions about future inflation. Perfect foresight is a widely applied in dynamic economic models to yield an equilibrium solution without uncertainty. Therefore, one can easily calculate the three-month real interest rate differential, $\left(r_{3,t} - r_{3,t}^{*}\right)$, which can then be used to capture the influence of the persistent shock e_t of the interest rate with longer duration.

In addition, the normalised one-period interest rate $r_{N,t}$, which is the negative risk premium for the three-month bonds, can be used to measure the effect of the temporary shock of interest rate. Following Ogaki and Santaella (Ogaki and Santaella 1999) and Byeon and Ogaki (1999), this normalised one-period interest rate is specified as:

(3.4.1) $$r_{N,t} = \frac{1}{3}\sum_{k=0}^{2} E_t\left(r_{1,t+k}\right) - r_{3,t},$$

The normalised one-month interest rate captures the deviation of one-month interest rates from the three-month interest rate, with $r_{1,t}$ and $r_{3,t}$ denoting the one-month and three-month nominal interest rates, respectively. The one period and two periods ahead forecasts of one-month interest rates are obtained from the VAR model estimation of order five for one-month nominal interest rate, three-month nominal interest rate, and inflation for every single country. An alternative to this approach is to use actual interest rates for one period and two periods ahead to proxy for the expected interest rates under perfect foresight.

Table 3-3 in Appendix I at the end of this chapter reports the basic descriptive statistics of the three-month real interest rate differentials, $\left(r_{3,t} - r_{3,t}^{*}\right)$, as well as the normalised one-month interest rate differentials, $\left(r_{N,t} - r_{N,t}^{*}\right)$, with expectations from VAR and under perfect foresight, respectively.

All these emerging countries seem to have similar patterns for normalised one-month interest rate differential and three-month real interest differential. Once again, Russia is an exception to this rule because it contains relatively fewer observations. Although

Taiwan and Chile have negative three-month real interest differentials in average values, they share a similar trend with that of the other economies studied. For most economies both the nominalised one-month interest rate and the three-month real interest rate differentials have relatively large standard deviations. Thus, it is necessary to check the stationarity for each interest rate differentials as well as for the exchange rate, respectively, for every sample economy. The augmented Dickey-Fuller (Dickey and Fuller 1979) approach is applied to test for the unit root. Table 3-4 reports the unit root test results for normalised one-month interest rate differential $\left(r_{N,t} - r^*_{N,t}\right)$, and three-month real interest rate differential $\left(r_{3,t} - r^*_{3,t}\right)$, respectively, for every single economy. The natural logarithm of real exchange rate $\ln s_t$ (which is calculated as a nominal exchange rate, multiplied by the U.K. price level, divided by the domestic price level) is also tested. A constant term is included in the test regressions.

Table 3-4 in Appendix I at the end of this chapter reports the Augmented Dickey-Fuller unit root test results for the log real exchange rate, the normalised one-month interest rate differential, and the three-month real interest rate differential, respectively. A constant term is included in the regressions with lag length automatically selected based on SIC for each series. The first column contains results for the log real exchange rate $\ln s_t$. One can easily observe that for most cases, the null hypothesis of unit root cannot be rejected at 5% level. This implies that the log real exchange rates are not stationary for most countries, except for Brazil, Hungary, Chile, Czech Republic, Russia, and Turkey. For the normalised one-month interest rate differentials, $\left(r_{N,t} - r^*_{N,t}\right)$, stationarity is obtained for all sample economies under perfect foresight assumption, and thirteen out of sixteen economies with VAR expectations at 5% level. Nevertheless, according to the results presented in the last two columns in Table 3-4, the three-month real interest rate differentials, $\left(r_{3,t} - r^*_{3,t}\right)$ are not stationary for most of these economies expect for: Hungary and Russia with

VAR expectations; and Taiwan, Malaysia and Russia under perfect foresight. Thus, it is necessary to implement the unit root test on each series in first difference, respectively, to obtain their orders of integration for further analysis. The results are reposted in Table 3-5 below.

The results in Table 3-5 in Appendix I at the end of this chapter show evidence of stationary first difference of each series at 5% level. Combining these results with the results in Table 3-4 shows that for series in levels one can conclude that majority of the emerging economies have their log real exchange rates being $I(1)$ series, except for Brazil, Hungary, Chile, Czech Republic, Russia and Turkey which have $I(0)$ series. The normalised interest rate differentials are $I(0)$ for all sample economies with expectations obtained under perfect foresight assumption, and for most of these economies (except for Brazil, South Africa and Russia) with expectations achieved from a VAR estimation. The three-month real interest rate differentials are $I(1)$ except for: Hungary and Russia with VAR expectations; and, Taiwan, Malaysia and Russia under perfect foresight.

Since some of the emerging economies contain relative short sample periods, analysis with individual country may not be that powerful. Hence, it is necessary and important to take into account the panel data constructions for all the emerging countries in the sample separately, as well as for the advanced and secondary emerging economies. Thus, the first step is also to look at the order of integration for each variable, but within the panel setting:

Table 3-6 and Table 3-7 in Appendix I at the end of this chapter report the panel unit root test results of LLC (details provided in Appendix II in Chapter 2). Although the null hypothesis of the unit root cannot be rejected for log real exchange rate and three-month real interest rate differential in levels, it is rejected in favour of stationarity for both of them in first differences. This implies that the log real exchange rate and the three-month real interest rate differential are $I(1)$ series. At the same time, the unit root hypothesis is rejected for the normalised one-period interest rate differential in levels; thereby, indicating that the normalised one-period interest rate differential is a stationary series.

3.5. The Economic Model Specification

In the empirical analysis the reduced form of the model (i.e. Equation (3.2.1) $s_t = \bar{s} - \left(\frac{1-\lambda}{b}\right)u_t - \left(\frac{1-\lambda}{b}\right)B^s_{F,t-1} - \left(\frac{\lambda}{1-\lambda c}\right)e_t + \lambda(\phi-1)\varepsilon_t$) is employed in order to find stylised facts about the relationship between the exchange rate and the term structure of interest rates. The important features of the data that were described in Section 3.4 are taken into consideration at this point. This approach is consistent with Ogaki and Santaella's (1999) model. The model itself is specified as:

(3.5.1) $$q_t = \mu + \alpha\left(r_{3,t} - r^*_{3,t}\right) + \beta\left(r_{N,t} - r^*_{N,t}\right) + \upsilon_t$$

Where q_t represents the real exchange rate, $\left(r_{3,t} - r^*_{3,t}\right)$ is the difference between three-month domestic and foreign real interest rates. It captures the impact of the interest rate shock with longer duration, e_t, in the model. Meanwhile, the normalised one-period interest rate differential, denoted as $\left(r_{N,t} - r^*_{N,t}\right)$, is employed in Equation (3.5.1) in order to capture the effect of the temporary interest rate shock in the model, ε_t.

In this chapter Equation (3.5.1) is considered as a cointegrating regression because the null hypothesis, which states that the first difference of the real exchange rate has a unit root, is rejected for most emerging economies included in the sample. Thus, both Park's (1992) CCR and Stock and Watson's (1993) DOLS are applied to analyse this relationship between the exchange rate and the term structure of interest rates for every individual economy. CCR is widely used in the empirical work in this area, so we will apply it here to be consistent with the literature. DOLS is considered as a more powerful methodology in analysing cointegrating relationship but it has not yet been widely used in this area, thus we will take consideration of both CCR and DOLS in order to check their consistency and so achieve robustness. However, different specifications are adopted among countries because the orders of differences for the leads and lags of the independent variables are chosen based on the orders of integration of the corresponding regressors. More specifically, both the three-month real interest rate differential and the normalised one-period interest rate differential are stationary in Hungary under rational expectation from VAR estimation, and with expectations under perfect foresight in Mexico, Taiwan Malaysia and Russia, so no first difference terms are needed to estimate the relationship between the exchange rate and the term structure of interest rates. However, for Brazil and South Africa with VAR expectations, where they are I(1) series for both three-month real interest rate differential and normalised one-period interest rate differential, the DOLS equation specification is written as:

(3.5.2)

$$q_t = \mu + \alpha\left(r_3 - r_3^*\right)_t + \beta\left(r_N - r_N^*\right)_t + \sum_{j=-2}^{2}\rho_j\Delta\left(r_3 - r_3^*\right)_{t-j} + \sum_{j=-2}^{2}\varphi_j\Delta\left(r_N - r_N^*\right)_{t-j} + \upsilon_t$$

Where Δ represents the first difference. Meanwhile, in Russia, the three-month real interest differential is stationary while the normalised one-period interest differential is I(1) with VAR expectations, thus:

(3.5.3) $$q_t = \mu + \alpha\left(r_3 - r_3^*\right)_t + \beta\left(r_N - r_N^*\right)_t + \sum_{j=-2}^{2}\varphi_j\Delta\left(r_N - r_N^*\right)_{t-j} + \upsilon_t$$

And for the other countries in this study the three-month interest differential is I(1) and the normalised one-period interest rate differential is I(0) with VAR expectations and/or expectations under perfect foresight. Therefore, we can specify the following equation:

(3.5.4) $$q_t = \mu + \alpha\left(r_3 - r_3^*\right)_t + \beta\left(r_N - r_N^*\right)_t + \sum_{j=-2}^{2}\rho_j\Delta\left(r_3 - r_3^*\right)_{t-j} + \upsilon_t$$

In the standard models, α is expected to be negative, while the sign of β can be either positive or negative. If the indirect complementarity between the one-period domestic and foreign bonds dominates their corresponding direct substitutability, then β is positive, and vice versa.

Clearly, DOLS is able to handle the unbalanced regression in which variables have different orders of integration (as described in Section 3.3) and it is emphasised as a better procedure to handle the cointegration relationship for relatively smaller samples than the CCR. Furthermore, DOLS is also valid for analysis of panel cointegrating relationship that controls for both time and cross-section fixed effects:

$$q_{it} = \phi_i + \gamma_t + \left(r_3 - r_3^*\right)'_{it}\alpha + \left(r_N - r_N^*\right)'_{it}\beta + \sum_{j=-2}^{2}\Delta\left(r_3 - r_3^*\right)'_{it+j}\rho + u_{it} \tag{3.5.5}$$

Shifts in different regime can be assessed through the tests of structural breaks in the cointegrating relationship (as discussed in Section 3.3). The corresponding auxiliary regression (3.3.14) is applied for the stability test under panel data framework. The Wald test statistic is reliable in testing the joint significance of coefficient estimates.

3.6. Empirical Results

Table 3-8 in Appendix I at the end of this chapter reports both CCR and DOLS results for the empirical relationship between the real exchange rate and the term structure of interest rates. The whole sample period is used for each individual economy, although some of these economies include relatively small numbers of observations. It can be seen that CCR and DOLS provide similar and consistent cointegrating relationships among emerging economies, and the results seem to be consistent with the expectations obtained from both the VAR model and under perfect foresight. These results provide evidence that the term structure of interest rates matters for the exchange rate in the emerging economies. The point estimate of α, which is the coefficient of the three-month real interest rate differential, is negative and statistically significantly different from zero at a 5% level for many emerging economies. Conventional wisdom suggests that an increase in the interest rate appreciates the exchange rate. The negative α is consistent with this standard direction, and it is also consistent with the theoretical model and discussions in Section 3.2. Nonetheless, there are a few exceptions. Among the advanced emerging economies, Taiwan has positive α, but it could not provide much information because this coefficient estimate is insignificantly different from zero even at a 10% level. A few countries in the secondary category (such as Chile, India, Pakistan and Philippines) show positive and statistically significant estimates of α. This might be happening because their sample periods are relatively short. For example, data are available from September 2002 for Pakistan and November 2000 for the Philippines. According to conventional wisdom an increase in the normalised one-period interest rate differential is supposed to be associated with an appreciation in the exchange rate, implying that β is expected to be negative. However, there is an alternative explanation which comes from the theoretical model that was discussed in Section 3.2: the exchange rate would depreciate if the indirect complementarity dominates the direct substitutability and therefore, one would observe a positive β. For Brazil, Mexico, Taiwan and Chile, we have obtained negative and statistically significant estimates of β. While for Malaysia and Philippines, positive and statistically significant estimates of β are yielded. These results imply that there is an indirect complementarity which dominates the direct substitutability in the currency market in these countries. It is also worth noticing that these results are not sensitive with expectations obtained from either VAR or under perfect foresight.

A few countries contain limited observations and they show an insignificant relationship between the exchange rate and the term structure of interest rates; for example, Russia only has 49 observations available from May 1995 to May 1999 in this analysis. It is difficult to reach a substantial conclusion with so short a sample period. Hence, the panel data analysis is implemented with fixed effects controlling for time and cross-section characteristics in order to get rid of the small sample bias and so achieve more powerful results and capture properties for the whole emerging economy.

Table 3-9 in Appendix I at the end of this chapter reports the results from panel DOLS estimations for all of the emerging countries, as well as for advanced and secondary emerging economies. Negative and statistically significant estimates of α are obtained with panel data constructions. This is consistent with the standard models of exchange rate and term structure of interest rates and supports the theory that was discussed in Section 3.2. Thus, a rise in the three-month real interest rate differential will lead to exchange rate appreciation in both advanced and secondary emerging economies. In the third and sixth columns of Table 3-9, one can observe negative and statistically significant point estimates of β for the whole sample and each subsample, with expectations obtained from both the VAR estimation and under perfect foresight. This illustrates that for the emerging economies, the indirect complementarity dominates the direct substitutability to make the β estimates inconsistent with traditional wisdom. In summary, increases in the interest rate differential will, ceteris paribus, be associated with domestic currency appreciation in both the short-run term and the long-run.

In the 1990s a number of emerging economies, influenced by the currency collapses which happened in that decade, had been moving toward floating exchange rate regimes. For instance, Brazil set its currency into an independently floating regime following its own currency crisis in 1999, which in turn had been caused by the 1997 Asian crisis and the 1998 Russia crisis. The Peso crawling peg was abandoned in Mexico in 1994, and from then on Mexico has adopted a floating exchange rate regime. Another example is Chile, whose exchange rate was classified as managed floating since 1997. Chile finally allowed its currency to float in 1999. Therefore, it is natural to examine the possible structural breaks in emerging economy cases. Dummy variables are included for both interest rate differentials to detect the break points during the sample period. Figure 3-1, Figure 3-2, and Figure 3-3 provide the Wald statistics for joint significance of coefficients to show the structural breaks for all emerging countries with VAR expectations, as well as for the advanced and secondary emerging countries. Figure 3-4, Figure 3-5 and Figure3-6 draw the same statistics but under perfect foresight. The χ^2 test results for corresponding coefficient restrictions are graphed with 5% and 10% critical values in the same plot. The points above corresponding lines of critical values indicate the presence of structural breaks. Thus, it is clear that in all of the cases the breaks appear mainly in the 1990s, especially around 1997 when the Asian crisis financial erupted. For instance, taking the whole sample with VAR expectation, the χ^2 test statistics are above their 5% critical value from December 1994 to March 1995, August 1996, and from March to April, June to September and November to December 1997. It is also worth noticing that there are fewer structural breaks for advanced emerging countries, indicating that the cointegrating relationship between the exchange rate and the term structure of interest rates is more stable in advanced emerging economies when compared to their secondary counterparts.

Figure 3-1: Structural breaks for all emerging economies with VAR expectation

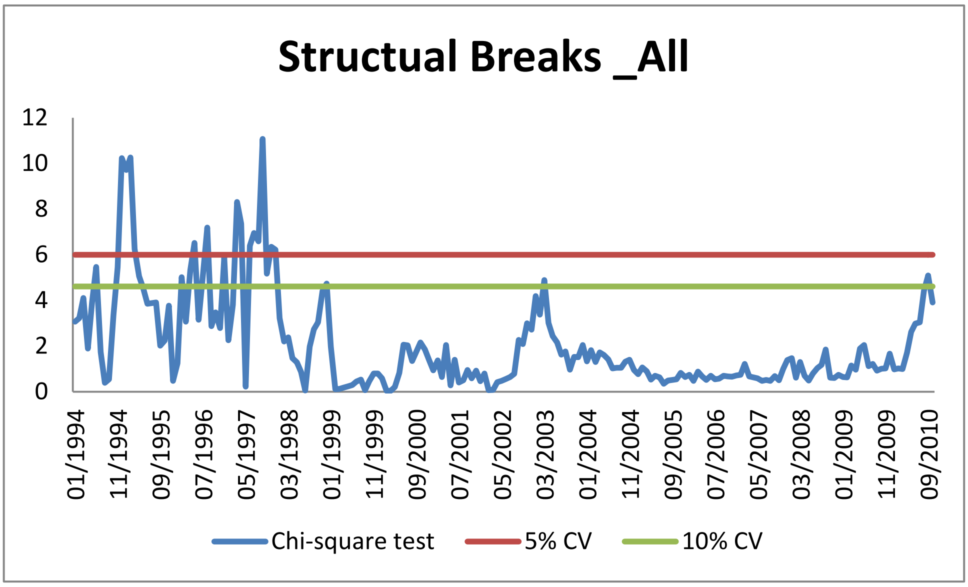


Figure 3-2: Structural breaks for advanced emerging economies with VAR expectation

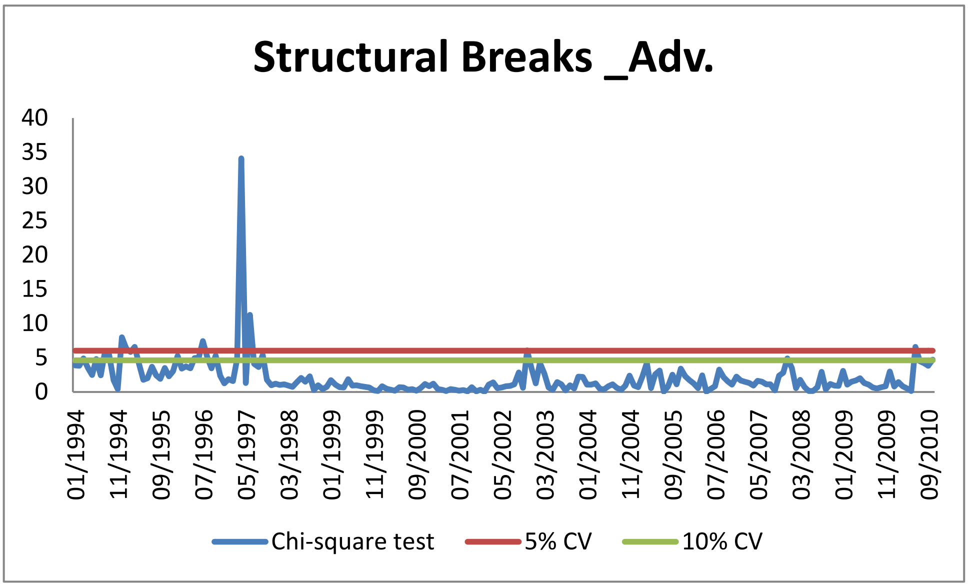


Figure 3-3: Structural breaks for secondary emerging economies with VAR expectation

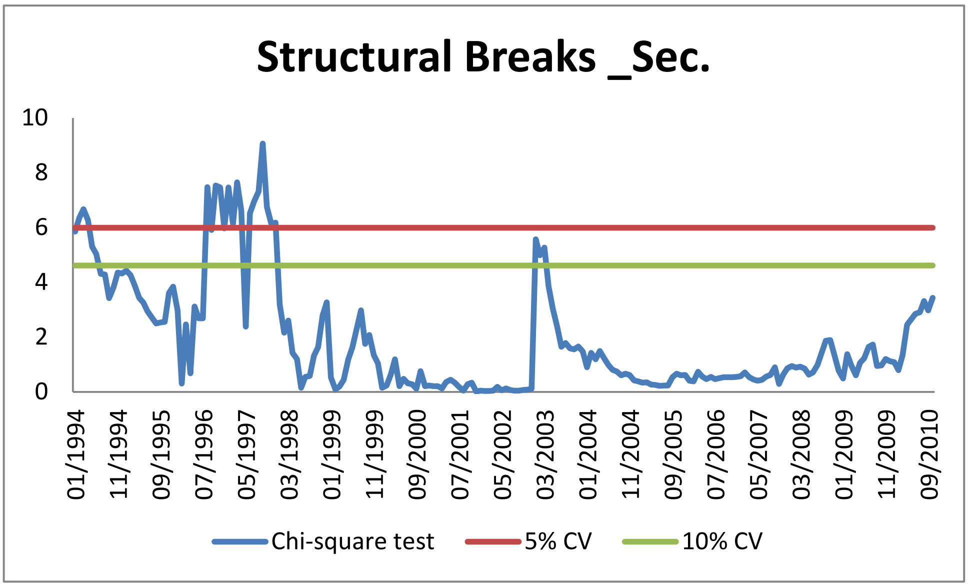


Figure 3-4: Structural breaks for all emerging economies with perfect foresight

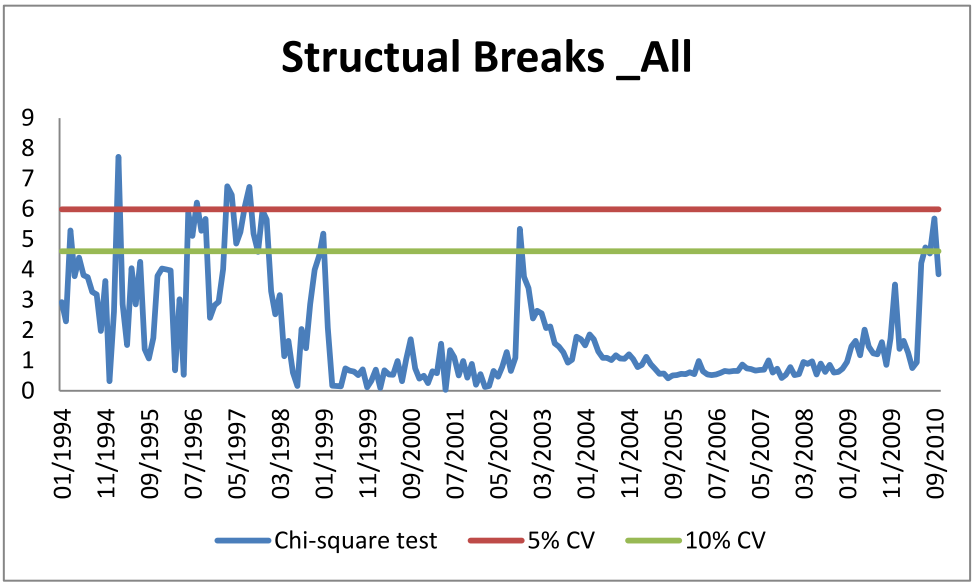


Figure 3-5: Structural breaks for advanced emerging economies with perfect foresight

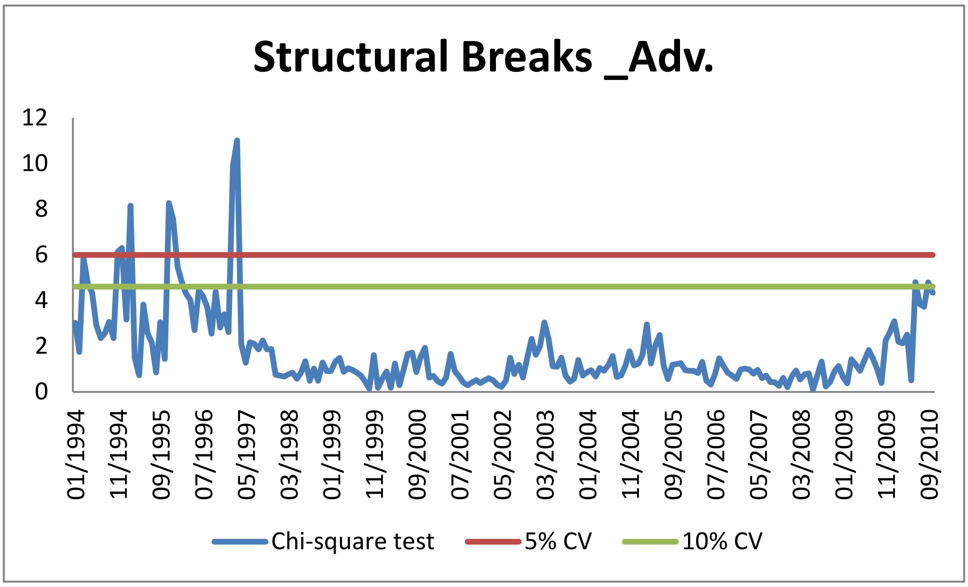
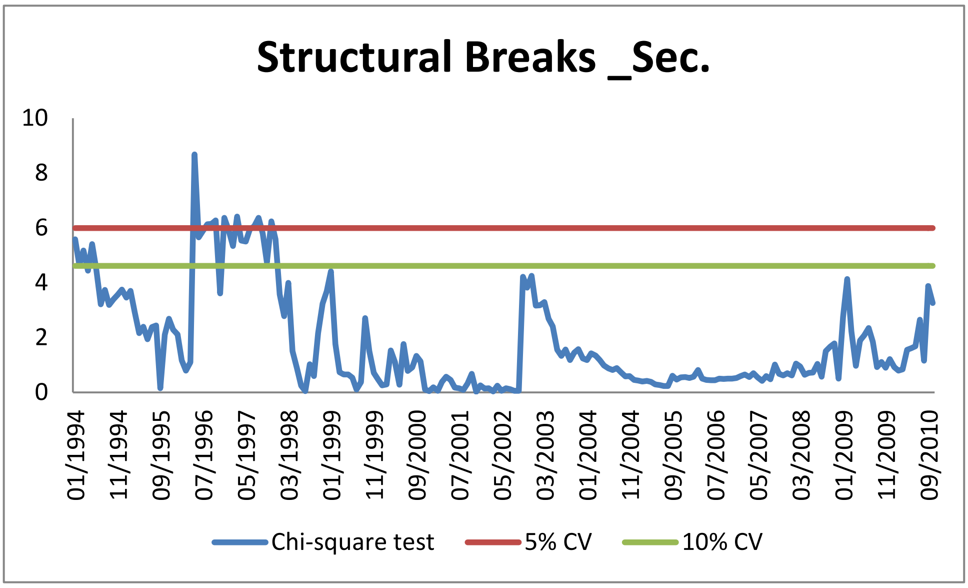


Figure 3-6: Structural breaks for secondary emerging economies with perfect foresight



The results show multiple structural breaks and the presence of them might change the cointegrating relationship between the exchange rate and the term structure of interest rate differentials. So it is important to better understand this cointegrating relationship with controlling these breaking points.

There are similar but different break points among subsamples according to Figures above. Table 3-10 in Appendix I at the end of this chapter reports panel DOLS cointegrating regression results controlling the structural breaks for the whole sample, and the advanced and secondary emerging economies. The second and fifth columns of Table 3-10 present the estimates of α. It is noteworthy that the coefficient of the three-month real interest rate differential continues to be statistically significantly negative. Similarly, the estimates of coefficient β also remain negative and statistically significant at a 5% level. By making a comparison between each subsample it can be seen that the qualitative relation of the term structure of interest rate differentials to the exchange rate is maintained while the quantitative relation slightly changes when taking consideration of the specific structural breaks. At the same time, the R^2 values are slightly higher when taking into account the structural breaks in the panel cointegrating relationship between the exchange rate and the term structure of interest rates.

3.7. Conclusion

This chapter investigates the relationship between exchange rate and the term structure of interest rates by regressing the log of real exchange rate on the three-month interest rate differential and normalised one-month interest rate differential for emerging economies. It extends Ogaki and Santaella's (1999) work by including more countries and treating the emerging economies as a whole market through a panel framework. Empirically, both CCR and DOLS methodologies are applied in analysis for every individual country and under panel construction, the structural breaks are further taken into consideration.

The relationship between exchange rate and the term structure of interest rates has important policy implications. It could help the monetary authority to control the changes of the exchange rates through interest rate channel. According to the economic model, when a monetary authority chooses to increase the domestic short-term interest rate, the reaction of the domestic long-term interest rate determines how the exchange rate changes. More specifically, if the increase in the domestic short-term interest rate causes a rise in the domestic long-term interest rate then the domestic currency will appreciate, which is consistent with the standard theory with risk neutral investors. However, if the long-term interest rate remains unchanged then the increase in the domestic short-term interest rate will lead to a depreciation in the domestic currency and the relationship between the exchange rate and the term structure of interest rates become less explicit.

The empirical results show evidence of the economic model and imply that the term structure of interest rates plays an important role in determining the exchange rate and they enrich the literature by providing these evidences for emerging economies. Negative slope coefficient estimates are found for the long-term interest differentials for most emerging countries, and they are statistically significant, although there are a few exceptions with positive and insignificant coefficient estimates. This result is consistent with traditional wisdom as well as standard exchange rate models. The sign of the slope coefficient for the short-term interest rate depends on the complicated relationship between the short-term interest rate, the long-term interest rate, and the exchange rate. Taking South Africa and Philippines as an example, it can be seen that a positive and statistically significant coefficient estimate is obtained for the short-term interest rate differential, implying that the indirect complementarity between the domestic short-term bonds and the foreign bonds dominates. Nonetheless, the corresponding slope coefficient for the short-term interest rate is statistically significant but negative, which indicates that the direct substitutability of those two assets dominates instead for some of the other emerging countries, (such as Brazil and Mexico). By taking emerging economies as a whole market under panel construction it is found that negative and significant slope coefficients are obtained for both short-term and long-term interest rate differentials. In addition to previous studies, the robustness of these results is checked using different cointegration methods as well as under different assuptions for expectations. However, the use of the three-month real interest rate differential and the normalized one-month interest rate differential might not be enough to describle for the whole picture of the term structure of interest rates; hence futher analysis on this point could be persued in this area.

Because the exchange rate regimes of most emerging economies have been changing, the structural breaks are taken into account in this study in order to examine the stability of the cointegrating relation between the exchange rate and the term structure of interest rates. The evidence shows parameter stability for this cointegrating regression of the real exchange change rate on the three-month real interest rate differential and normalised one-month interest rate differential, indicating that this cointegrating relationship is stable despite exchange regime changes in the emerging markets.

Appendix I

Table 3-1: Summary statistics of exchange rate and inflation

	Inclusion sample		Exchange rate		Inflation	
	Start date	**End date**	**Mean**	**S.D.**	**Mean**	**S.D.**
<u>**Advanced:**</u>						
Brazil	04/2000	03/2011	0.273571	(0.063694)	0.566351	(0.500992)
Hungary	09/1995	03/2011	0.002930	(0.000549)	0.681279	(0.737132)
Mexico	03/1993	03/2011	0.076379	(0.044697)	0.817061	(0.985102)
Poland	06/1993	03/2011	0.197334	(0.048022)	0.697845	(0.940852)
South Africa	02/2002	01/2011	0.078237	(0.009601)	0.405873	(0.471046)
Taiwan	03/1993	03/2011	0.019779	(0.002926)	0.121709	(0.877511)
<u>**Secondary:**</u>						
Chile	01/1994	03/2011	0.001188	(0.000234)	0.344344	(0.441981)
Czech Republic	03/1993	03/2011	0.023336	(0.005197)	0.439627	(0.869296)
India	12/1998	02/2011	0.013276	(0.001089)	0.460775	(0.839118)
Indonesia	03/1996	03/2011	0.000087	(0.000061)	0.899728	(1.654452)
Malaysia	03/1993	03/2011	0.185156	(0.042751)	0.219820	(0.409320)
Pakistan	09/2002	03/2011	0.008735	(0.001117)	0.831175	(0.877470)
Philippines	11/2000	03/2011	0.011989	(0.001678)	0.422772	(0.460937)
Russia	05/1995	05/1999	0.099345	(0.038005)	3.283671	(5.686642)
Thailand	03/1993	03/2011	0.018170	(0.004502)	0.283270	(0.549120)
Turkey	08/2002	03/2011	0.401860	(0.026705)	0.873298	(0.901006)

The table presents the summary statistics of the exchange rates and inflation in a monthly horizon. Standard deviations (S.D.) are reposted in parenthesis. The start and end dates specify the sample included for each emerging country, respectively.

Table 3-2: Summary statistics of interest rates

	Inclusion sample		1-month interest rate		3-month interest rate	
	Start date	**End date**	**Mean**	**S.D.**	**Mean**	**S.D.**
<u>**Advanced:**</u>						
Brazil	04/2000	03/2011	15.65371	(4.806670)	15.34295	(5.138012)
Hungary	09/1995	03/2011	11.97358	(6.067097)	11.90043	(6.005512)
Mexico	03/1993	03/2011	12.99083	(8.374507)	13.48700	(8.644602)
Poland	06/1993	03/2011	13.28131	(9.333692)	13.44832	(9.470059)
South Africa	02/2002	01/2011	8.891954	(2.261888)	9.082074	(2.299683)
Taiwan	03/1993	03/2011	3.059240	(1.956607)	3.283272	(2.136994)
<u>**Secondary:**</u>						
Chile	01/1994	03/2011	0.581498	(0.391223)	0.459130	(0.230938)
Czech Republic	04/1992	03/2011	6.254605	(4.940647)	6.352851	(4.717140)
India	12/1998	02/2011	7.050000	(2.087270)	7.559388	(2.143538)
Indonesia	03/1996	03/2011	15.02727	(12.41896)	14.73995	(10.42117)
Malaysia	03/1993	03/2011	4.191244	(1.929682)	4.266820	(1.936152)
Pakistan	09/2002	03/2011	8.379903	(4.088360)	8.659466	(4.154053)
Philippines	11/2000	03/2011	4.270112	(1.363546)	4.370008	(1.290433)
Russia	05/1995	05/1999	56.49776	(30.84537)	55.60714	(26.25544)
Thailand	03/1993	03/2011	6.119023	(5.664786)	6.164396	(5.432170)
Turkey	08/2002	03/2011	19.67686	(11.29451)	20.12151	(11.65720)

The table presents the summary statistics of the one- and three-month interest rates on a monthly horizon. Standard deviations (S.D.) are reposted in parenthesis. The start and end dates specify the sample included for each emerging country, respectively.

Table 3-3: A summary of statistic interest rate differentials

	Normalised 1-month interest rate differential, $\left(r_{N,t}-r^{*}_{N,t}\right)^{A}$		Normalised 1-month interest rate differential, $\left(r_{N,t}-r^{*}_{N,t}\right)^{B}$		3-month real interest rate differential, $\left(r_{3,t}-r^{*}_{3,t}\right)^{A}$		3-month real interest rate differential, $\left(r_{3,t}-r^{*}_{3,t}\right)^{B}$	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
Advanced:								
Brazil	0.4618	(1.3576)	0.4369	(1.4572)	12.179	(5.4711)	12.124	(5.3337)
Hungary	0.0858	(0.3130)	0.0657	(0.5777)	7.4523	(4.3412)	7.7677	(4.8632)
Mexico	-0.4211	(1.2105)	-0.4401	(2.1167)	9.0177	(7.0514)	9.0896	(7.0273)
Poland	-0.1382	(0.3995)	-0.1681	(0.5897)	8.8225	(7.4543)	9.1752	(7.8288)
South Africa	-0.1059	(0.2833)	-0.1124	(0.3588)	6.3118	(2.9109)	6.4313	(2.8140)
Taiwan	-0.1143	(0.2877)	-0.1289	(0.3477)	-0.5406	(1.5214)	-0.4727	(1.7735)
Secondary:								
Chile	0.2335	(0.2349)	0.2400	(0.2857)	-3.5602	(2.0732)	-3.5661	(2.1189)
Czech Rep.	0.0381	(0.4834)	0.0031	(1.0507)	1.9032	(3.3914)	2.0779	(3.6858)
India	-0.3577	(0.3546)	-0.3674	(0.5208)	3.9695	(1.6608)	4.0163	(1.8279)
Indonesia	0.3914	(3.4395)	0.3662	(3.7755)	10.463	(9.3914)	10.450	(9.3365)
Malaysia	0.0195	(0.2164)	0.0192	(0.3236)	0.3404	(1.8433)	0.4020	(1.9393)
Pakistan	-0.0543	(0.4326)	-0.0672	(0.5681)	5.4115	(4.3396)	5.3893	(4.3850)
Philippines	-0.0039	(0.2636)	0.0084	(0.3614)	1.4778	(2.0605)	1.5074	(2.0264)
Russia	2.8207	(15.684)	-0.3733	(20.503)	41.776	(19.737)	47.065	(25.729)
Thailand	0.0351	(0.5447)	0.0364	(0.9550)	2.1716	(4.3874)	2.2529	(4.4340)
Turkey	-0.6422	(1.0751)	-0.7060	(1.4193)	15.967	(10.051)	17.199	(11.458)

The table presents the summary statistics of the normalised one-month interest rate differential and three-month real interest rate differential on a monthly horizon with standard deviations reposted in parenthesis. [A] represents interest rate differential with expectations obtained from VAR model estimation of order five for one-month nominal interest rate, three-month nominal interest rate, and inflation. [B] stands for interest differentical with expectations under perfect foresight assumption.

Table 3-4: Unit root tests of variables in levels

	$\ln q_t$	$\left(r_{N,t} - r^*_{N,t}\right)^A$	$\left(r_{N,t} - r^*_{N,t}\right)^B$	$\left(r_{3,t} - r^*_{3,t}\right)^A$	$\left(r_{3,t} - r^*_{3,t}\right)^B$
Advanced:					
Brazil	-9.37887***	-2.83919*	-3.29208**	-1.41085	-1.53008
	[0.0000]	[0.0558]	[0.0173]	[0.5751]	[0.5153]
Hungary	-4.26919***	-10.3854***	-8.31950***	-3.76693***	-2.61595*
	[0.0007]	[0.0000]	[0.0000]	[0.0039]	[0.0917]
Mexico	-1.47402	-6.13481***	-9.17267***	-2.86895*	-1.68890
	[0.5450]	[0.0000]	[0.0000]	[0.0508]	[0.4354]
Poland	-1.60533	-3.94595***	-7.99163***	-2.49735	-1.51047
	[0.4781]	[0.0021]	[0.0000]	[0.1176]	[0.4354]
South Africa	-2.03183	-2.02754	-3.55899***	-1.23885	-1.51047
	[0.2730]	[0.2748]	[0.0078]	[0.6552]	[0.5246]
Taiwan	-0.84847	-3.06115**	-3.19684**	-2.30991	-2.94374**
	[0.8027]	[0.0311]	[0.0215]	[0.1698]	[0.0421]
Secondary:					
Chile	-5.26615***	-4.57263***	-3.78502***	-0.95602	-2.33018
	[0.0000]	[0.0002]	[0.0036]	[0.7685]	[0.1636]
Czech Rep.	-3.20581**	-5.14215***	-5.70168***	-2.40199	-2.66700*
	[0.0210]	[0.0000]	[0.0000]	[0.1424]	[0.0816]
India	-0.81109	-6.33329***	-6.74321***	-2.22381	-2.12702
	[0.8135]	[0.0000]	[0.0000]	[0.1989]	[0.2345]
Indonesia	-2.15051	-3.93776***	-4.14552***	-1.97592	-2.17584
	[0.2254]	[0.0022]	[0.0011]	[0.2973]	[0.2159]
Malaysia	-1.85179	-8.12272***	-5.88139***	-2.14291	-2.95789**
	[0.3548]	[0.0000]	[0.0000]	[0.2282]	[0.0406]
Pakistan	1.23700	-6.05307***	-7.94025***	-0.11540	0.21299
	[0.9983]	[0.0000]	[0.0000]	[0.9439]	[0.9321]
Philippines	-1.05305	-4.18270***	-4.86286***	-1.68117	-2.77719*

	$\ln q_t$	$\left(r_{N,t} - r^*_{N,t}\right)^A$	$\left(r_{N,t} - r^*_{N,t}\right)^B$	$\left(r_{3,t} - r^*_{3,t}\right)^A$	$\left(r_{3,t} - r^*_{3,t}\right)^B$
	[0.7341]	[0.0011]	[0.0001]	[0.4382]	[0.0649]
Russia	-7.55483***	-2.37931	-4.18159***	-4.03704***	-3.73239***
	[0.0000]	[0.1537]	[0.0018]	[0.0030]	[0.0065]
Thailand	-1.60474	-3.59197***	-4.38707***	-2.78097*	-2.28685
	[0.4784]	[0.0067]	[0.0004]	[0.0628]	[0.1772]
Turkey	-13.0511***	-5.13171***	-5.70450***	-2.63246*	-2.48672
	[0.0000]	[0.0000]	[0.0000]	[0.0900]	[0.1217]

This table presents the results of Augmented Dickey-Fuller tests of unit root for real exchange rate q_t , normalised one-month interest rate differential and three-month real interest rate differential, respectively. Lag lengths are automatically selected based on Schwarz Information Criterion. [A] represents interest rate differential with expectations obtained from VAR model estimation of order five for one-month nominal interest rate, three-month nominal interest rate and, inflation. [B] stands for interest differentical with expectations under perfect foresight assumption. P-values are reposted within brackets beneath the corresponding t-statistics. * represents significance at 10% level, ** stands for significance at 5% level and * indicates significance at 1% level.**

Table 3-5: Unit root tests of variables in 1st differences

	$\Delta \ln q_t$	$\Delta\left(r_{N,t} - r^*_{N,t}\right)^A$	$\Delta\left(r_{N,t} - r^*_{N,t}\right)^B$	$\Delta\left(r_{3,t} - r^*_{3,t}\right)^A$	$\Delta\left(r_{3,t} - r^*_{3,t}\right)^B$
Advanced:					
Brazil	-12.1838***	-15.0612***	-14.0362***	-14.1187***	-13.8645***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Hungary	-1.94567**	-12.0465***	-10.9560***	-14.5697***	-3.00423***
	[0.0496]	[0.0000]	[0.0000]	[0.0000]	[0.0028]
Mexico	-8.37374***	-16.5392***	-10.1746***	-15.8981***	-15.9688***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Poland	-13.5032***	-15.9445***	-12.5388***	-6.63451***	-4.27316***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
South	-10.9183***	-10.6862***	-13.4036***	-8.80211***	-12.7054***
Africa	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Taiwan	-17.6784***	-15.8473***	-16.8741***	-14.5965***	-14.0178***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Secondary:					
Chile	-12.5330***	-11.9085***	-14.7011***	-13.0786***	-2.87626***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0042]
Czech Rep.	-3.32233***	-14.8011***	-11.4151***	-13.0564***	-3.80623***
	[0.0010]	[0.0000]	[0.0000]	[0.0000]	[0.0002]
India	-2.25725**	-10.0640***	-8.01679***	-12.0329***	-2.78272***
	[0.0235]	[0.0000]	[0.0000]	[0.0000]	[0.0056]
Indonesia	-3.14592***	-6.15995***	-11.3495***	-12.3230***	-12.1505***
	[0.0018]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Malaysia	-15.2705***	-13.3256***	-15.0007***	-12.0257***	-18.4658***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Pakistan	-4.02808***	-10.6811***	-12.8298***	-9.88325***	-16.1161***
	[0.0001]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Philippines	-14.1478***	-11.5879***	-8.611780***	-8.46244***	-2.35263***

	$\Delta \ln q_t$	$\Delta\left(r_{N,t} - r^*_{N,t}\right)^A$	$\Delta\left(r_{N,t} - r^*_{N,t}\right)^B$	$\Delta\left(r_{3,t} - r^*_{3,t}\right)^A$	$\Delta\left(r_{3,t} - r^*_{3,t}\right)^B$
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0187]
Russia	-2.15426**	-10.6513***	-9.38066***	-9.01079***	-10.3798***
	[0.0304]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Thailand	-14.7844***	-7.44902***	-11.3220***	-6.73272***	-15.7936***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Turkey	-3.03986***	-11.5267***	-12.1462***	-10.1213***	-11.2911***
	[0.0025]	[0.0000]	[0.0000]	[0.0000]	[0.0000]

The table presents results of Augmented Dickey-Fuller tests of unit root for the changes of the real exchange rate, the normalised one-month interest rate differential, and the three-month real interest rate differential, respectively. Lag lengths are automatically selected based on Schwarz Information Criterion. ^{A} represents interest rate differential with expectations obtained from VAR model estimation of order five for one-month nominal interest rate, three-month nominal interest rate, and inflation. ^{B} stands for interest differentical with expectations under perfect foresight assumption. P-values are reposted within brackets beneath the corresponding t-statistics. * indicates significance at 10% level, ** represents significance at 5% level and * denotes significance at 1% level.**

Table 3-6: Panel unit root tests of variables in levels

	$\ln s_t$	$\left(r_{N,t} - r_{N,t}^*\right)^A$	$\left(r_{N,t} - r_{N,t}^*\right)^B$	$\left(r_{3,t} - r_{3,t}^*\right)^A$	$\left(r_{3,t} - r_{3,t}^*\right)^B$
All	138.549	-15.4596***	-21.3847***	-1.01090	-1.01840
	[1.0000]	[0.0000]	[0.0000]	[0.1560]	[0.1542]
Advanced	243.004	-11.9211***	-17.5452***	-0.48313	0.16870
	[1.0000]	[0.0000]	[0.0000]	[0.3145]	[0.5670]
Secondary	16.5022	-10.5774***	-13.9393***	-0.96235	-1.47656*
	[1.0000]	[0.0000]	[0.0000]	[0.1679]	[0.0699]

The null hypothesis of panel unit root is tested using Levin, Lin and Chu test with maximum lags. Lag length selection is based on SIC. Newey-west bandwidth selection and Bartlett kernel is applied. [A] represents interest rate differential with expectations obtained from VAR model estimation of order five for the one-month nominal interest rate, the three-month nominal interest rate, and inflation. [B] stands for interest differentical with expectations under perfect foresight assumption. P-values are reposted within brackets beneath the corresponding t-statistics. * indicates significance at 10% level, ** represents significance at 5% level and * denotes significance at 1% level.**

Table 3-7: Panel unit root tests of variables in 1st differences

	$\Delta \ln q_t$	$\Delta\left(r_{N,t} - r_{N,t}^*\right)^A$	$\Delta\left(r_{N,t} - r_{N,t}^*\right)^B$	$\Delta\left(r_{3,t} - r_{3,t}^*\right)^A$	$\Delta\left(r_{3,t} - r_{3,t}^*\right)^B$
All	-23.7939***	-43.2268***	-46.6847***	-41.3147***	-44.0820***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Advanced	-17.3677***	-30.4967***	-30.9088***	-28.7014***	-26.9928***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Secondary	-16.0816***	-30.8187***	-35.3867***	-29.9532***	-34.9172***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]

The null hypothesis of panel unit root is tested using Levin, Lin and Chu test with maximum lags. Lag length selection is based on SIC. Newey-west bandwidth selection and Bartlett kernel is applied. [A] represents interest rate differential with expectations obtained from VAR model estimation of order five for the one-month nominal interest rate, the three-month nominal interest rate, and inflation. [B] stands for interest differentical with expectations under perfect foresight assumption. P-values are reposted within brackets beneath the corresponding t-statistics. * indicates significance at 10% level, ** represents significance at 5% level and * denotes significance at 1% level.**

Table 3-8: CCR and DOLS results

	CCR				DOLS			
	Expectations from VAR		Expectations under Perfect Foresight		Expectations from VAR		Expectations under Perfect Foresight	
Economy	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$
Advanced:								
Brazil	-0.003***	-0.008***	-0.003***	-0.005***	-0.002***	-0.003*	-0.002***	-0.0017
	(0.0005)	(0.0023)	(0.0005)	(0.0016)	(0.0003)	(0.0016)	(0.0005)	(0.0014)
Hungary	-0.122	3.816**	-0.080	1.316**	-0.286***	0.442	-0.287***	0.337*
	(0.0771)	(1.6597)	(0.0848)	(0.5806)	(0.0301)	(0.3269)	(0.0288)	(0.1866)
Mexico	-0.355***	-1.673**	-0.229***	-0.322	-0.197***	-0.902**	-0.127***	-0.193***
	(0.0808)	(0.7675)	(0.0591)	(0.3737)	(0.0408)	(0.4293)	(0.0201)	(0.0474)
Poland	-0.024***	0.252	-0.031***	0.059	-0.029***	0.074	-0.031***	0.048
	(0.0082)	(0.1634)	(0.0054)	(0.0787)	(0.0026)	(0.0491)	(0.0025)	(0.0312)
South	-0.011	0.349	-0.028	-0.121	0.007	0.219***	-0.007	-0.013
Africa	(0.0262)	(0.3420)	(0.0286)	(0.2621)	(0.0080)	(0.0727)	(0.0117)	(0.0786)
Taiwan	0.029	-0.676***	0.028	-0.585***	0.027	-0.583***	0.021	-0.392***
	(0.0449)	(0.1707)	(0.0560)	(0.1743)	(0.0189)	(0.0854)	(0.0156)	(0.0683)
Secondary:								
Chile	0.169***	-1.172***	0.193***	-0.958***	0.146***	-0.741*	0.164***	-0.511
	(0.0704)	(0.3932)	(0.0663)	(0.3638)	(0.0424)	(0.4470)	(0.0386)	(0.3446)
Czech Rep.	-0.084***	0.070	-0.083***	0.017	-0.072***	0.129	-0.069***	0.042
	(0.0222)	(0.1739)	(0.0219)	(0.0661)	(0.0128)	(0.1057)	(0.0120)	(0.0405)
India	0.087***	1.135*	0.041***	0.825	0.048	0.004	0.045	-0.050
	(0.0173)	(0.6731)	(0.0140)	(0.6099)	(0.0383)	(0.1860)	(0.0374)	(0.1232)
Indonesia	-0.509***	0.156	-0.432*	-0.611	-0.298***	0.231	-0.0217***	-0.238
	(0.1823)	(0.5993)	(0.2234)	(0.6319)	(0.0873)	(0.2551)	(0.0639)	(0.2515)
Malaysia	0.050	0.855	0.067	0.869***	0.021	0.215**	0.031***	0.183***
	(0.0386)	(0.5357)	(0.0412)	(0.2883)	(0.0130)	(0.1072)	(0.0111)	(0.0616)

	CCR				DOLS			
	Expectations from VAR		Expectations under Perfect Foresight		Expectations from VAR		Expectations under Perfect Foresight	
Economy	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$
Pakistan	0.137***	0.017	0.134***	0.117	0.127***	0.021	0.124***	0.060
	(0.0117)	(0.1403)	(0.0092)	(0.0879)	(0.0068)	(0.0647)	(0.0060)	(0.0392)
Philippines	0.220*	6.084***	0.016	0.543	-0.044	0.463*	-0.035	0.114
	(0.1323)	(1.7635)	(0.2637)	(1.2087)	(0.0246)	(0.2873)	(0.0260)	(0.1625)
Russia	-0.006	0.015	-0.012	0.015**	-0.002	0.010	-0.016*	0.007
	(0.0087)	(0.0115)	(0.0092)	(0.0061)	(0.0025)	(0.0084)	(0.0084)	(0.0092)
Thailand	-0.045*	-0.061	-0.027	0.068	-0.0170***	0.117	-0.017***	0.043
	(0.0268)	(0.2639)	(0.0297)	(0.1755)	(0.0046)	(0.0884)	(0.0048)	(0.0352)
Turkey	-0.0003***	-0.002*	-0.0002****	-0.0004	-0.0001***	-0.0002	-0.0001***	-0.0002*
	(0.0001)	(0.0010)	(0.0001)	(0.0006)	(0.0000)	(0.0003)	(0.0000)	(0.0001)

This table reports the cointegrating relationship between the real exchange rate and the term structure of interest rates $q_t = \mu + \alpha\left(r_{3,t} - r^*_{3,t}\right) + \beta\left(r_{N,t} - r^*_{N,t}\right) + \upsilon_t$. Both CCR and DOLS estimation results are provided with standard errors beneath the corresponding coefficient estimates. Newey-West is used to control heteroskedasticity and serial correlation. * denotes significance at 10% level, ** represents significance at 5% and * indicates significance at 1% level.**

Table 3-9: Panel DOLS results

	Expectations from VAR			Expectations under Perfect Foresight		
Economy	$\hat{\alpha}$	$\hat{\beta}$	R^2	$\hat{\alpha}$	$\hat{\beta}$	R^2
All	-0.041204***	-0.079138***	87.0%	-0.030666***	-0.072643***	86.3%
	(0.010321)	(0.024127)		(0.009923)	(0.0174240)	
Advanced	-0.030648***	-0.441093***	95.1%	-0.0271024***	-0.141173***	94.5%
	(0.004660)	(0.046374)		(0.004983)	(0.031704)	
Secondary	-0.065097***	-0.057181**	86.5%	-0.047110***	-0.069600***	85.7%
	(0.015236)	(0.024766)		(0.014086)	(0.017995)	

This table presents coefficient estimates of DOLS regression (3.5.5) $s_{it} = \phi_i + \gamma_t + \left(r_3 - r_3^*\right)'_{it}\alpha + \beta\left(r_N - r_N^*\right)'_{it}\beta + \sum_{j=-2}^{2}\Delta\left(r_3 - r_3^*\right)'_{it+j}\rho + u_{it}$ **under panel data constructions with fixed effects for all emerging economy, advanced and secondary emerging economy, respectively. Cross-section SUR is applied to control heteroskedasticity and serial correlation. Standard errors are reported in parenthesis beneath the corresponding coefficient estimates. * denotes significance at 10% level, ** represents significance at 5% level and *** indicates significance at 1% level.**

Table 3-10: Panel DOLS results with structural breaks

	Expectations from VAR			Expectations under Perfect Foresight		
Economy	$\hat{\alpha}$	$\hat{\beta}$	R^2	$\hat{\alpha}$	$\hat{\beta}$	R^2
All	-0.033570***	-0.084970***	87.5%	-0.026230***	-0.081784***	86.5%
	(0.010496)	(0.026509)		(0.010142)	(0.018915)	
Advanced	-0.030445***	-0.406425***	95.2%	-0.023000***	-0.141907***	94.6%
	(0.004771)	(0.046419)		(0.005034)	(0.033227)	
Secondary	-0.062218***	-0.078413**	87.6%	-0.037822**	-0.081115***	86.4%
	(0.015370)	(0.031755)		(0.014913)	(0.021671)	

This table presents coefficient estimates of DOLS regressions under panel data constructions with fixed effects for all emerging economy, advanced and secondary emerging economy, respectively. Dummy variables are used for all the periods with Wald statiscs significant at 5% to control structural breaks. Cross-section SUR is applied to control heteroskedasticity and serial correlation. Standard errors are reported in parenthesis beneath corresponding coefficient estimates. * denotes significance at 10% level, ** represents significance at 5% level and * stands for significance at 1% level, respectively.**

Chapter 4 **Security Risk and Term Structure of Interest Rates**

4.1. Introduction

Various empirical studies have provided evidence that the nominal interest rates and term structure of interest rates forecast the stock and bond returns. For example, Cox et al. (1985) provide a theory of the term structure of interest rates. Campbell (1987) states that the term structure of interest rates predicts stock returns and shows the importance of the nominal interest rates uncertainty in pricing both short-term and long-term assets by estimating a model of asset returns with a fixed-weighted "benchmark" portfolio of bills, bonds and stocks. Campbell and Shiller (1991b) demonstrate that the long rate tends to fall and the short rate tends to rise when the yield spread between the long-term and short-term interest rates is relatively high. Recently, Cochrane and Piazzesi (2005) show that the return-forecasting factor, which is a tent-shaped combination of forward rates, is countercyclical and predicts stock returns. They also find that this single factor positively forecasts future excess returns on different maturity bonds with a high value of R^2.

The standard asset pricing models, which describe the relation between risk and expected returns, predict that the expected excess return on an asset can be expressed as the product of the asset's systematic risk and the price of the risk in equilibrium. Thus, as Viceira (2007a) pointed out, the time variation in expected bond excess returns is determined by the time variation in the aggregate price of risk and/or the quantity of bond risk based on these models. Fama and French (1989b) find evidence that common components exist in the time variation of bond and stock expected returns. Campbell and Cochrance (1999) set up consumption based models using external habit information and suggest that the time variation in the expected excess returns on bonds is partially explained by a time-varying aggregate price of risk.

Furthermore, Wachter (2006) finds that there is a positive forecasting relation between the yield spread and future excess returns of bonds which is generated by the external habit preferences.

This chapter extends the research in this area by examining whether the security risk, defined as the quantity of security risk, is also time-varying. It will also ask whether this time variation can be explained by the short-term interest rates and yield spread, which are the variables correlated with the time variation in security excess returns. Viceira (2007b) provides a similar analysis on bond risk, but only for the U.S. bond market. This chapter adds to Viceira's (2007b) study by investigating the relationship between security risk and the nominal term structure of interest rates for each individual country in the G7, as well as under panel construction. If the expected excess returns of securities change in response to the time variation in risk terms, then it is natural to expect that the variables of term structure of interest rates could help to explain changes in security risk because they forecast security excess returns.

In this chapter, we focus on the second moments of bond and stock returns. There are various previous studies in this area which have attempted to allocate the determinants of the comovement of bond and stock returns, such as Barsky (1989), Shiller and Beltratti (1992), Campbell and Ammer (1993a), Andersen et al. (2005a) and Boyd et al. (2005). The well-known standard CAPM suggests that in the stock market the risk of an asset can be measured as the covariance of the returns on the aggregate market portfolio and that asset. For the bond market this CAPM implies that the covariance of bond returns with stock returns could be one proxy for bond risk. Therefore, we use the second moments (such as the realised volatility of bond returns, the realised covariance of bond returns with stock returns, and the realised bond beta) as proxies for bond risk. Meanwhile, the unconditional comovement of bond and stock returns, which is measured as the realised covariance of bond returns with stock returns, is also taken into account. Thus, the details of using these second moments are discussed and the relationship between the time variation in these second moments and the variables that proxy for business conditions for G7 economies is examined in this chapter.

The empirical studies conducted in this current chapter show that there is a systematic variation in the security risk, which is consistent with the traditional wisdom. Both the bond return volatility and the covariance between bond and stock returns seem to be persistent and mean-reverting processes. This study also shows evidence that generally the short-term nominal interest rate forecasts positively the realised bond return volatility, the realised covariance of bond returns with stock returns, as well as the bond CAPM beta for most G7 economies over the sample period. These findings are consistent with Viceira (2007b), whose research focused only on the U.S. economy. In addition, these results add to the empirical evidence on time variation in term structure of interest rates forecasting time variation in stock return volatility and exchange rate volatility.

Viceira (2007b) shows solid empirical evidence that yield spread positively affects bond excess returns, she also argued that there is a positive relation between the changes in the stock return volatility as well as exchange rate volatility and interest rates movements. Hence, it is worthwhile to further examine the effects of the short-term interest rate and the term structure of nominal interest rates on the time variation in the second moments of security returns. If these effects exist then the interest rate policy will be important in reducing the stock and bond market volatility. However, to date little empirical work has been done in this area. Viceira's (2007b) research of this relationship was limited to the U.S. Therefore, it is interesting to ask if the results for the US are robust and whether this is also the case for other developed economies. This current study contributes to research in this area in several points. Firstly, this chapter theoretically discusses the foundation for the application of the realised second moments in modelling the dynamics and it empirically examines the relationship between the time variation in the security risk (as measured by these realised second moments) and the time variation in the term structure of interest rates for G7 economies. Secondly, this study provides further empirical evidence of the effect of the short-term rate on second moments of security returns for the G7 economies as a whole, with analysis under panel construction. This also shows that the yield spread is also a statistically significant determinant in forecasting the time variation in security risk. In addition, the effects of the recent financial crisis on the relationship between time variation in security risk and time variation in the term structure of interest rates is also examined to confirm the stability through the sample period. The empirical results suggest that this relation has been changed significantly after the economic crisis. The relationship between the second moments of security returns and interest rates became at odds as the economy fell apart.

The rest of this chapter is organised as follows. Section 4.2 summarises and discusses the relevant previous literature. Section 4.3 describes the measures of the realised second moments of bond and stock returns, it also discusses the descriptive statistics of data and variables that are used in this study. The empirical model specifications and the main results are presented in Section 4.4. And finally, Section 4.5 concludes this chapter.

4.2. Literature Review

There are numerous empirical studies on the time variation of expected returns on both bonds and stocks. For example, Fama and French (1989b) find a risk premium that is related to longer-term aspects of business conditions in expected returns of stocks and long-term bonds. They also show that the variation in that premium is stronger for stocks than for bonds and is also stronger for low-grade bonds than for high-grade bonds, indicating that the expected returns are lower when economic conditions are strong, and vice versa. Campbell and Cochrane (1999) implement a consumption-based model with a slow-moving external habit added to the standard constant relative risk aversion utility function in order to generate long-horizon predictability of excess returns on stocks and bonds, and persistent movement in return volatility. They show evidence of the procyclical variation of stock prices as well as the countercyclical variation of the volatility in stock market. Their model states that expected returns and return volatility rise when consumption decreases, and it suggests a time-varying price of risk to explain the time-series behaviour of aggregate stock returns. More recently, Wachter (2006) generalises Campbell and Cochrane's (1999) model by introducing an exogenous inflation process and allowing surplus consumption to influence the risk-free rate. They report a positive relation between bond excess return and yield spread. In addition, Viceira (2007b) investigates the time-varying properties of the quantity of bond risk and tests whether this time variation can also be explained by the variables which are used to explain the bond excess returns. As might be expected, he reports a positive relationship between short-term rate, yield spread, and bond risk.

Previous research also pays attention to the comovement of stock and bond returns. Campbell (1986) was one of the earliest studies and he uses a general equilibrium representative agent exchange model to study the asset pricing of bonds and stocks. He elucidates that the real bonds do not necessarily yield less than stocks when they have same maturity date and are held to maturity. He also finds that stocks with greater payoff uncertainty do not have greater return uncertainty over short holding period. Fama and French (1989b) suggest that the forecasts of excess returns of stocks and bonds are correlated. Campbell and Ammer (1993a) account for the variance of stock returns jointly with that of long-term bond returns, as well as the covariance between returns of stocks and bonds. They show that stock excess returns are greatly influenced by news about stock future excess returns, while bond excess returns are largely determined by news about future inflation. More recently, Andersen et al. (2005a) find that high-frequency stocks, bonds, and exchange rates respond to macroeconomic news differently over the business cycle. They suggest that this can help to explain the time-varying correlation between stocks and bond returns, as well as the relatively small equity market news effect when averaged across recessions and expansions. Boyd et al. (2005) also show that a business cycle component exists in the variation of the second moments of stock returns.

The realised second moment of returns has been used to study risks since the 1970s. For example, Officer (1973) used it to examine the market-factor variability from 1897 to 1969 for the New York Stock Exchange. Later, Merton (1980) applied the same method to estimate the expected market returns in equilibrium models. Schwert (1989) analysed the relation of stock volatility with macroeconomic volatility, financial leverage, and stock trading activity. He shows evidence that the stock return variability was high during the Great Depression of 1929 to 1939, which is consistent with the results found in Officer (1973). In more recent works this method has been reinvigorated. For example, Andersen et al. (2003) provides a general framework to model and forecast daily and lower frequency volatilities and correlations. They point out that the use of realised volatility constructed from high-frequency intraday returns permits the use of traditional time series procedures for modelling and forecasting. Barndorff-Nielsen and Shephard (2004) use realised covariance to analyse multivariate high frequency financial data, econometrically studying how high frequency regressions and covariance change through time.

Glosten et al. (1993a) analysed the relation between the expected value and the volatility of stock excess return and find evidence that there is a negative relation between conditional expected monthly return and conditional variance of monthly return. Glosten et al. (1993a) also showed that the nominal short-term interest rate helps to forecast the volatility in the stock market because it reflects inflation uncertainty, which is considered to be correlated with aggregate economic uncertainty. If the short rate can be considered as a proxy for inflation uncertainty and economic uncertainty, then it is natural to expect that the short rate can also predict the volatility in the bond market.

Therefore, the main focus of this study is to fill the gaps in the literature by finding out whether the second moments of bond and stock returns are time-varying and whether the term structure of nominal interest rates can help to forecast this time variation in bond and stock return volatility and the covariance of bond and stock returns and the bond CAPM beta.

4.3. Empirical Measures of Security Risk

One of the basic empirical measures of security risk is to use the realised second moments of the bond and stock returns. This measure is recommended by Officer (1973), Merton (1980), French, Schwert and Stambaugh (1987), Schwert (1989) and Viceira (2007b) and many other research papers. In this chapter, the realised volatility of bond returns, the realised volatility of stock returns, the realised covariance of bond and stock returns, and CAPM beta are used as a proxy for bond risk. These realised second moment measurements have also been widely used in the context of stock returns as well as exchange rates, such as Andersen et al. (2003), Barndorff –Nielsen and Shephard (2004) and Andersen et al. (2005b).

By definition, the realised volatility of bond returns can be measured as the integrated instantaneous volatility, that is:

(4.3.1) $$\sigma_B^2(t,n) = \frac{1}{n}\sum_{d=t_1}^{t_D} r_{B,d}^2$$

Where $[t_1, t_D]$ denotes the daily returns between the time t and $t+n$, with only working days included. $r_{B,d}$ denotes the log returns of bond on day d. Thus, the realised volatility of bond returns – the variance of the bond returns – equals to the average value of the squares of bond daily returns over a certain period. More pecifically, it is calculated by the sum of the squares of bond daily returns in a certain period divided by the number of days included in that period. This measure is consistent with Viceira (2007b). Similarly, the realised volatility of stock returns between t and $t+n$ can be specified as:

(4.3.2) $$\sigma_S^2(t,n) = \frac{1}{n}\sum_{d=t_1}^{t_D} r_{S,d}^2$$

With $r_{S,d}$ denotes the log returns of stock on day d. Thus, the realised covariance between the bond and stock returns can be written as:

$$\sigma_{B,S}(t,n) = \frac{1}{n}\sum_{d=t_1}^{t_D} r_{B,d} \times r_{S,d} \tag{4.3.3}$$

Alternatively, there are also some normalised measures of the covariance of bond and stock returns, such as correlation and beta. The realised bond CAPM beta is used as a proxy for bond risk. The realized bond CAMP beta is measured as:

$$\beta_{B,S}(t,n) = \frac{\sigma_{S,B}(t,n)}{\sigma_S^2(t,n)} \tag{4.3.4}$$

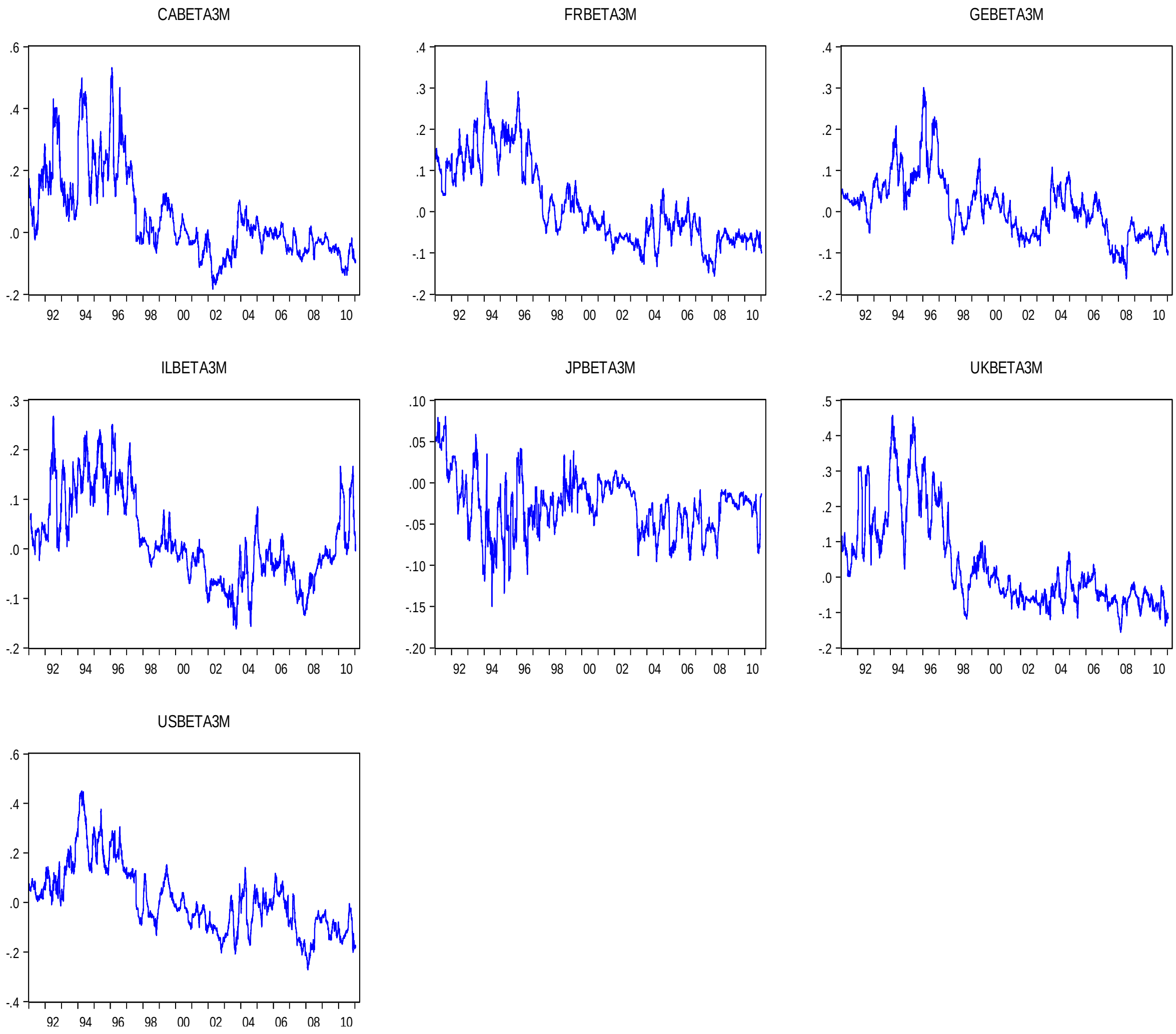
These realised second moments are based on the daily returns of bonds and stocks which were obtained from *Datastream* for G7 countries. The time series analysis is applied to each individual developed economy, respectively. The sample period is included from January 1st 1991 to April 18th 2011. The stock and bond returns are calculated from their daily price indices. Consistent with Viceira (2007b), the five-year constant maturity bond is the main focus in this empirical study. All the tables of data statistics are reported in Appendix I at the end of this chapter.

Table 4-1 represents the realised volatility of stock returns during the period January 1st 1991 to April 18th 2011 for the G7 countries, respectively. The results show similar patterns of realised stock return volatility for these developed economies. Generally, the mean of the realised stock return volatility increases with the horizon of spreads for Canada, France, Japan and UK, while the minimum mean value of the realized volatility of stock returns are obtained at one-year horizon for Germany, Italy and the U.S. However, the standard deviation decreases at the longest horizon, except for Canada.

In addition, basic descriptive statistics of the realised volatility of bond returns, the realised covariance of bond and stock returns, and CAPM beta are reported in Tables 4-2, 4-3 and 4-4 for G7 countries for the sample period.

Over the sample period, the bond return is much more stable than corresponding stock return, which is consistent with traditional wisdom. The bond return becomes less volatile as the investment horizon spreads. Meanwhile, the corresponding standard deviation also decreases for each economy. It is worth noting that, with the exception Japan, the covariances between the returns on bonds and stocks are positive in short-horizon but they turn negative in the long-horizon. Furthermore, the CAPM beta tends to have the same trend as the covariance of daily bond returns with daily stock returns. Figure 4-1 plots the three-month rolling estimate of bond CAPM betas over the sample period computed using daily returns on bonds and stocks.

Figure 4-1: CAPM beta of bonds



These figures illustrate why it is worthwhile studying time variance in bond risk. They show that the low full sample estimates of bond betas for these countries hide considerable variation over time. It also can be seen that the bond betas show time varying heteroskedasticity with periods of low bond betas followed by periods of high betas. This implies that some of the variation might be systematic. Combined with tables of descriptive statistics above, one can observe considerable variation in the comovement of bond and stock returns. In addition to the bond CAPM beta, both the realised bond volatility and the realised covariance of bond returns with stock returns have relatively large standard deviations. The standard deviation also appears to be greater in the short-horizon than in the long-horizon. Table 4-5 below reports the correlation of the second moments:

As expected, Table 4-5 shows that, with the exception of Italy, the bond return volatility in G7 countries is less volatile to its mean than stock return volatility. Table 4-5 also presents the correlation of the realised second moments for the G7 countries. Generally, the realised bond CAPM beta is negatively correlated with the realised volatility of stock returns. Again, Japan is an exception. This implies that times of high volatility in the stock market tend to coincide with times of low covariance between bond and stock returns. This result is consistent with conventional wisdom as well as recent literature, such as Viceira's (2007b) research for the U.S. Except for Canada and Japan, the correlation between bond return volatility and stock return volatility is positive for G7 countries, indicating that times of high volatility in the bond market tend to coincide with times of high stock market volatility. However, the correlation between bond CAPM beta and bond return volatility is positive for Canada, France, Italy, and the UK, which implies that the times of high volatility in the bond market tend to coincide with times of increased comovement between bond and stock returns for these countries. In contrast, this correlation is negative for Germany, Japan and the U.S.

In order to eliminate the small sample biasedness and obtain more robust results, one could treat G7 countries as a whole market because they are under a similar economic environment. Table 4-6 below reports the descriptive statistics and properties under panel construction:

Finally, Table 4-6 summarises the statistics of the second moment measurements under panel construction for G7 economies as a whole. Firstly, the stock market is more volatile than the bond market. In addition, the realised stock return volatility is more volatile to its mean than the realised bond return volatility, especially in the short-horizon. Secondly, the realised bond CAPM beta is negatively correlated with the realised stock return volatility at -23.1% to -50.8% from short-horizon to long-horizon. However, the realised bond CAPM beta is positively correlated with the realised bond return volatility in the 33.3%-65.6% range. Meanwhile, the correlation between the realised volatility of bond returns and the realised volatility of stock returns is also positive, with the exception of the longest horizon. These results elucidate that times of high volatility in the bond market tend to coincide with times of high volatility in the stock market. Furthermore, times of high volatility in the bond market also tend to coincide with times of increased comovement between bond and stock returns, which is consistent with that for individual economy in G7.

4.4. The Model Specifications and the Main Empirical Results

4.4.1. Time Series Analysis

This section explores whether the term structure of interest rates have significant effects on the bond risk, which is measured as the realised second moments of bond returns. Specifically, this chapter examines the effects of the short-term nominal interest rate as well as the yield spread between long-term nominal bonds and the short-term nominal interest rate on the realised volatility of bond returns, the realised covariance between bond and stock returns, and the bond CAPM betas, respectively. In addition, the corresponding forecasting regressions for the realised volatility of stock returns are also present for completeness.

This chapter examines whether the time variation in bond risk is related to time variation in the term structure of interest rate. Firstly, the realised covariance at horizons up to sixty months between bond and stock returns are regressed onto a constant, the lagged value of the realised covariance, the lagged short-term interest rate, and the lagged yield spread. The short-term interest proxies for economic uncertainty and yield spread proxies for business conditions. These two variables are commonly used to represent the term structure of interest rates and they are proved to be the main factors in determing the security returns. The regression can be specified follow Viceira's (2007b) study as:

(4.4.1) $$\sigma_{B,S}(t,n)=\alpha+\sigma_{B,S}(t)+tr(t)+spr(t)+\varepsilon$$

Where $\sigma_{B,S}(t)$ measures the lagged realised covariance of bond returns with stock returns. The short rate $tr(t)$ is the log yield on the one-month Treasury Bill and the spread $spr(t)$ measures the difference between the log yield on a five-year constant maturity bond and the log yield on the Treasury Bill. Hence, Equation (4.4.1) is a forcasting regression of the future covariance of bond and stock returns in terms of the corresponding covariance, interest rate and yield spread at the current period.

Secondly, the realised bond CAPM betas at horizons up to five years are also regressed onto the same regressors that were used in the realised covariance regressions, which follows Viceira's (2007b) equation specification:

(4.4.2) $$\beta_{B,S}(t,n) = \alpha + \beta_{B,S}(t) + tr(t) + spr(t) + \varepsilon$$

Where $\beta_{B,S}(t)$ presents the lagged realised bond CAPM beta.

In addition, the regressions of the realised bond return volatility as well as stock return volatility on lagged short-term interest rate and yield spread are also taken into consideration. These predictive regressions taken from Viceira's (2007b) can be respectively written as:

(4.4.3) $$\sigma_B^2(t,n) = \alpha + \sigma_B^2(t) + tr(t) + spr(t) + \varepsilon$$

And:

(4.4.4) $$\sigma_S^2(t,n) = \alpha + \sigma_S^2(t) + tr(t) + spr(t) + \varepsilon$$

Where $\sigma_B^2(t)$ and $\sigma_S^2(t)$ define the lagged realised volatility of bond and stock returns, respectively.

Tables 4-7 to 4-20, provided in Appendix I at the end of this chapter, report the results of the regressions of realised second moments measured at horizons of up to three years expressed as the equations above for every single country in the G7. Panel I in Table 4-7 presents forecasting regression results for $\sigma_{B,S}(t,n)$, the realised covariance of bond and stock returns that are defined in Equation (4.3.3) at different horizons for Canada. Panel II in Table 4-7 presents the results for $\beta_{B,S}(t,n)$, the corresponding realised CAPM beta of bond returns that is defined in Equation (4.3.4) for Canada. Table 4-8 presents the predictive regression results for log bond return volatility (Panel III) and for log stock return volatility (Panel IV) for Canada. The subsequent Tables 4-9 to 4-20 report similar regression results for other sample countries. All of these tables report the coefficient estimates with the Newey-West HAC standard errors.The R^2 of the regression estimation is also reported.

Table 4-7 shows that the yield spread has a positive effect on forecasting the realized covariance of bond and stock returns at horizons up to thirty-six months for Canada. The coefficient estimate on the yield spread is statistically significant up to a horizon of thirty-six months. It indicates that the yield spread is a siginificant factor in determing the realized bond covariance at different horizons within three years. Meanwhile, the yield spread also positively forecasts the bond CAPM beta and the corresponding coefficient estimate on the yield spread is statistically significant at all horizons in the bond CAPM beta predictive regression for Canada. Thus, all these measures of bond risk with different horizons could be positively explained by the yield spread. Fama and French (1989b) provide empirical evidence that the yield spread is high around business cycle troughs while it is low near business cycle peaks. Consequently, one can consider the yield spread as a proxy for countercyclical time variation in bond risk. Hence, these results indicate that there is countercyclical variation in the comovement of bond returns with stock returns in Canada. In addition, there is also strong evidence that the short rate positively forecasts the realised covariance of bond and stock returns, as well as the bond CAPM beta for Canada, except at a horizon of sixty months. The corresponding slope coefficient is statistically significant in both predictive regressions.

Additionally, Table 4-8 presents that there is also evidence that the yield spread is related to the movements in volatilities of bond returns and stock returns. The slope coefficient estimate of the yield spread in the predictive regressions for bond return volatility is statistically significant and positive except at the sixty-month horizon, which is statistically significant but negative. In the predictive regression for stock return volatility for Canada the slope estimate of the yield spread is negative at all horizons and it is statistically significant. The estimates of the coefficient on the short rate in the forecasting regressions for bond return volatility are all statistically significant at all horizons; however, the short rate forecasts negatively the stock return volatility. Since the short rate is proved to move procyclically, these results imply that the short rate captures a procyclical component in the time variation in the bond risk for Canada.

Table 4-7 and Table 4-8 also show that the lagged value of the second moment is statistically significant in forecasting the realised covariance of bond and stock returns, the bond CAPM beta, and the realised bond and stock return volatilities. This result implies the consistence in the movements of bond and stock risks. Additionally, the intercepts of the second moment predictive regressions are negative and highly significant for realized covariance and bond CAPM beta, although they are not reported here to save space.

Figure 4-2: The realised 3-month bond beta (left axis) and the short rate (right axis) for Canada

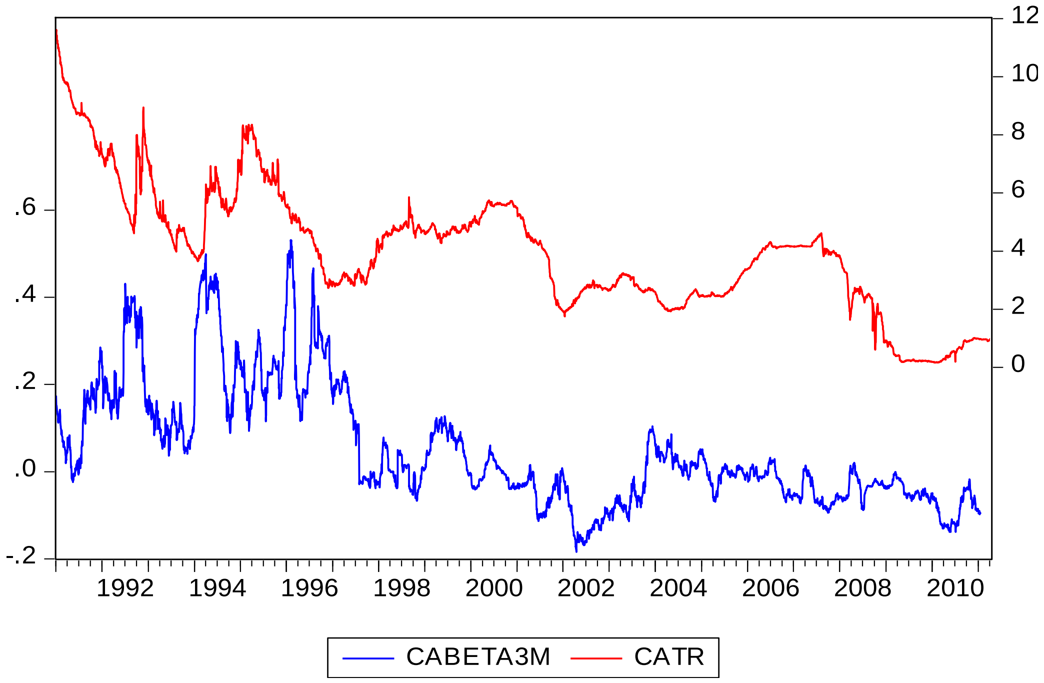


Figure 4-3: The realised 3-month bond beta (left axis) and the yield spread (right axis) for Canada

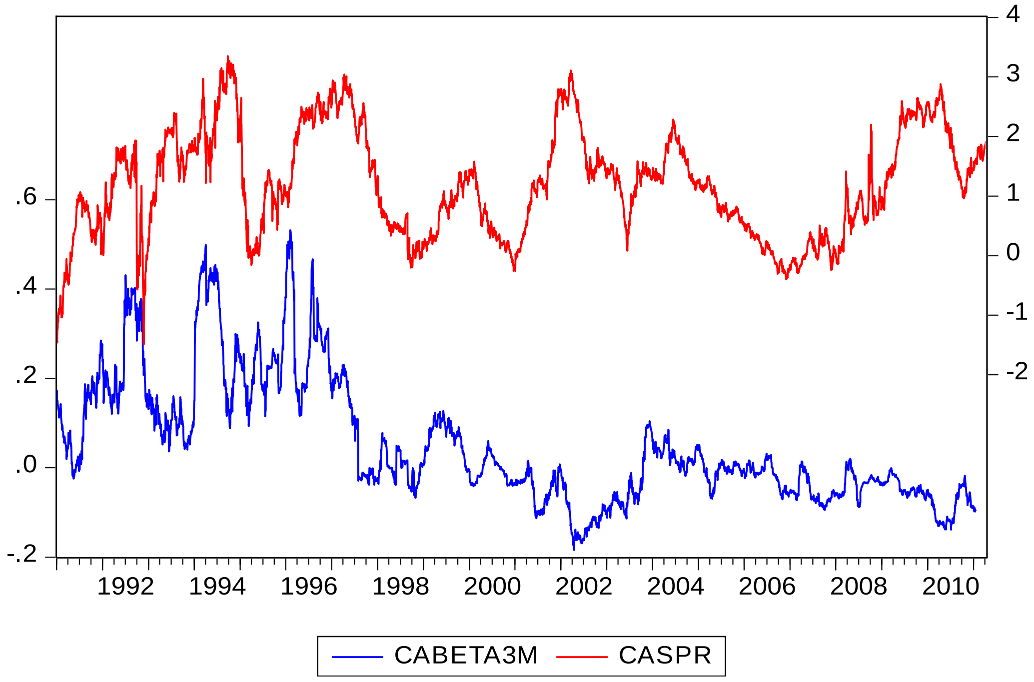


Figure 4-2 plots the time series of the three-month bond CAPM beta and the nominal short rate on one-month Treasury bill for Canada. Figure 4-3 draws the time series of the three-month bond CAPM beta as well as the yield spread between short- and long-term bonds. In addition, Table 4-8 reports that the R^2 of the regression of bond CAPM beta is 63.1% for Canada. Therefore, these results suggest that the movements in the term structure of interest rates capture a large fraction of the total variability in the realised bond risk, although these term structure variables have difficulties in fitting the last part of the sample.

The results of forecasting regressions for second moments are similar for France, Germany, Italy and UK. There are only a few differences of note. The yield spread has a positive effect on forecasting the realised covariance of bond returns with stock returns at all horizons for France, Germany, Italy and UK. The coefficient estimate on the yield spread is statistically significant, with the exception of France at the six month horizon. At the same time, the yield spread also positively forecasts the bond

CAPM beta, except for Germany at the six-month horizon and Italy at the thirty-six month horizon where the coefficients are negative but insignificant, the corresponding coefficients for France at the six month horizon and the twelve month horizon are further expectations which are negative but significant. The yield spread also positively forecasts the bond return volatility for Italy and UK at all horizons; however, it negatively but significantly forecasts the bond return volatility for France at six, twelve and sixty month horizons and for Germany at all horizons. Similarly to Canada, the short rate has similar effects on stock and bond return volatilities for France, Italy and UK, although it tends to have negative effects on the bond return volatility for Germany at most horizons.

Table 4-15 shows that the yield spread forecasts positively the realised covariance of bond and stock returns and its normalisation given by the bond CAPM beta, except at sixty-month horizon for the realised covariance and the twelve-month horizon for the bond CAPM beta for Japan. However, the slope coefficient of the yield spread in the regressions for bond CAPM is not statistically significant for Japan, except at the sixty month horizon. Meanwhile, the estimates of the coefficient on short rate in the forecasting regressions for the second moments are statistically significant but negative for covariance and bond beta in Japan. In the U.S. economy the yield spread and the short rate forecasts negatively the bond return volatility as well as the stock return volatility, and the corresponding coefficient estimates are statistically significant.

4.4.2. Panel Analysis

Parameters estimated in the time series for these economies might be completed with imprecision because of the relative short sample periods included. In order to provide more robust estimates of the relation between the bond risk and the term structure of interest rates, in this chapter we estimate the relationship in a panel framework and report the results in Appendix I.

Table 4-21 shows that the yield spread forecasts positively both the realised covariance of bond and stock returns and the bond CAPM beta for the G7 economies. This result is consistent with the results from the time series analysis for each individual country. The coefficient estimate on the yield spread is statistically significant at all horizons in the covariance predictive regression, and it is significant up to a horizon of thirty-six months in the bond beta regression. These results imply a countercyclical variation in the comovement of bond returns with stock returns. In addition, the short rate has positive and statistically significant effect on predicting both the covariance of bond and stock returns as well as the bond CAPM beta, except at the twelve-month horizon for the bond CAPM beta.

Table 4-22 provides strong evidence that the yield spread is related to movements in bond return volatility. The corresponding coefficient is positive and statistically significant at all horizons. The yield spread has a statistically significant but negative effect on stock return volatility in long-horizon. Nonetheless, the short rate positively forecasts the volatility of stock returns and the volatility of bond returns. These results are consistent with previous evidence of stock return volatility and they extend the literature to the bond return volatility. Since the short rate also significantly positively forecasts the covariance of bond and stock returns, these results suggest that the short rate captures a procyclical component in the time variation of the second moments of bond returns.

The lagged value of the second moment has a positive and statistically significant effect on forecasting corresponding bond risk, except at the sixty-month horizon for covariance between bond and stock returns and the sixty-month horizon for stock return volatility. The intercept, although not reported here to save space, also has a statistically significant but negative effect on the bond risk prediction, which indicates that times of low short-term interest rates and a flat yield curve tend to coincide with periods of low or negative second moments.

Figure 4-4: The Mean of the realised 3-month bond beta (left axis) and the mean of short rate (right axis) for G7

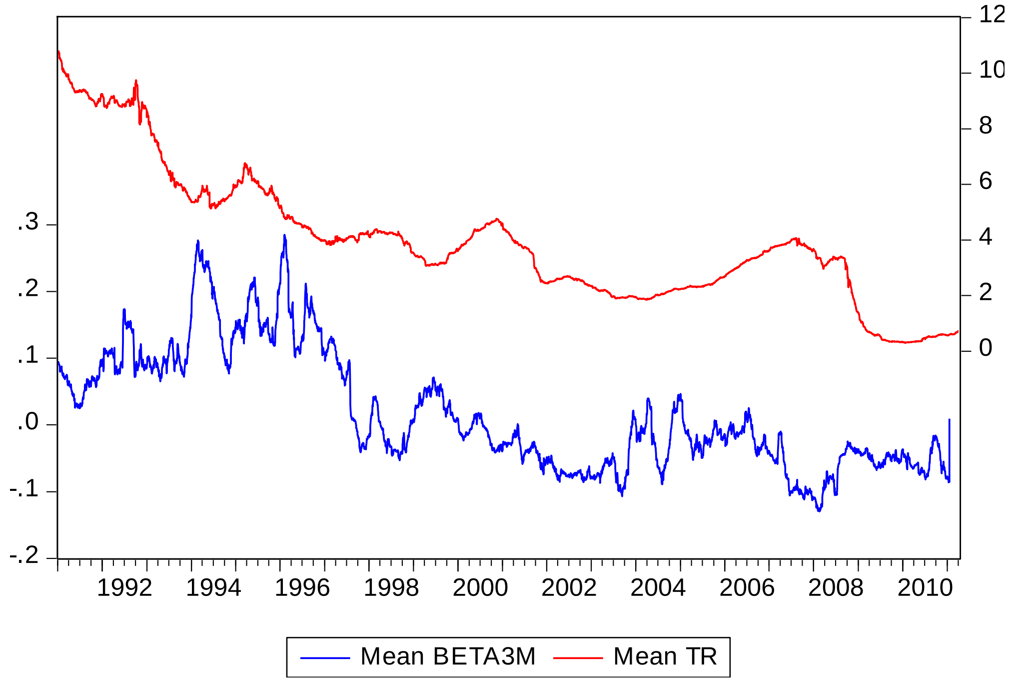


Figure 4-5: The mean of the realised 3-month bond beta (left axis) and the mean of the yield spread (right axis) for G7

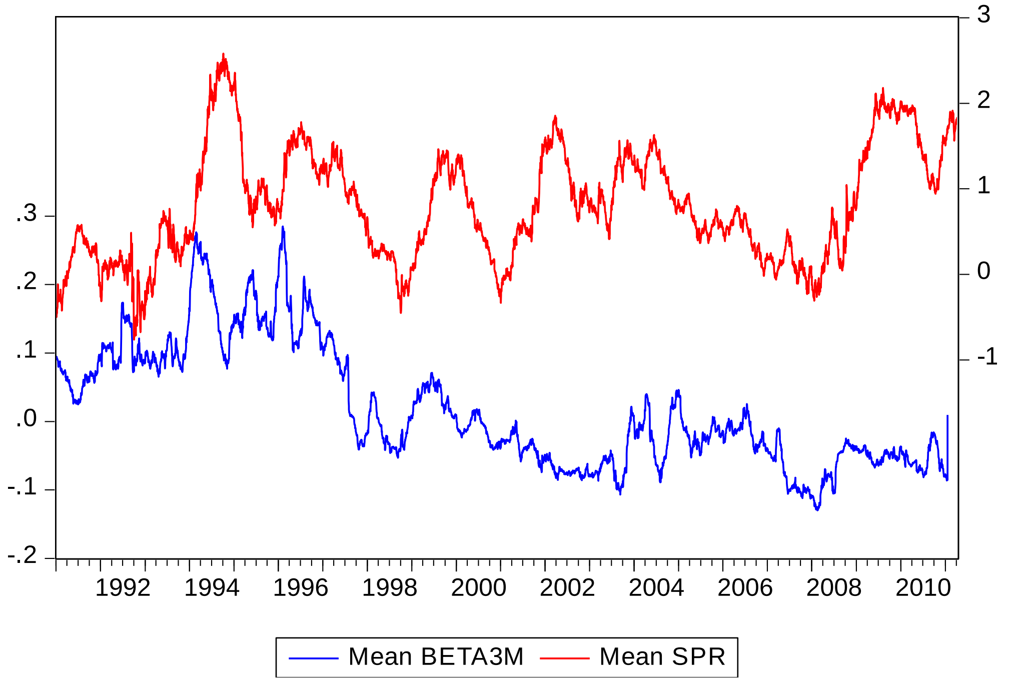


Figure 4-4 plots the mean of the realised three-month bond CAPM beta and the mean of the log yield of the one-month Treasury bill across the G7 economies. Figure 4-5 plots the mean of the realised three-month bond CAPM beta against the mean of the yield spread. It can be observed that both the short rate and the yield spread are related to the bond risk measured as bond CAPM beta, although as expected the short rate is relatively flatter among the period. Both figures suggest that the term structure variables capture the general direction of the bond CAPM beta.

The recent financial crisis erupted in 2007, since when the short-term nominal interest rates have decreased dramatically in the U.S. which has been followed by a long period of low short-term nominal interest rates in the G7. This trend can be seen in Figure 4-4. This chapter also examines whether the relationship between the security risk and the term structure of interest rates is stable following the crisis. A dummy variable is used to capture the effects of the short rate and the yield spread on the second moments of bond and stock returns. Table 4-23 and 4-24 report regressions similar to those shown13606141019 in Table 4-21 and 4-22, except that they add an extra term that interacts each regressor with the dummy variable, which is equal to zero between January 1st 1991 and December 31st 2006 and which is equal to one between January 1st 2007 to April 18th 2011. Panel I in Table 23 shows the results for regressions of realised covariance between bond and stock returns. Panel II in Table 4-23 reposts the results for the realised bond CAPM beta. Panels III and IV in Table 4-24 report the regression results for realized bond and stock return volatility, respectively. Only horizons up to twelve months are taken into consideration since the subperiod is not long enough to obtain reliable results for changes in longer horizons.

Table 4-23 and Table 4-24 show that the coefficients on the short rate in the covariance, bond CAPM beta, and stock return volatility regressions is significantly smaller in the post-crisis period than that in the earlier period. The coefficient on the short rate interaction term is negative and statistically large in magnitude. The coefficient of the yield spread tends to have the same trend for covariance and bond CAPM beta regressions. These results indicate that the relationship between the secutiry risk and the term structure of interest rates have been considerably changed since the recent financial crisis in 2007. In contrast, the coefficients on the interaction terms of the short rate and the yield spread are statistically significant and positive in bond return volatility regression. The bond and stock risk has become hard to forecast in the post-2007 period. Taking alternative measurements of bond risk into consideration for instance, the term structure of interest rates positively forecasts realised bond CAPM betas but negatively forecasts realised bond return volatility.

4.5. Conclusion

This chapter analyses the time variation in the realised covariance of bond returns with stock returns, the bond CAPM beta, and the realised volatility of bond returns and stock returns, respectively. It shows that these second moments are systematically related to changes in the term structure of nominal interest rates.

There is an empirical stylised fact in that the time variation in the expected excess returns of long-term bonds is persistent and positively related to the time variation in the yield spread. Viceira (2007b) further argues that the time variation in the bond risk is also positively related to the changes in the yield spread for the U.S. economy. We provide additional empirical evidence that the time variation in bond risk (which is measured as realised covariance of bond returns with stock returns, bond CAPM beta, and realised bond return volatility) is statistically significantly and positively related with the movement in the yield spread for most G7 economies over the period January 1991 to April 2011.

There is also another empirical stylised fact in that the short-term nominal interest rates play an important role in forecasting the stock return volatility as well as the exchange rate volatility. This chapter extends this in order to examine the relationship between the short rate and the bond return volatility as well as the stock return volatility. This shows that the short-term nominal interest rate is also statistically significant in predicting the time variation in bond risk and stock risk, such as the realised covariance of bond returns with stock returns, the bond CAPM beta and the realised volatilities of bond returns and stock returns. The short rate is considered to be a proxy for economic uncertainty and the yield spread tends to be a proxy for business conditions; hence, these results imply that the central bank could control volatility of the bond and stock markets through adjustments of the interest rate policiy.

Furthermore, as another extension of the literature, this chapter also provides strong empirical evidence of the effect of the short-term interest rate on time variation in the second moments of bond and stock returns for the G7 economies as a whole with analysis under panel construction. The yield spread is another statistically significant determinant in forecasting the time variation in bond and stock risks. In addition, the effects of the recent financial crisis on the relationship between time variation in bond and stock risks and time variation in the term structure of interest rates is also taken into consideration in order to confirm their stability throughout the sample period. The empirical results suggest that this relation has been changed significantly following the 2007 economic crisis. The relationship between the second moments of bond and stock returns and interest rates became at odds as the economy fell apart.

Appendix I

Table 4-1: The realised volatility of stock returns

Economy	Stock Return Volatility, $\sigma_S^2(t,n)$									
	3-month		6-month		12-month		36-month		60-month	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Canada	0.870	(0.746)	0.877	(0.647)	0.886	(0.563)	1.025	(0.647)	1.311	(0.836)
France	1.306	(1.233)	1.308	(1.072)	1.304	(0.922)	1.360	(0.688)	1.491	(0.508)
Germany	1.321	(0.999)	1.318	(0.837)	1.291	(0.701)	1.343	(0.601)	1.533	(0.579)
Italy	1.562	(1.209)	1.561	(1.007)	1.549	(0.841)	1.560	(0.593)	1.648	(0.445)
Japan	1.389	(0.796)	1.396	(0.609)	1.396	(0.472)	1.444	(0.443)	1.566	(0.418)
UK	0.845	(0.825)	0.848	(0.730)	0.849	(0.623)	0.926	(0.514)	1.074	(0.471)
US	0.976	(0.920)	0.975	(0.815)	0.970	(0.733)	1.060	(0.675)	1.265	(0.608)

This table reports the basic statistics of the realised volatility of stock returns for G7 countries, respectively. These volatilities whichh are defined in Equation (4.3.1) are calculated based on the daily log returns on stocks.

Table 4-2: The realised volatility of bond returns

Economy	Bond Return Volatility, $\sigma_B^2(t,n)$									
	3-month		6-month		12-month		36-month		60-month	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Canada	0.079	(0.059)	0.079	(0.049)	0.078	(0.043)	0.073	(0.036)	0.068	(0.028)
France	0.044	(0.028)	0.044	(0.023)	0.044	(0.019)	0.044	(0.014)	0.043	(0.009)
Germany	0.037	(0.022)	0.038	(0.027)	0.038	(0.014)	0.039	(0.008)	0.041	(0.005)
Italy	0.076	(0.087)	0.076	(0.078)	0.076	(0.070)	0.070	(0.059)	0.061	(0.044)
Japan	0.029	(0.029)	0.029	(0.025)	0.029	(0.020)	0.029	(0.014)	0.028	(0.012)
UK	0.053	(0.049)	0.052	(0.041)	0.052	(0.032)	0.051	(0.024)	0.049	(0.018)
US	0.069	(0.035)	0.069	(0.029)	0.069	(0.024)	0.072	(0.019)	0.038	(0.067)

This table reports the basic statistics of the realised volatility of bond returns for G7 countries, respectively. These volatilities which are defined in Equation (4.3.2) are calculated based on the daily log returns on five-year constant maturity bonds.

Table 4-3: The realised covariance of bond and stock returns

Economy	Covariance of bond and stock returns, $\sigma_{B,S}(t,n)$									
	3-month		6-month		12-month		36-month		60-month	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Canada	0.027	(0.092)	0.027	(0.081)	0.027	(0.071)	0.016	(0.066)	-0.003	(0.068)
France	0.007	(0.123)	0.006	(0.114)	0.005	(0.107)	-0.010	(0.096)	-0.031	(0.087)
Germany	0.010	(0.078)	0.009	(0.070)	0.016	(0.126)	-0.002	(0.053)	-0.020	(0.058)
Italy	0.056	(0.152)	0.056	(0.138)	0.055	(0.129)	0.039	(0.119)	0.020	(0.103)
Japan	-0.029	(0.152)	-0.030	(0.038)	-0.032	(0.029)	-0.039	(0.021)	-0.042	(0.020)
UK	0.017	(0.112)	0.016	(0.098)	0.016	(0.087)	0.001	(0.075)	-0.018	(0.069)
US	-0.013	(0.121)	-0.013	(0.111)	-0.014	(0.099)	-0.028	(0.087)	-0.051	(0.084)

This table reports the basic statistics of the realised covariance of bond and stock returns for G7 countries, respectively. These covariances defined in Equation (4.3.3) are calculated based on the daily log returns on the five-year constant maturity bonds and the log daily returns of stocks.

Table 4-4: CAPM beta

Economy	CAPM beta, $\beta_{B,S}(t,n)$									
	3-month		6-month		12-month		36-month		60-month	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Canada	0.083	(0.144)	0.082	(0.136)	0.080	(0.132)	0.058	(0.117)	0.033	(0.096)
France	0.044	(0.100)	0.041	(0.096)	0.038	(0.094)	-0.010	(0.096)	-0.002	(0.077)
Germany	0.034	(0.067)	0.032	(0.062)	0.029	(0.057)	-0.001	(0.035)	-0.001	(0.040)
Italy	0.034	(0.092)	0.034	(0.086)	0.033	(0.083)	0.019	(0.080)	0.007	(0.068)
Japan	-0.025	(0.037)	-0.026	(0.030)	-0.027	(0.025)	-0.030	(0.017)	-0.028	(0.012)
UK	0.070	(0.137)	0.070	(0.132)	0.070	(0.129)	0.044	(0.121)	0.016	(0.100)
US	0.049	(0.129)	0.047	(0.123)	0.044	(0.119)	0.018	(0.112)	-0.011	(0.089)

This table reports the basic statistics of CAPM beta for G7 countries, respectively. These betas defined in Equation (4.3.4) are calculated based on the daily log returns on the five-year constant maturity bonds and the log daily returns of stocks.

Table 4-5: Three-month realized bond beta and volatility of bond and stock returns

Economy	$S.D./Mean$			Correlation (%)		
	$\beta_{B,S}(t,3m)$	$\sigma_B^2(t,3m)$	$\sigma_S^2(t,3m)$	$\beta_{B,S}$ & σ_B^2	$\beta_{B,S}$ & σ_S^2	σ_B^2 & σ_S^2
Canada	2.710	0.738	1.867	67.7	-23.1	-0.9
France	5.795	0.634	1.110	30.9	-33.2	31.5
Germany	6.269	0.620	1.190	-3.2	-34.9	44.5
Italy	4.108	1.118	0.977	62.8	-2.2	18.0
Japan	-1.229	1.029	1.076	-20.8	10.7	-2.0
UK	3.453	0.877	1.358	49.4	-30.2	27.2
US	10.004	0.685	1.583	-25.6	-28.5	65.6

This table reports the alternative statistics of the three-month realised bond CAPM beta and the volatility of bond and stock returns for G7 countries, respectively. These betas are calculated based on the daily log returns on the five-year constant maturity bonds and the log daily returns of stocks.

Table 4-6: The realised second moments under panel construction

	3-month	6-month	12-month	36-month	60-month
σ_S^2 **Mean**	1.504	1.511	1.522	1.487	1.413
σ_S^2 **S.D./Mean**	1.318	1.111	0.926	0.622	0.423
σ_B^2 **Mean**	0.056	0.056	0.056	0.055	0.047
σ_B^2 **S.D./Mean**	0.937	0.841	0.747	0.621	0.762
$\beta_{B,S}$ **Mean**	0.018	0.018	0.018	0.004	0.002
$\beta_{B,S}$ **S.D./Mean**	6.065	5.915	5.719	24.262	40.119
$Corr\left(\beta_{B,S}, \sigma_B^2\right)$ **(%)**	33.3	34.5	37.2	46.2	65.6
$Corr\left(\beta_{B,S}, \sigma_S^2\right)$ **(%)**	-23.1	-28.5	-35.4	-50.2	-50.8
$Corr\left(\sigma_B^2, \sigma_S^2\right)$ **(%)**	20.3	18.6	17.0	1.6	-22.3

This table reports the statistics of the realized stock return volatility, the realised bond return volatility, the realised covariance between returns on bond and stock, and the realised bond CAPM beta for the whole G7 market. These betas are calculated based on the daily log returns on the five-year constant maturity bonds and the log daily returns of stocks.

Table 4-7: Covariance and bond beta forecasting regression for Canada

Panel I: Covariance regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.389291***	0.020854***	0.026563***	38.0%
	(0.049830)	(0.003368)	(0.006455)	
6	0.323483***	0.025145***	0.027353***	41.9%
	(0.043430)	(0.002683)	(0.005432)	
12	0.440628***	0.021593***	0.032783***	53.8%
	(0.039471)	(0.002185)	(0.004470)	
36	0.038381	0.025028***	0.063978***	55.1%
	(0.058161)	(0.002437)	(0.003741)	
60	0.261413***	0.015699***	0.031366***	61.3%
	(0.036241)	(0.002016)	(0.002232)	

Panel II: CAPM beta regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.606563***	0.017961***	0.021890***	63.1%
	(0.046736)	(0.002812)	(0.006454)	
6	0.565920***	0.023400***	0.021040***	66.4%
	(0.046078)	(0.002726)	(0.006677)	
12	0.467475***	0.030369***	0.026930***	64.8%
	(0.052124)	(0.003468)	(0.006256)	
36	0.155447***	0.025154***	0.038891***	52.6%
	(0.037627)	(0.003557)	(0.004814)	
60	0.128309***	-0.001981***	0.004830**	67.3%
	(0.008696)	(0.000941)	(0.001355)	

Table 4-7 reports the overlapping regressions of realized covariances (Panel I) and bond CAPM betas (Panel II) onto a constant, their own lagged value, the treasury rate, tr(t) and the yield spread, spr(t). Newey-West HAC standard errors and covariance are applied with AIC maxlags. Corresponding standard errors are reported within parenthesis. * presents significance at 10%, ** denotes significance at 5% and * indicates significance at 1%.**

Table 4-8: Volatility forecasting regression for Canada

Panel III: Bond return volatility regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.240675***	0008166***	0.019716***	25.7%
	(0.042057)	(0.001235)	(0.003369)	
6	0.208623***	0.010254***	0.019460***	36.2%
	(0.049376)	(0.001039)	(0.002703)	
12	0.293369***	0.008620***	0.013402***	43.5%
	(0.056025)	(0.001308)	(0.002483)	
36	-0.085587***	0.011962***	0.011979***	54.8%
	(0.031000)	(0.000792)	(0.001080)	
60	0.145578***	0.002378***	-0.000829***	81.2%
	(0.005441)	(0.000169)	(0.000253)	

Panel IV: Stock return volatility regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.393110***	-0.258347***	-0.405189***	24.3%
	(0.077042)	(0.064164)	(0.116782)	
6	0.308796***	-0.291675***	-0.545114***	22.1%
	(0.042615)	(0.060519)	(0.102663)	
12	0.129578***	-0.405567***	-0.834051***	22.2%
	(0.033566)	(0.063487)	(0.108348)	
36	-0.965802***	-0.352120***	-1.102046***	47.7%
	(0.079053)	(0.038270)	(0.065085)	
60	-1.231877***	-0.780651***	-0.776281***	54.6%
	(0.085505)	(0.040846)	(0.055302)	

Table 4-8 reports overlapping regressions of realised bond return volatilities (Panel III) and stock return volatilities (Panel IV) onto a constant, their own lagged value, the treasury rate, tr(t) and the yield spread, spr(t). Newey-West HAC standard errors and covariance are applied with AIC maxlags. Corresponding standard errors are reported within parentheses. * presents significance at 10%, ** denotes significance at 5% and * indicates significicance at 1%.**

Table 4-9: Covariance and bond beta forecasting regression for France

Panel I: Covariance regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	R^2
3	0.550426***	0.015304***	0.018037***	45.9%
	(0.049230)	(0.002841)	(0.006060)	
6	0.695697***	0.005658**	0.003477	57.1%
	(0.051207)	(0.002795)	(0.005257)	
12	0.592198***	0.011800***	0.015001***	49.8%
	(0.050995)	(0.003164)	(0.005892)	
36	0.184809***	0.024628***	0.053453***	32.7%
	(0.049691)	(0.003631)	(0.007497)	
60	0.150264***	0.010931***	0.026733***	41.3%
	(0.022100)	(0.002561)	(0.003716)	

Panel II: CAPM beta regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	R^2
3	0.737279***	0.008079***	0.004063	75.6%
	(0.034232)	(0.001996)	(0.004307)	
6	0.837415***	0.003164**	-0.008863**	85.9%
	(0.026751)	(0.001475)	(0.003032)	
12	0.767556***	0.006381***	-0.009046***	84.7%
	(0.032338)	(0.001802)	(0.003289)	
36	0.184809***	0.024628***	0.053453***	32.7%
	(0.049691)	(0.003631)	(0.007497)	
60	0.233214***	0.001595***	0.005473***	86.5%
	(0.006426)	(0.000654)	(0.001073)	

Table 4-9 reports overlapping regressions of realised covariances (Panel I) and bond CAPM betas (Panel II) onto a constant, their own lagged value, the treasury rate, tr(t) and the yield spread, spr(t). Newey-West HAC standard errors and covariance are applied with AIC maxlags. Corresponding standard errors are reported within parenthesis. * presents significance at 10%, ** denotes significance at 5% and * indicates significance at 1%.**

Table 4-10: Volatility forecasting regression for France

Panel III: Bond return volatility regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.437158***	0.001611**	-0.000923	25.9%
	(0.044925)	(0.000852)	(0.001717)	
6	0.373881***	0.001695**	-0.003605**	29.6%
	(0.045330)	(0.000756)	(0.001789)	
12	0.199349***	0.003048***	-0.003884**	36.5%
	(0.036919)	(0.000512)	(0.001620)	
36	-0.604882***	0.006510***	0.001547**	64.6%
	(0.028326)	(0.000347)	(0.000649)	
60	0.043333*	-0.002154***	-0.002205***	19.6%
	(0.023962)	(0.000220)	(0.000522)	

Panel IV: Stock return volatility regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.418261***	-0.048146*	-0.059265	18.9%
	(0.055230)	(0.028443)	(0.077555)	
6	0.357919***	-0.029823	-0.022583	14.0%
	(0.039926)	(0.024342)	(0.065378)	
12	0.239890***	-0.097120***	-0.173293***	8.9%
	(0.040092)	(0.030709)	(0.069462)	
36	-0.593396***	-0.205637***	-0.389412***	27.3%
	(0.045546)	(0.030323)	(0.056949)	
60	-0.744518***	-0.299230***	-0.331997***	54.5%
	(0.039413)	(0.020948)	(0.028853)	

Table 4-10 reports overlapping regressions of realised bond return volatilities (Panel III) and stock return volatilities (Panel IV) onto a constant, their own lagged value, the treasury rate, tr(t) and the yield spread, spr(t). Newey-West HAC standard errors and covariance are applied with AIC maxlags. Corresponding standard errors are reported within parenthesis. * presents significance at 10%, ** denotes significance at 5% and * indicates significance at 1%.**

Table 4-11: Covariance and bond beta forecasting regression for Germany

Panel I: Covariance regression				
Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.483749***	0.014188***	0.030252***	37.6%
	(0.052397)	(0.002745)	(0.008010)	
6	0.708919***	0.000963	0.011276**	54.2%
	(0.041881)	(0.002124)	(0.005751)	
12	0.555935***	0.021361***	0.070889***	44.4%
	(0.040312)	(0.005006)	(0.012055)	
36	-0.112666	0.015790***	0.082257***	39.5%
	(0.073406)	(0.004429)	(0.005625)	
60	0.558559***	0.018457***	0.028343***	55.6%
	(0.072321)	(0.002935)	(0.003189)	
Panel II: CAPM beta regression				
Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.734982***	0.003581***	0.004260	58.9%
	(0.044522)	(0.001280)	(0.003244)	
6	0.797110***	0.001572	-0.002476	61.9%
	(0.037548)	(0.001265)	(0.003187)	
12	0.475501***	0.012736***	0.016837***	41.1%
	(0.053587)	(0.001740)	(0.004039)	
36	-0.145996**	0.014972***	0.038543***	38.3%
	(0.056845)	(0.001881)	(0.002637)	
60	0.326672**	0.005263**	0.010466**	71.3%
	(0.020830)	(0.000772)	(0.001316)	

Table 4-11 reports overlapping regressions of realised covariances (Panel I) and bond CAPM betas (Panel II) onto a constant, their own lagged value, the treasury rate, tr(t) and the yield spread, spr(t). Newey-West HAC standard errors and covariance are applied with AIC maxlags. Corresponding standard errors are reported within parenthesis. * presents significance at 10%, ** denotes significance at 5% and * indicates significance at 1%.**

Table 4-12: Volatility forecasting regression for Germany

Panel III: Bond return volatility regression				
Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.514442***	-0.001880***	-0.005178***	29.1%
	(0.039993)	(0.000511)	(0.001299)	
6	0.301184**	-0.002167***	-0.007294***	11.5%
	(0.125332)	(0.000528)	(0.001363)	
12	0.312953***	-0.000677	-0.008168***	16.5%
	(0.044035)	(0.000569)	(0.001290)	
36	-0.639373***	0.004375***	-0.001991***	62.8%
	(0.057397)	(0.000339)	(0.000425)	
60	-0.030061	-0.003118***	-0.001577***	21.2%
	(0.089377)	(0.000319)	(0.000459)	

Panel IV: Stock return volatility regression				
Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.329257***	-0.185729***	-0.622320***	20.5%
	(0.044949)	(0.060606)	(0.208518)	
6	0.294845***	-0.192934***	-0.630465***	20.5%
	(0.037502)	(0.046537)	(0.155100)	
12	0.221144***	-0.252675***	-0.785272***	23.4%
	(0.028540)	(0.044574)	(0.119330)	
36	-0.880362***	-0.153617***	-0.894259***	51.1%
	(0.053021)	(0.045349)	(0.052067)	
60	-0.736919***	-0.494067***	-0.411875***	47.0%
	(0.053470)	(0.032108)	(0.041437)	

Table 4-12 reports overlapping regressions of realised bond return volatilities (Panel III) and stock return volatilities (Panel IV) onto a constant, their own lagged value, the treasury rate, tr(t) and the yield spread, spr(t). Newey-West HAC standard errors and covariance are applied with AIC maxlags. Corresponding standard errors are reported within parenthesis. * presents significance at 10%, ** denotes significance at 5% land * indicates significance at 1%.**

Table 4-13: Covariance and bond beta forecasting regression for Italy

Panel I: Covariance regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.379672***	0.015593***	0.032605***	39.9%
	(0.052522)	(0.002226)	(0.006077)	
6	0.513343***	0.012405***	0.024455***	52.4%
	(0.044230)	(0.002005)	(0.004841)	
12	0.349196***	0.018268***	0.041308***	55.2%
	(0.049135)	(0.001896)	(0.005217)	
36	0.060153	0.023981***	0.022523***	68.8%
	(0.040281)	(0.001888)	(0.002317)	
60	-0.107756***	0.017839***	0.0048048***	69.5%
	(0.013506)	(0.000663)	(0.001451)	

Panel II: CAPM beta regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.597263***	0.006795***	0.014835***	63.2%
	(0.033725)	(0.000986)	(0.002504)	
6	0.663075***	0.006498***	0.015537***	74.7%
	(0.032623)	(0.000940)	(0.002056)	
12	0.552341***	0.008997***	0.023935***	75.4%
	(0.033835)	(0.000934)	(0.002010)	
36	0.105504***	0.015805***	0.016861***	75.8%
	(0.029988)	(0.001113)	(0.001751)	
60	0.007214	0.008210***	-0.002101	54.9%
	(0.024320)	(0.000610)	(0.001300)	

Table 4-13 reports overlapping regressions of realised covariances (Panel I) and bond CAPM betas (Panel II) onto a constant, their own lagged value, the treasury rate, tr(t) and the yield spread, spr(t). Newey-West HAC standard errors and covariance are applied with AIC maxlags. Corresponding standard errors are reported within parenthesis. * presents significance at 10%, ** denotes significance at 5% and * indicates significance at 1%.**

Table 4-14: Volatility forecasting regression for Italy

Panel III: Bond return volatility regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.380806***	0.008296***	0.010486***	45.8%
	(0.065415)	(0.001588)	(0.003184)	
6	0.264269***	0.010312***	0.007937**	52.5%
	(0.081319)	(0.001914)	(0.003120)	
12	0.133206*	0.012948***	0.010204***	66.2%
	(0.079848)	(0.001514)	(0.003139)	
36	-0.244201***	0.011354***	0.010098***	54.3%
	(0.034528)	(0.000844)	(0.000916)	
60	0.011729	-0.000196	0.000032	0.4%
	(0.008227)	(0.000309)	(0.000413)	

Panel IV: Stock return volatility regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.374963***	-0.021232	-0.277783***	15.9%
	(0.039554)	(0.013768)	(0.076376)	
6	0.374603***	-0.015377	-0.341756***	16.3%
	(0.035561)	(0.011257)	(0.059011)	
12	0.328941***	-0.015346	-0.498625***	17.6%
	(0.034379)	(0.010784)	(0.054345)	
36	-0.580429***	0.078584***	-0.282824***	42.3%
	(0.053606)	(0.008962)	(0.023531)	
60	-1.526194***	0.007270	-0.136312***	87.6%
	(0.031627)	(0.006359)	(0.020882)	

Table 4-14 reports overlapping regressions of realised bond return volatilities (Panel III) and stock return volatilities (Panel IV) onto a constant, their own lagged value, the treasury rate, tr(t) and the yield spread, spr(t). Newey-West HAC standard errors and covariance are applied with AIC maxlags. Corresponding standard errors are reported within parenthesis. * presents significance at 10%， ** denotes significance at 5% and * indicates significance at 1%.**

Table 4-15: Covariance and bond beta forecasting regression for Japan

Panel I: Covariance regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	R^2
3	0.428545***	-0.027376***	0.024255***	29.5%
	(0.039769)	(0.005170)	(0.005141)	
6	0.477005***	-0.025557***	0.022436***	37.2%
	(0.040945)	(0.004075)	(0.004489)	
12	0.193624***	-0.029246***	0.027130***	18.8%
	(0.039276)	(0.003847)	(0.004480)	
36	0.836620***	-0.005138**	0.020819***	17.9%
	(0.083118)	(0.002281)	(0.003353)	
60	-1.305677***	0.053401***	-0.002067	63.8%
	(0.064095)	(0.005850)	(0.002222)	

Panel II: CAPM beta regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	R^2
3	0.255539***	-0.014717***	0.002116	16.4%
	(0.047243)	(0.003848)	(0.004712)	
6	0.378529***	-0.006994**	0.000726	23.5%
	(0.052308)	(0.002807)	(0.003511)	
12	0.485262***	-0.000887	-0.000863	30.3%
	(0.044708)	(0.001726)	(0.002194)	
36	-0.182098***	-0.004437***	0.001576	5.5%
	(0.036202)	(0.001092)	(0.001666)	
60	-0.938650***	0.002340	0.006994***	86.2%
	(0.031678)	(0.002522)	(0.000910)	

Table 4-15 reports overlapping regressions of realised covariances (Panel I) and bond CAPM betas (Panel II) onto a constant, their own lagged value, the treasury rate, tr(t) and the yield spread, spr(t). Newey-West HAC standard errors and covariance are applied with AIC maxlags. Corresponding standard errors are reported within parenthesis. * presents significance at 10%, ** denotes significance at 5% and * indicates significance at 1%.**

Table 4-16: Volatility forecasting regression for Japan

Panel III: Bond return volatility regression				
Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.345993***	0.008338**	0.003030	20.8%
	(0.062135)	(0.003455)	(0.002209)	
6	0.277116***	0.010710***	0.001892	22.3%
	(0.050524)	(0.003058)	(0.002043)	
12	0.120732***	0.014651***	0.002835*	26.6%
	(0.003070)	(0.001039)	(0.001744)	
36	0.173311***	0.005088***	0.009477***	41.9%
	(0.032918)	(0.000657)	(0.001274)	
60	0.001760	0.021925***	0.007150***	61.8%
	(0.027486)	(0.002900)	(0.001010)	

Panel IV: Stock return volatility regression				
Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.209658***	0.793570***	-1.372658***	12.7%
	(0.049324)	(0.241865)	(0.295811)	
6	0.242471***	0.822378***	-1.217192***	17.0%
	(0.053265)	(0.170327)	(0.183474)	
12	0.004427	0.923922***	-1.637358***	19.9%
	(0.035651)	(0.161409)	(0.203609)	
36	-1.455248***	0.009544	-0.746922***	37.6%
	(0.097947)	(0.059927)	(0.098606)	
60	-0.624184***	-1.244115***	0.221250***	15.2%
	(0.104838)	(0.150238)	(0.052644)	

Table 4-16 reports overlapping regressions of realised bond return volatilities (Panel III) and stock return volatilities (Panel IV) onto a constant, their own lagged value, the treasury rate, tr(t) and the yield spread, spr(t). Newey-West HAC standard errors and covariance are applied with AIC maxlags. Corresponding standard errors are reported within parenthesis. * presents significance at 10%, ** denotes significance at 5% and * indicates significance at 1%.**

Table 4-17: Covariance and bond beta forecasting regression for the U.K.

Panel I: Covariance regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.274334*** (0.049824)	0.027078*** (0.003196)	0.046550*** (0.005694)	37.7%
6	0.452184*** (0.058823)	0.018704*** (0.003120)	0.032679*** (0.004347)	50.2%
12	0.292944*** (0.063815)	0.023290*** (0.004416)	0.045927*** (0.004698)	46.5%
36	0.053438 (0.120452)	0.020375*** (0.007387)	0.043778*** (0.005933)	43.9%
60	0.706663*** (0.034566)	-0.023539*** (0.002436)	0.004481** (0.001655)	79.0%

Panel II: CAPM beta regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.552072*** (0.052230)	0.021018*** (0.003556)	0.037842*** (0.006849)	69.1%
6	0.505226*** (0.049137)	0.026269*** (0.003452)	0.042122*** (0.006736)	73.2%
12	0.511317*** (0.057471)	0.026128*** (0.003838)	0.043213*** (0.0006526)	75.5%
36	0.155192** (0.071983)	0.016243*** (0.006893)	0.046240*** (0.006107)	59.7%
60	0.194444*** (0.007496)	-0.004133** (0.000724)	0.004868*** (0.000863)	87.0%

Table 4-17 reports overlaping regressions of realised covariances (Panel I) and bond CAPM betas (Panel II) onto a constant, their own lagged value, the treasury rate, tr(t) and the yield spread, spr(t). Newey-West HAC standard errors and covariance are applied with AIC maxlags. Corresponding standard errors are reported within parenthesis. * presents significance at 10%, ** denotes significance at 5% and * indicates significance at 1%.**

Table 4-18: Volatility forecasting regression for the U.K.

Panel III: Bond return volatility regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	R^2
3	0.387827***	0.003579**	0.004231***	19.8%
	(0.067303)	(0.001350)	(0.002220)	
6	0.287327***	0.005147***	0.002934	16.0%
	(0.056361)	(0.000982)	(0.002108)	
12	0.282569***	0.006481***	0.001315	20.7%
	(0.059931)	(0.000799)	(0.002070)	
36	-0.661095***	0.018173***	0.015771***	36.6%
	(0.056098)	(0.001027)	(0.001149)	
60	-0.134129***	0.004636***	0.001233***	14.0%
	(0.042603)	(0.000671)	(0.000523)	

Panel IV: Stock return volatility regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	R^2
3	0.410367***	-0.085377***	-0.308345***	23.3%
	(0.061433)	(0.019549)	(0.066097)	
6	0.402769***	-0.050781***	-0.328659***	22.8%
	(0.048683)	(0.016396)	(0.049268)	
12	0.355476***	-0.045410**	-0.453546***	24.6%
	(0.046419)	(0.022469)	(0.050754)	
36	-1.336954***	-0.462339***	-0.517095***	56.6%
	(0.080042)	(0.036079)	(0.023235)	
60	0.183154	0.040983	-0.211464***	24.3%
	(0.117331)	(0.042068)	(0.025698)	

Table 4-18 reports overlapping regressions of realised bond return volatilities (Panel III) and stock return volatilities (Panel IV) onto a constant, their own lagged value, the treasury rate, tr(t) and the yield spread, spr(t). Newey-West HAC standard errors and covariance are applied with AIC maxlags. Corresponding standard errors are reported within parenthesis. * presents significance at 10%, ** denotes significance at 5% and * indicates significance at 1%.**

Table 4-19: Covariance and bond beta forecasting regression for the U.S.

Panel I: Covariance regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	R^2
3	0.607278***	0.013589***	0.013717***	48.0%
	(0.064057)	(0.004340)	(0.006078)	
6	0.555152***	0.012061***	0.017102***	41.2%
	(0.076356)	(0.004627)	(0.006663)	
12	0.325540***	0.028334***	0.052929***	31.5%
	(0.064458)	(0.006339)	(0.008846)	
36	0.224463***	0.019195**	0.101496***	44.4%
	(0.110836)	(0.007126)	(0.006918)	
60	0.893231***	-0.023340***	0.007159	56.3%
	(0.046669)	(0.003457)	(0.004996)	

Panel II: CAPM beta regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	R^2
3	0.704207***	0.011934***	0.018965***	65.6%
	(0.039850)	(0.002863)	(0.004650)	
6	0.771709***	0.004315*	0.018111***	67.0%
	(0.047132)	(0.002687)	(0.003945)	
12	0.770365***	-0.002103	0.024010***	57.7%
	(0.043405)	(0.003379)	(0.005513)	
36	0.337031***	0.009506***	0.047684***	54.1%
	(0.030971)	(0.002932)	(0.005784)	
60	0.286363***	-0.001742**	0.000573	78.5%
	(0.013713)	(0.000864)	(0.001502)	

Table 4-19 reports overlapping regressions of realised covariances (Panel I) and bond CAPM betas (Panel II) onto a constant, their own lagged value, the treasury rate, tr(t) and the yield spread, spr(t). Newey-West HAC standard errors and covariance are applied with AIC maxlags. Corresponding standard errors are reported within parenthesis. * presents significance at 10%, ** denotes significance at 5% and * indicates significance at 1%.**

Table 4-20: Volatility forecasting regression for the U.S.

Panel III: Bond return volatility regression				
Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.475903***	-0.008118***	-0.007939***	38.8%
	(0.055182)	(0.001073)	(0.002075)	
6	0.578961***	-0.004863***	-0.009128***	42.9%
	(0.058273)	(0.001000)	(0.002032)	
12	0.176589**	-0.010703***	-0.014387***	21.1%
	(0.063415)	(0.001593)	(0.002501)	
36	-1.438742***	-0.012158***	-0.015961***	62.9%
	(0.054887)	(0.000617)	(0.001472)	
60	-0.340794***	0.038246***	0.039527***	61.1%
	(0.051360)	(0.001867)	(0.003924)	

Panel IV: Stock return volatility regression				
Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.446547***	-0.133466**	-0.161201***	24.5%
	(0.07005)	(0.054555)	(0.063322)	
6	0.304599***	-0.171723***	-0.227307***	15.5%
	(0.051799)	(0.055963)	(0.058954)	
12	0.095558*	-0.298415***	-0.559281***	13.3%
	(0.051468)	(0.073640)	(0.087782)	
36	-0.312436***	-0.103080**	-0.807098	51.6%
	(0.073651)	(0.037667)	(0.046092)	
60	-0.530275***	-0.137734***	-0.271203***	21.1%
	(0.053348)	(0.029506)	(0.047990)	

Table 4-20 reports overlapping regressions of realised bond return volatilities (Panel III) and stock return volatilities (Panel IV) onto a constant, their own lagged value, the treasury rate, tr(t) and the yield spread, spr(t). Newey-West HAC standard errors and covariance are applied with AIC maxlags. Corresponding standard errors are reported within parenthesis. * presents significance at 10%, ** denotes significance at 5% and * indicates significance at 1%.**

Table 4-21: Covariance and bond beta forecasting regression for G7 in panel framework

Panel I: Covariance regression				
Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.363855***	0.010750***	0.009747***	79.5%
	(0.007677)	(0.000668)	(0.001074)	
6	0.429585***	0.008962***	0.007853***	84.0%
	(0.007942)	(0.000531)	(0.000849)	
12	0.543097***	0.003711***	0.009227***	84.0%
	(0.010383)	(0.000483)	(0.000839)	
36	0.142449***	0.008724***	0.024564***	85.0%
	(0.011123)	(0.000476)	(0.000717)	
60	-0.062812***	0.001762***	0.004317***	83.9%
	(0.007031)	(0.000414)	(0.000695)	
Panel II: CAPM beta regression				
Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.587554***	0.001608***	0.005923***	82.8%
	(0.005847)	(0.000340)	(0.000600)	
6	0.633637	0.000495**	0.005425***	86.8%
	(0.005586)	(0.000284)	(0.000509)	
12	0.612807***	-0.000951***	0.007762***	88.1%
	(0.005827)	(0.000289)	(0.000486)	
36	0.233708***	0.001964***	0.015956***	80.4%
	(0.007085)	(0.000246)	(0.000571)	
60	0.039903***	0.001161***	0.000151	86.6%
	(0.002898)	(0.000206)	(0.000361)	

Table 4-21 reports overlapping regressions of realised covariances (Panel I) and bond CAPM betas (Panel II) onto a constant, their own lagged value, the treasury rate, tr(t) and the yield spread, spr(t), under panel construction. Fixed effects are applied with cross-section SUR controlling for heteroskedasticity and cross-section correlation. Corresponding standard errors are reported within parenthesis. * presents significance at 10%, ** denotes significance at 5% and * indicates significance at 1%.**

Table 4-22: Volatility forecasting regression for G7 in panel framework

Panel III: Bond return volatility regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.430431***	0.007670***	0.013480***	70.7%
	(0.007360)	(0.000285)	(0.000473)	
6	0.495173***	0.006830***	0.010358***	74.3%
	(0.007311)	(0.000244)	(0.000413)	
12	0.473033***	0.008132***	0.011782***	77.5%
	(0.008176)	(0.000213)	(0.000348)	
36	0.218168***	0.002802***	0.003919***	74.5%
	(0.008948)	(0.000238)	(0.000301)	
60	-0.265100***	0.003338***	-0.006951***	52.2%
	(0.012649)	(0.000378)	(0.000562)	

Panel IV: Stock return volatility regression

Horizon (months)	**Lagged**	**tr(t)**	**spr(t)**	**R^2**
3	0.414459***	0.042533***	0.005040	89.2%
	(0.008629)	(0.005221)	(0.008822)	
6	0.392957***	0.047158***	0.003405	89.4%
	(0.009021)	(0.004525)	(0.007534)	
12	0.259587***	0.066650***	0.005948	88.3%
	(0.010339)	(0.004033)	(0.006865)	
36	0.339774***	0.084863***	-0.086878***	89.2%
	(0.012046)	(0.002490)	(0.005293)	
60	-0.216186***	0.040002***	-0.103220***	79.8%
	(0.009121)	(0.003412)	(0.007373)	

Table 4-22 reports overlapping regressions of realised bond return volatilities (Panel III) and stock return volatilities (Panel IV) onto a constant, their own lagged value, the treasury rate, tr(t) and the yield spread, spr(t), under panel construction. Fixed effects are applied with cross-section SUR controlling for heteroskedasticity and cross-section correlation. Corresponding standard errors are reported within parenthesis. * presents significance at 10%, ** denotes significance at 5% and * indicates significance at 1%.**

Table 4-23: Stability of covariance and bond beta predictive regressions

Panel I: Covariance regression

Horizon (months)	**Lagged**	**dum*Lagged**	**tr(t)**	**dum*tr(t)**	**spr(t)**	**dum*spr(t)**	**R^2**
3	0.3449***	0.0362**	0.0102***	-0.0113***	0.0104***	-0.0215***	79.7%
	(0.00940)	(0.01487)	(0.00069)	(0.00120)	(0.00109)	(0.00208)	
6	0.3975***	0.0621***	0.0087***	-0.0130***	0.0079***	-0.0177***	84.2%
	(0.00941)	(0.01519)	(0.00055)	(0.00099)	(0.00086)	(0.00181)	
12	0.2863***	0.4372***	0.0082***	-0.0177***	0.0070***	0.0236***	85.8%
	(0.01203)	(0.01827)	(0.00047)	(0.00101)	(0.00077)	(0.00168)	

Panel II: Bond CAPM beta regression

Horizon (months)	**Lagged**	**dum*Lagged**	**tr(t)**	**dum*tr(t)**	**spr(t)**	**dum*spr(t)**	**R^2**
3	0.5608***	0.1623***	0.0011***	-0.0078***	0.0062***	-0.0134***	83.0%
	(0.00624)	(0.01847)	(0.00034)	(0.00077)	(0.00061)	(0.00133)	
6	0.6080***	0.1491***	0.00006	-0.0081***	0.0054***	-0.0113***	87.0%
	(0.00594)	(0.01797)	(0.00029)	(0.00062)	(0.00052)	(0.00111)	
12	0.5985***	0.0843***	-0.0013***	-0.0085***	0.0074***	-0.0083***	88.2%
	(0.00593)	(0.02747)	(0.00029)	(0.00062)	(0.00049)	(0.00120)	

Table 4-23 reports the overlapping regressions of realissed covariances (Panel I) and bond CAPM betas (Panel II) under panel construction onto a constant, their own lagged value, the treasury rate, tr(t) and the yield spread, spr(t), as well as the dummy variable, dum, which is equal to zero between January 1st 1991 and December 31st 2006, and which is equal to one between January 1st 2007 to January 18th 2011. Fixed effects are applied with cross-section SUR controlling for heteroskedasticity and cross-section correlation. Corresponding standard errors are reported within parenthesis. * presents significance at 10%, ** denotes significance at 5% and * indicates significance at 1%.**

Table 4-24: Stability of volatility forecasting regression

Panel III: Bond return volatility regression

Horizon (months)	**Lagged**	**dum*Lagged**	**tr(t)**	**dum*tr(t)**	**spr(t)**	**dum*spr(t)**	R^2
3	0.3392***	0.2877***	0.0097***	0.0027***	0.0162***	0.0024**	71.5%
	(0.00845)	(0.01665)	(0.00030)	(0.00044)	(0.00049)	(0.00096)	
6	0.3507***	0.4474***	0.0098***	0.0037***	0.0152***	-0.0009	76.0%
	(0.00831)	(0.01601)	(0.00025)	(0.000360	(0.00042)	(0.00086)	
12	0.2289***	0.1972***	0.0128***	0.0107***	0.0190***	0.0142***	75.6%
	(0.000716)	(0.01830)	(0.00021)	(0.00031)	(0.00032)	(0.00079)	

Panel IV: Stock return volatility regression

Horizon (months)	**Lagged**	**dum*Lagged**	**tr(t)**	**dum*tr(t)**	**spr(t)**	**dum*spr(t)**	R^2
3	0.4276***	-0.0506***	0.0423***	-0.1332***	-0.0416***	0.2267***	89.5%
	(0.01057)	(0.01648)	(0.00531)	(0.01114)	(0.00882)	(0.01863)	
6	0.4154***	-0.0795***	0.0455***	-0.1340***	-0.0458***	0.2376***	89.8%
	(0.01056)	(0.01702)	(0.00453)	(0.00931)	(0.00745)	(0.01598)	
12	0.2864***	-0.0959***	0.0683***	-0.0845***	-0.0432***	0.3282***	88.9%
	(0.01180)	(0.02011)	(0.00399)	(0.00820)	(0.00676)	(0.01426)	

Table 4-24 reports overlapping regressions of realised bond return volatility (Panel III) and stock return volatility (Panel IV) under panel construction onto a constant, their own lagged value, the treasury rate, tr(t) and the yield spread, spr(t), as well as the dummy variable, dum, which is equal to zero between January 1st 1991 and December 31st 2006, and which is equal to one between January 1st 2007 to January 18th 2011. Fixed effects are applied with cross-section SUR controlling for heteroskedasticity and cross-section correlation. Corresponding standard errors are reported within parenthesis. * presents significance at 10%, ** denotes significance at 5% and * indicates significance at 1%.**

Chapter 5 **Directors' Pay and Firm Performance in the UK, 2004-2009**

5.1. Introduction

Recently, the compensation of Executive Directors has attracted worldwide public attention and media interest. Of particular concern has been the compensation of a number of high profile chief executives. For example, in the U.S. a CNN Money report which was titled "CEO pay: Sky high gets even higher" showed that the average pay ratio of CEO-to-worker has been leaping from year to year. In 2004, for example, the CEO-to-worker pay ratio reached 431-to-1, while it was only 42-to-1 in 1982 and 107-to-1 in 1990. Meanwhile, Bebchuk and Grinstein (2005) point out that according to the research of Harvard University on the pay of the top five executives' from across a large set of public companies, the earnings of those executives amounted to approximately 10% of their companies' earnings during 2001 to 2003, which was almost double of what was during the period of 1993 to 1995. In 2007, although the companies slowed down and some companies saw huge drops in their profitability, "their CEO pay still chugged to yet more dizzying height". For instance, Stan O'Neal, Merrill Lynch's former boss, left with a package of $159m after losing $8 billion (Tanugi 2009). Treasury Secretary Geithner (2009) from the US commented on 10th June 2009, that "this financial crisis had many significant causes, but executive compensation practices were a contributing factor."

In the UK, the generous executive pay package and its rapid increase has led to an increasing level of public anger in the past two decades. In 1995 the chief executive of British Gas received a pay rise of over 75%. Public debate about executive compensation has consequently erupted following a number of such large increases in executive pay. In the U.K. the average CEO-to-employee pay ratio has increased from 47-to-1 to 128-to-1 over a decade according to commentators' reports, whereas management guru Peter Drucker proposed that this ratio should be no larger than 20-to-1 in the U.K. In another example, in 1999 Vodafone's shareholders tried to block a £10m bonus to its CEO. Many directors who are responsible for setting executive compensation packages believe that those packages need trimming. More recently, during the recovery from financial crisis several large public firms have taken reconsideration about their executive compensation structures. For example, Shell announced in 2010 that they will freeze executive directors' salaries for a year. Meanwhile, HSBC has shifted the emphasis from performance-related pay to fixed income, although there are reports of 30% to 40% salary rises for the top executives at HSBC which are reported by Nick Tapazio (2010) from CIMA (Charted Institute of Management Accountants).

In this chapter we will aim to examine the relationship between directors' emolument and corporate performance of the chief executive, the highest paid director, and the whole board of large public firms in the U.K. over the period 2004-2009. In comparison to the U.S., empirical studies on directors' remuneration and firm performance are rather limited and very few have analysed the pay of both the CEO and the highest paid director. Cadbury's (1992) report significantly improved the disclosure of directors' remuneration. Greenbury's (1995) report further suggested scrutiny over the constructing of the directors' pay additional to full disclosure. Moreover, Hampel's (1998) report emphasised the inclusion of detailed remuneration information in a company's annual report. Higgs (2003) highlighted the important role of non-executive directors on setting remuneration packages. Since this point research on executive compensation has started to become easier and it has attracted much attention. For example, Conyon (1997) takes a sample of top director remuneration packages within 213 large UK firms recorded from 1988 to 1993 in order to estimate the innovations of corporate governance. He finds a positive relationship between director compensation and shareholder returns. He also shows the influence of remuneration committees, which are responsible for setting executives' compensation, on director compensation. Conyon and Murphy (2000) investigated CEO pay and incentives for both U.S. and U.K. companies. They indicate that in 1997 CEO pay in the U.S. was higher than that in the U.K., while controlling for economic determinants for the compensation package. Gregg et al. (2005) finds an asymmetric relationship between executive cash compensation and corporate performance with relatively high and low corporate returns, and suggests that overall there is little relationship between pay and performance. Additionally, Ozkan (2007) uses a hand-collected data set of 390 non-financial companies and has identified a significantly positive relationship between corporate performance and CEO cash compensation, but an insignificant relationship for total compensation. Meanwhile, Girma et al. (2007) reports that there is a weak link between CEO compensation and performance for U.K. companies over the period 1981 to 1996. Therefore, it can be seen that the evidence from previous studies relating to the directors' remuneration and corporate performance in the U.K. is mixed.

In this chapter, firstly, we will reconsider the basic pay-performance relationship by re-examining the link between directors' pay and firm performance with the most recent data of FTSE 350 companies over the period 2004 to 2009. In order to shed a new light on this pay-performance relationship we will extend the scope by empirically analysing the compensation packages of not only the CEO but also of the highest paid director and the whole board of those corporations.

A key contribution of this chapter is to evaluate the directors' compensation for CEO (both cash and total pay), the highest paid director, and the whole board of directors among FTSE 350 firms for the sample period 2004 to 2009, and for the pre-crisis subsample period of 2004 to 2006 and the post-crisis period of 2008 to 2009. In the empirical estimations this study will control for a comprehensive set of variables, such as: firm size, board size, financial leverage. Secondly, we will also analyse the differences in pay-performance relationship among industries and between firms with different dividend payout policies. Thirdly, we will investigate the impacts of the latest financial crisis which erupted in mid-2007 on the corporate pay-performance relationship. This can be seen as one of the main contributions in this chapter. Last but not least, this chapter will also shed a light on the influence of remuneration policy on corporate returns and growth opportunities because this has rarely been examined in the previous studies. Another contribution of this study is that it will use a fixed effects method to implement panel data estimation with the inclusion of both white diagonal and cross-section SUR to control for the observation specific heteroskedasticity and cross-section correlation. Although the panel estimation with fixed effects has been applied in several previous studies, few of them have taken account of heteroskedasticity and cross-section correlation problems through estimations. In addition, the bootstrapping methodology is applied in this study in order to check the robustness of the findings. There are in addition two further contributions of this chapter. The first contribution is that this study will analyse the pay-performance relationship for both CEO and highest paid director in the firm and compare and discuss the difference, whereas the previous studies have only examined one counterpart. The second contribution of this study is that besides the effect of firm performance on directors' pay it will also look at this pay-performance relationship through the opposite direction in order to consider how the directors' remuneration policy influences the firm's performance.

In this chapter the empirical results indicate that there is a positive and significant relationship between the directors' pay and corporate performance for CEO cash and total compensation, as well as remuneration for highest paid director and whole board, respectively. The findings in this study support the idea that U.K. corporate governance reports have been effective at constructing a closer link between pay and performance. In agreement with most of the previous studies, this study finds that a firm's size plays an important role in determining the directors' remuneration packages, while board size does not have a significant impact. Additionally, this study will show that firms from different industries have significantly different relationships between pay and performance for CEOs, highest paid directors, and the total board. Companies in the financial industry have the strongest link between their directors' pay and corporate performance. However, for CEO compensation only, firms with different dividend policies generate significantly different magnitudes in the pay-performance relationship. Firms with higher dividend payout ratios have a weaker link between CEO total pay and performance.

In this chapter we also find that the relationship between the directors' remuneration and a firm's performance has weakened after the fiscal year 2007. Because of the data limitation, this study could only examine the relationship with observation in two years after the financial crisis. These results indicate that the latest financial crisis, which first erupted in the middle of 2007, has had a crucial impact on the pay-performance relationship among the largest firms in the U.K. The economy has not yet fully recovered and our results demonstrate that the link between directors' remuneration and a firm's performance has broken down because many of these firms have faced sharp decreases in returns, and even bankruptcies, without similar significant changes happening in their directors' compensation packages. Nonetheless, our analysis suggests that the directors' pay has a positive and significant influence on a firm's returns and growth opportunities.

This chapter is organised as follows. Section 5.2 summarises the agency theory, important governance reports, and the previous empirical literature. Econometric methodologies are discussed in Section 5.3. Section 5.4 describes the data and variables being used. Section 5.5 outlines the modelling framework which is used to analyse the relationship between the directors' pay and corporate performance. The empirical findings are presented and discussed in Section 5.6. And finally, Section 5.7 concludes this chapter.

5.2. Theory and The Literature

5.2.1. Agency Theory

Agency theory has been considered as the basis for guiding the research on the relationship of directors' pay and corporate performance (e.g., Jensen and Murphy (1990), Roth and O'Donnell (1996), Murphy (1999), Miller, Wiseman and Gomez-Mejia (2002), McKnight and Tomkins (2004)). Under the principal-agent framework, the principal (i.e. the shareholders) would like to set a contract to attract the agent (known as the CEO or other executive directors). If the shareholders had complete information about the actions of the CEO or the senior directors as well as the investment opportunities, then in a perfect world there would be a perfectly enforceable contract between the principal and the agent. However, because of the information asymmetry the shareholders cannot fully observe the managerial actions and do not know which of these actions will truly increase the shareholders' wealth. Thus, in these circumstances, according to agency theory, compensation packages have to be designed to align the interests of the directors, especially executive directors, to those of the shareholders.

There are three fundamental behavioural assumptions which are required within a principal-agent framework, which is that both the principal and the agent are:

1. Rational,

2. Self-interested; and,

3. The agent is effort-averse and risk-averse (Jensen and Meckling 1976).

Under these assumptions, conflicts of interest between the two parties arise because both attempt to maximise their own utilities without taking consideration of the counterpart's welfare. Shareholders simply want the CEO and directors to act to get a certain expected return, while the CEO and directors may only care about their own gains through particular activities. Thus, given the presence of information asymmetry, a hidden-action (i.e. moral hazard) occurs. That is, the CEO or senior director would act to maximise their compensation without taking account of the shareholders' objectives (Baiman (1990), Eisenhardt (1989), Nilakant and Rao (1994), Milkovich and Bloom (1998)). More specifically, the principal's pay-off can be defined as a function of output minus the pay to the agent, and the agent's pay-off can be defined as a function of remuneration minus the cost-of-effort to construct a principal-agent framework. Following Holmstrom and Milgrom (1987), the model could be specified as below:

The agent's problem: $\max\limits_{x} E[U(w)] - c(x)$

$$s.t. U(w) = -e^{-rw}, \qquad w \sim N(\overline{w}, \sigma_w^2)$$

$$w = g(y) = \kappa + \varphi y$$

$$y = x + \varepsilon, \qquad \varepsilon \sim N(0, \sigma^2)$$

A constant absolute risk averse (CARA) utility function, $U(w) = -e^{-rw}$ is defined here because the agent is assumed to be risk averse according to agency theory. w is defined as the wealth of the agent and it is assumed to be normally distributed, which is, $w \sim N(\overline{w}, \sigma_w^2)$. Wealth w contains two parts, the fixed salary κ and the incentive pay which can be defined as a proportion of y (which is the output level that can be observed by the principal). The output level y is determined by the agent's effort x and a random component $\varepsilon \sim N(0, \sigma^2)$. Using the properties of a normal function and an exponential function, the agent's problem becomes how to use the effort level x to maximize $\kappa + \varphi x - \frac{r\varphi^2}{2}\sigma^2 - c(x)$. Therefore, the first derivative can be simply specified as $c'(x) = \varphi$.

Meanwhile, the principal's problem can be stated as:

$$\max_{x} E[y-w]$$

$$s.t. y = x + \varepsilon$$

$$w = g(y) = \kappa + \varphi y$$

$$E[U(w)] - c(x) \geq U*$$

$$c'(x) = \varphi$$

Where $U*$ is defined as the agent's reservation utility level, which is determined exogenously. With respect to x, the first order condition can be written as $\varphi = \dfrac{1}{1 + rc''(x)\sigma^2}$. Thus, the wealth of the agent (which could be measured as remuneration) is simply:

$$w = \kappa + \frac{1}{1 + rc''(x)\sigma^2} y$$

From the model specification above, we can observe the following aspects:

1. Remuneration depends on both base pay and incentive pay.
2. There are two constrains that the principal has to face in order to design the optimal contract. One is the participation (or individual rationality) constraint which requires the principal to set a certain contract to attract some agent with the remuneration at least equal to the opportunities that the agent could get from outside. The other constraint is to align the agent's own interests to those of the principal's.
3. In addition to the base salary, the incentive pay is determined by three factors,

including: the level of agent's risk aversion, the cost of effort provided by the agent, and the variability of the firm's performance.

4. It can be observed in the model that the agent's remuneration will increase with the improvement in the firm performance, and decrease with the firm risk, while other factors are fixed.

5. As the risk aversion and/or marginal cost-of-effort ($c''(x)$ is the slope of the marginal cost of effort) increases, the incentive pay decreases; thus, the remuneration level decreases.

The executives, or the top managers (i.e. the agent), are considered as risk averse in the literature. Under this assumption, the executives would like their remuneration to be less risky (Harris and Raviv 1979), which indicates that the executives will want their fixed cash compensation to contribute more in the remuneration package when compared to the equity-based incentive compensation. Meanwhile, since both the compensation and the human capital are related to the firm's performance then it is assumed that the executives would take action to reduce the firm's risk, which might reduce the firm's value at the same time, in order to reduce their own risk (Amihud and Lev 1981). On the other hand, the shareholders (i.e. the principal) are risk neutral because they can diversify their firm-specific risk simply by holding diversified portfolios (Mehran 1994). Thus, incongruence occurs between the shareholders and executives because the shareholders' utility is assumed to be long-term holding portfolios while the executives' utility is assumed to be in terms of human capital and short-term gain (McKnight and Tomkins 2004). The shareholders want to maximise the firm value while the executives tend to reduce their compensation risk by taking action that may reduce the return in the mean time. Two suggestions have been made in the literature: the first is to tie the executives' compensation to the firm's performance directly (as discussed in Grossman and Hart (1983) for instance) and the second is to use more equity-based compensation (which is discussed in Jensen and Murphy (1990)). Hence, given the principal-agent framework, the firm risk (negative related to compensation) as well as the performance (positive related to compensation) should be taken into account when analysing the determinants of the executives' remuneration packages.

Additionally, apart from agency theory, some other elements might be important to determine the executives' pay. For instance, according to the theory of empirical regularity the corporate sales can be treated as one of the important factors in constructing the executives' compensation contracts. The intuition of linking firm size to remuneration is the theory of labour market efficiency, which suggests that relatively large companies will require and could be able to design more attractive contracts to recruit more talented and capable executives. Meanwhile, as Cole et al.(2006) have suggested, financial leverage could be taken into account when determining executive pay.

5.2.2. Several Important Reports

Several important reports were issued in the U.K. in the 1990s, such as: Cadbury (1992), Greenbury (1995) and Hampel (1998). These reports focus on corporate governance issues and they advocated governance changes. The Cadbury Committee was set up in 1991 following the Conservative government's requirement for corporate governance which aimed to allay public concerns over the failure to relate executive pay to a firm's performance, such as: 'creative accounting' practices which try to obfuscate the calculation of shareholder values, a number of high-profile CEOs who appeared to deliberately discourage financial transparency, and the rapid growth of executive compensation without corresponding success in their companies (Cadbury 1992). The Combined Code, also called 'Code of Best Practice', was established following the Cadbury report to enable the shareholders to monitor corporate executives more efficiently, thus aligning the interests of the executive agents to those of the shareholder principals. Cadbury (1992) required the establishment of remuneration committees in firms to take responsibility for setting executive pay, which is transferred from managers. It also recommended disclosure of the elements of compensation packages, decentralisation of control by splitting functions of the CEO and the chair of the board, and the independence of non-executives on the board by fixing the duration of their contracts without automatic renewal. The London Stock Exchange endorsed the Cadbury Code and ensured its compliance among publicly traded firms. According to the survey by Conyon (1997), the overwhelming majority of large U.K. companies implemented the Cadbury Code rapidly and widely.

The Greenbury report (1995) responded to public and shareholder concerns about the rapid increases of the directors' remuneration, the large amounts of compensation paid to some departing directors, and also some of the wider concerns about accountability for directors' remuneration, especially in industries within a less competitive environment. *'The key themes are accountability, responsibility, full disclosure, alignment of director and shareholder interests and improved company performance.'* The Greenbury report recommended that the board of directors should establish a remuneration committee, which consists exclusively of non-executive directors who have no personal financial interest, to deal with the potential conflicts of interest between shareholders and directors. The remuneration committee should make a report to shareholders each year, and this report forms a part of the company's annual report. This report should provide the full details of all elements in the directors' remuneration packages, such as: basic salary, annual bonuses, long-term incentive schemes and benefits in kind, as well as the company's directors' remuneration policy, including levels, comparator groups of companies, performance criteria, pension provision, and contracts of service. Greenbury (1995) required the directors' remuneration packages to be designed to align the directors' interests to those of shareholders, to attract and motivate directors of a high quality, and to make the directors take into account the performance of their own and other comparable companies. The Greenbury (1995) report recommended the use of performance-based compensation, such as annual bonuses and long-term incentive schemes, it also required that the directors should be eligible and performance conditions should be relevant to improve the business. In addition, the movement of share prices and other indicators should not be considered as a factor to design performance-based compensation because it might reflect inflation or other general movements in the market. With the power and influence of the London Stock Exchange and investor institutions, the Greenbury Code with all of these recommendations has been rapidly and widely implemented among British companies, especially in listed companies.

The Hampel (1998) report highlighted the importance of corporate governance and full disclosure was considered to be the most significant element. The Hampel report reviewed the Cadbury code as well as a number of relevant issues in the Greenbury report and it took careful reconsideration of the roles of directors, shareholders and auditors in corporate governance. Hampel recommended that the boards in the listed companies should play the role of leadership and control effectively. The chairman of the board and the chief executive officer were recommended to have distinct responsibilities. Any combination of the roles of these two should be publicly explained because a separation is felt to be necessary to avoid the board becoming dominated by one individual, as Cadbury (1992) pointed out. The board should be balanced with executive and non-executive directors, it should supply sufficient information in a timely fashion, and its directors should be re-elected at regular intervals. The directors' remuneration plays an important part in the process of corporate governance. Companies need to have a formal and transparent procedure for developing a remuneration policy and fixing remuneration packages. Hampel (1998) emphasised the need for U.S. style disclosure in a company's annual report which should contain both a statement of remuneration policy and detailed remuneration information for each individual director. This form of disclosure allows for more specific analysis of a company's performance, governance practice, and compensation policy. Hampel's (1998) recommendations also form a part of the London Stock Exchange combined code, which all companies listed on the London Stock Exchange must abide by. According to the recommendations of these three reports the directors' remuneration is expected to be *'sufficient to attract and retain the directors needed to run the company successfully, but should not be more than is necessary'; and also 'the remuneration of executive directors should link rewards to corporate and individual performance'.*

In addition, the Higgs (2003) report focused on the role and effectiveness of non-executive directors. It emphasised that the non-executive directors should *'contribute to and constructively challenge development of company strategy'* and *'scrutinise management performance'*. Although Hampel (1998) recommended the balance of executive and non-executive directors, Higgs (2003) highlighted that at least half of the board (excluding the chairman) should be comprised of independent non-executive directors. The remuneration committee should consist entirely of independent non-executive directors who are responsible for setting the chairman's and the executive directors' remunerations. Higgs (2003) also suggested that companies should construct a transparent procedure for their remuneration policy development and they should fix the remuneration of individual directors. Moreover, as in the previous reports, Higgs (2003) recommended that the rewards in executive directors' compensation packages should be linked to corporate performance.

In summary, these reports have all played a very important role in improving the transparency of the directors' remuneration for U.K. companies. It is nearly impossible to analyse executive compensation in Britain before the 1990s because of the difficulty of getting data and information which is a consequence of the poor disclosure of remuneration packages for U.K. companies. After Cadbury (1992) the annual reports of UK firms have been required to include detailed information about their directors' remuneration, which makes it much easier to evaluate the remuneration policy and total compensation packages.

5.2.3. Empirical Literature

Recently, a considerable amount of research has been done to identify the determinants of directors' remuneration packages, such as: Jensen and Murphy (1990), Conyon (1997), and Gregg et al (2005). One of the fundamental hypotheses tests in the empirical literature is to examine for the presence of a significantly positive relationship between executive compensation and a firm's performance. Jensen and Murphy (1990) in their seminar work in the U.S. examined the 2,213 CEOs listed in Executive Compensation Survey during the period 1974 to 1986. They found that there is no significant relationship between executive compensation and corporate performance. Since then, the lack of empirical regularity has been identified and widely estimated in the U.S. For example, Milkovich and Bloom (1998) extend the research in this area by taking account of the business risk (both systematic and unsystematic risk) and they suggest that those firms with higher business risk will tend to deemphasise their incentive pay and will rely more on the base pay in the compensation packages. They also find that firms who face higher risk and use a greater proportion of incentive pay will attain lower performance.

More recently, Coles, Daniel and Naveen (2006) report that managerial compensation not only relates to the firm's risk but it will also influence their investment and debt policies. In their study Coles, Daniel and Naveen (2006) used data on executive compensation for firms in the S&P 500, S&P Midcap 400 and S&P Smallcap 600 covering the period 1992-2002, and obtain a strong causal relationship.

Compared to the US, the literature in the UK is relatively limited until the 1990s, culminating in the influential reports issued by the Cadbury (1992), Greenbury (1995) and Hampel (1998) (Conyon and Murphy 2000). The table (Table I) below extends the results provided by Peck and Conyon (1998), and Conyon and Sadler (2001) and it also shows some recent evidence on directors' emoluments and firm performance relationship for the UK, as well as some important research for the US. Following the Cadbury (1992) report (which recommends the setting up of the remuneration and audit committee which mainly consists of non-executive directors) the disclosure of the executive compensation packages has been improved significantly. The Greenbury (1995) report makes further recommendations to improve: the disclosure of executive pay, the scrutiny over the constructing of the executive pay, and the numbers and responsibilities of the non-executive directors on the board. Meanwhile, the Hampel (1998) report emphasises the independence of the non-executives on the board. Conyon (1997) takes a sample of top director remuneration packages within 213 large UK firms recorded from 1988 to 1993 in order to estimate the innovations of the corporate governance. He finds a positive relationship between director compensation and shareholder returns. He also shows the influence of remuneration committees (which are responsible for setting executives' compensation) on director compensation. Conyon and Murphy (2000) investigate CEO pay and incentives for both US and UK companies. They indicate that for 1997, CEO pay in the U.S was higher than that in the UK (while controlling for economic determinants for the compensation package). In addition, companies in the U.S. relied more heavily on incentive compensation. Gregg et al.(2005) finds an asymmetric relationship between executive cash compensation and corporate performance with relatively high and low corporate returns, and suggests that overall there is little relationship between pay and performance. In addition, Ozkan (2007) uses a hand-collected data set of 390 non-financial companies and identifies a significantly positive relationship between corporate performance and CEO cash compensation, but an insignificant relationship for total compensation. In this chapter, we reconsider the pay-performance relationship by re-examining the link between executive pay and firm performance with the most recent data of FTSE 350 companies during the period 2004-2009, and we will then try to allocate the determinants of the directors' remuneration.

Another relative issue besides the determination of the director pay is how the pay of the executives and the whole board of directors influences the performance of the company. There are few empirical studies focusing on the effect of executive remuneration on firm value, and the results of these works are often conflicting. For example, Mehran (1995) finds that the corporate performance is positively related to the equity-based compensation. We will extend this previous research in order to examine total compensation and the compensation for the whole board. In addition, this study uses improved econometric methodologies to examine the pay-performance relationship. This chapter achieves robust results with more recent data for the largest companies in the U.K.

Table I: Some evidence of the pay-performance relationship

Study	Data	Compensation measure	Performance measure	Estimated coefficient (s.e.) [t's]	Remarks
Jensen and Murphy (1990)	U.S. data on 2213 CEOs, 1974-86	(1) Change in salary and bonus of CEO (2) Change in CEO total pay	Change in shareholder return dated at (a) period t and (b) period t-1	(1a) 0.0000139 [8.4] (1b) 0.0000080 [5.5] (2a) 0.0000235 [5.2] (2b) 0.0000094 [2.4]	Performance effects regarded as small
Main (1991)	512 U.K. companies, 1969-89	Change in salary and bonus of highest-paid director	Stock market return	0.038 (0.012)	
Gregg et al. (1993)	288 U.K. companies, 1983-91	Change in highest-paid director's remuneration (salary+bonus)	Change in shareholder returns	1983-88: 0.027 [2.112] 1989-91: -0.024 [1.102]	Time heterogeneity in performance effect on compensation Disappears after 1988
Main and Johnston (1993)	220 U.K. companies, 1990	Salary and bonus of highest-paid director	Risk adjusted market return	0.100 (0.135)	Cross section evidence
Conyon and Leech (1994)	294 U.K. companies, 1983-86	Change highest director pay (salary+bonus)	(a) Shareholder wealth in period t-1 (b) Change in shareholder wealth in period t-1	(a) 0.006565 (0.003601) (b) 0.059003 (0.020096)	Effects of governance discussed
Conyon and Gregg	169 U.K.	Change in salary and bonus of	Shareholder return	1985-87: 0.076 (0.032)	

Study	Data	Compensation measure	Performance measure	Estimated coefficient (s.e.) [t's]	Remarks
(1994)	companies, 1985-90	highest-paid director		1988-90: 0.020 (0.036)	
Conyon(1995)	28 U.K. privatised companies, 1990-94	Change in salary and bonus of highest-paid director	(1) Total shareholder return (2) Return on shareholders' equity (3) Return on long-term capital in period t-1	(1) -0.0001025 (0.0009154) (2) -0.0000006 (0.0056089) (3) 0.0039333 (0.0042299)	
Smith and Szymanski (1995)	51 quoted U.K. companies, 1981-91	All directors' remuneration (basic salary + performance related pay + benefits)	Earnings per share	Cross section:0.03 (0.10) Time series: 0.03 (0.24)	Argue for the need to include effect of average executive pay as an 'outside option'
Mehran (1995)	153 randomly-selected manufacturing firms in 1979-80	(1) % of CEOs' equity-based compensation (2) % of CEOs' shares and stock options outstanding	(a) Tobin's Q (b) Return on assets	(a1) 0.361*** (3.500) (b1) 1.876** (2.323) (a2) 8.394*** (3.982) (b2) 11.664** (2.115)	
Main et al. (1996)	60 large U.K. companies, 1983-89	Board emoluments, highest paid director remuneration and CEO compensation (1) Salary and bonus	Share performance	For Board (1) 0.151 (0.115) (2) 0.713 (0.264) For CEO:	Dynamic Models include sector performance terms

Study	Data	Compensation measure	Performance measure	Estimated coefficient (s.e.) [t's]	Remarks
		(2) Total remuneration (including stock options)		(1) 0.146 (0.113) (2) 0.729 (0.282)	
Conyon (1997)	213 large U.K. companies, 1988-93	Changes in compensation of highest paid director (salary + bonus)	Shareholder return	0.060602 (0.019921)	Outcomes ambiguous
Conyon and Peck (1998)	94 FTSE 100 companies, 1991-94	Changes in salary and bonus of highest-paid director in companies where: (1) Proportion of outside directors on remuneration committee is above the median (2) Same proportion is below median	Shareholder return	(1) 0.088 (0.047) (2) 0.033 (0.087)	Data derived directly from annual reports Board structure effects on pay evaluated Outcome ambiguous
Hall and Liebman (1998)	478 U.S. companies, 1980-94	(1) Change in CEO salary and bonus (2) Change in CEO salary, bonus and option grants	Shareholder return dated at: (a) period t; and, (b) period t-1	(1a) 0.1630 (0.0116) (1b) 0.0596 (0.0105) (2a) 0.2799 (0.0224) (2b) -0.0156 (0.0236)	
Conyon (1998)	40 small to medium sized companies, 1985-92	Change in remuneration of the highest-paid director	(1) Profits per employee (2) Sales growth	(1) 0.0026 [0.87] (2) 0.245 [1.17]	Controls for CEO turnover

Study	Data	Compensation measure	Performance measure	Estimated coefficient (s.e.) [t's]	Remarks
Milkovich and Bloom (1998)	Over 500 U.S. companies, 1981-88	(1) Manager's incentive pay (2) Manager's base pay	(a) Total shareholder return	(a1) 0.14 (0.20) (a2) 0.04*** (0.02)	Relationship between managerial Compensation and firm risk also taken into account
Aggarwal and Samwick (1999)	1500 U.S. companies, 1993-96	(1) Change in salary, bonus and value of current option grants of CEO (2) Change in salary, bonus, value of current option grants, value of option and equity holdings of CEO.	Change in shareholder wealth	(1) 0.432 (0.053) (2) 1.036 (0.313)	Model also considers other compensation measures and extends analysis to other executives
Benito and Conyon (1999)	1093 quoted U.K. companies, 1985-94	Salary, bonus and benefits of highest-paid director	(1) Shareholder return in period t-1 (2) Relative stock price performance in period t-1	Fixed effects: (1) 0.0671 (0.0201) (2) -0.0394 (0.0492) Random effects: (1) 0.0762 (0.0193) (2) -0.0642 (0.0476)	Little board governance effects found
Conyon and Murphy (2000)	510 U.K. firms and 1666 U.S. firms in	Change in CEO salary+bonus	Shareholder return	0.1213 [2.0]	(1) Models and compares pay-performance

Study	Data	Compensation measure	Performance measure	Estimated coefficient (s.e.) [t's]	Remarks
	fiscal year 1997				sensitivity in the US and the UK: UK mean 2.33%; median 0.25% US mean 4.18%; median 1.48% (2) Models CEO incentives
Conyon and Sadler (2001)	100 large U.K. companies in 1997	(1) Total board pay-for-performance sensitivity (2) Total board PPS squared	(a) Shareholder return	(a1) 0.0868** (0.0364) (a2) -0.0030* (0.0016)	(1) Quantile regression estimation (2) PPS and organizational level examined
Conyon et al. (2001)	100 U.K. companies for fiscal year 1997-98	(1) Executives' cash compensation (2) Executives' incentive compensation (3) Executives' total compensation	Shareholder return	(1) 0.4199*** (0.1122) (2) 0.8268** (0.3371) (3) 0.3794*** (0.1276)	Focus on the relationship between corporate tournaments and executive compensation
Carpenter and Sanders (2002)	199 U.S. firms, 1992	(1) CEO pay structure (2) Top management team	(a) ROA	(a1) 6.98* (a2) 18.04**	

Study	Data	Compensation measure	Performance measure	Estimated coefficient (s.e.) [t's]	Remarks
		(TMT) external alignment (3) TMT internal alignment		(a3) 7.82***	
Miller *et* (2002)	441 publicly traded firms, 1994-98	(1) Pay mix, calculated as total variable pay (bonuses, LTIP, and stock option awards) divided by total pay (2) Average total compensation	(a) Total stock return 1994-98 (b) Systematic market risk (c) Unsystematic market risk (d) Systematic income risk (e) Unsystematic income risk	(1a) 0.33*** (7.24) (1b) 0.15*** (3.17) (1c) 0.11** (2.04) (1d) -0.02 (-0.46) (1e) 0.05 (1.04) (2a) 0.40*** (9.09) (2b) 0.17*** (3.56) (2c) 0.23*** (4.64) (2d) 0.05 (1.06) (2e) 0.19*** (3.89)	
McKnight and Tomkins (2004)	228 U.K. publicly held firms, 1992-97	CEO (1) salary, (2) bonus, (3) salary and bonus, (4) share options and (5) total pay	Shareholder return	(1) 0.02 [0.75] (2) 0.21***[3.4] (3) 0.03 [0.66] (4) 5.9**** [13.2] (5) -0.19 [-1.6]	Models also include slope dummies of CEO tenure and age
Gregg et al. (2005)	415 FTSE 350 companies, 1994-2002	(1) Total board cash compensation (2) Highest paid director cash	Total shareholder retur	(1) 0.0686** (0.0167) (2) 0.068** (0.0180)	Different measures of returns included: market adjusted return and

Study	Data	Compensation measure	Performance measure	Estimated coefficient (s.e.) [t's]	Remarks
		compensation			industry adjusted return
Ozkan (2006)	414 large U.K. companies for fiscal year 2003/2004.	(1) CEO cash compensation. (2) CEO equity-based compensation (3) CEO total compensation	(a) Stock return (b) Tobin's Q	(1a) 31.393 [0.85] (1b) 41.881* [1.64] (2a) -27.436 [-0.44] (2b) 38.755 [1.25] (3a) 30.853 [0.50] (3b) 75.771* [1.64]	Corporate governance mechanisms included Outcome ambiguous
Girma et al. (2007)	992 companies, 1981-96	CEO pay growth	(1) Profit growth (pre-Cadbury) (2) profit growth (post-Cadbury)	(1) 0.001* [2.30] (2) 0.001* [2.19]	Aiming to test the effects of Cadbury report Outcomes ambiguous
Ozkan (2007)	390 U.K. non-financial firms, 1999-2005	(1) CEO's cash compensation (2) CEO's total compensation	(a) Shareholder return (b) Tobin's Q	(1a) 0.077* (1.90) (1b) -0.0002 (-0.04) (2a) 0.080 (1.31) (2b) 0.027 (1.08)	GMM estimation method applied

5.3. Methodology

Panel data sets combine time series and cross sections. They are commonly used in economics because they contain a rich source of information about the economy. Panel data estimation allows us to exploit time series variation in the directors' remuneration, corporate performance, and other relevant variables. It controls for unobserved time-invariant firm-specific effects in order to eliminate a potential source of omitted variable bias.

5.3.1. Fixed Effects with White Diagonal

The panel model with period and cross-section specific effects can be written as:

$$y_{it} = \mu + \alpha_i + \gamma_t + \beta' X_{it} + \varepsilon_{it}$$

The White cross-section methodology is used to derive the robust covariances. It treats the pool regression as a multivariate regression, where there is an equation for each cross-section. It then calculates White-type robust standard errors for the system of equations. The coefficient covariance estimator can be written as:

$$\left(\frac{N^*}{N^* - K^*}\right)\left(\sum_t X_t' X_t\right)^{-1}\left(\sum_t X_t' \hat{\varepsilon}_t \hat{\varepsilon}_t' X_t\right)\left(\sum_t X_t' X_t\right)^{-1}$$

Where the leading term is a degrees of freedom adjustment depending on the total number of observations in the stacked data, *N** is the total number of stacked observations, and *K** is the total number of estimated parameters.

This estimator is robust to cross-section (contemporaneous) correlation as well as different error variances in each cross-section. Specifically, the unconditional contemporaneous variance matrix $E(\varepsilon_t \varepsilon_t') = \Omega_M$ is unrestricted and the conditional variance matrix $E(\varepsilon_t \varepsilon_t' | X_t^*)$ can depend on X_t^* in arbitrary, unknown fashion (Wooldridge 2002). By applying this method it is possible to control for the problem of cross-section correlation, which might appear under panel constructions.

Alternatively, the White period method is robust to arbitrary serial correlation and time-varying variances in the disturbances. The coefficient covariances are calculated using:

$$\left(\frac{N^*}{N^*-K^*}\right)\left(\sum_i X_i' X_i\right)^{-1}\left(\sum_i X_i'\hat{\varepsilon}_i\hat{\varepsilon}_i' X_i\right)\left(\sum_i X_i' X_i\right)^{-1}$$

where the summations are taken over individual s and individual stacked data instead of periods.

The White period robust coefficient variance estimator is designed to accommodate arbitrary serial correlation and time varying variances in the disturbances. The corresponding multivariate regression (with an equation for each period) allows the unconditional variance matrix $E(\varepsilon_i\varepsilon_i') = \Omega_T$ to be unrestricted, and the conditional variance matrix $E(\varepsilon_i\varepsilon_i' | X_i^*)$ may depend on X_i^* in general fashion.

In contrast, the White (diagonal) method is robust to observation specific heteroskedasticity in the disturbances but it is not robust to the correlation between residuals for different observations. The coefficient asymptotic variance is estimated as:

$$\left(\frac{N^*}{N^*-K^*}\right)\left(\sum_{i,t} X_{it}' X_{it}\right)^{-1}\left(\sum_{i,t} X_{it}'\hat{\varepsilon}_{it}\hat{\varepsilon}_{it}' X_{it}\right)\left(\sum_{i,t} X_{it}' X_{it}\right)^{-1}$$

This method allows the unconditional variance matrix $E(\varepsilon\varepsilon') = \Lambda$ to be unrestricted diagonal matrix, and the conditional variances $E(\varepsilon_{it}^2 | X_i^*)$to depend on X_i^* in general fashion. Note that this method is both more general and more restrictive than the previous approaches. It is more general in that observations in the same cross-section or period may have different variances, it is more restrictive in that off-diagonal variances are restricted to be zero.

5.3.2. Fixed Effects with Cross-section SUR

The structure allows for condition between the contemporaneous residuals for cross-section *i* and *j*, but it restricts residuals in different periods to be uncorrelated. More specifically, it assumes that:

$$E(\varepsilon_{it}\varepsilon_{jt} | X_t^*) = \sigma_{ij}$$

$$E(\varepsilon_{is}\varepsilon_{jt} | X_t^*) = 0$$

For all *i, j,s* and *t* with $s \neq t$. Note that the contemporaneous covariances do not vary over *t*.

Using the period specific residual vectors, we may rewrite this assumption as:

$$E\left(\varepsilon_t \varepsilon_t' \middle| X_t *\right) = \Omega_M$$

For all *t*, where:

$$\Omega_M = \begin{pmatrix} \sigma_{11} & \sigma_{12} & \cdots & \sigma_{1M} \\ \sigma_{12} & \sigma_{22} & & \vdots \\ & & \ddots & \\ \sigma_{M1} & \cdots & & \sigma_{MM} \end{pmatrix}$$

This is termed as a Cross-section SUR specification since it involves covariances across cross-sections as in a seemingly unrelated regressions type framework, where each equation corresponds to a cross-section.

Cross-section SUR weighted least squares on this specification (sometimes referred to as the Parks estimator) is simply the feasible GLS estimator for systems where the residuals are both cross-sectionally heteroskedastic and contemporaneously correlated. Residuals are employed from first stage estimates to form an estimate of Ω_M, and then in the second stage feasible GLS is performed.

However, there are potential pitfalls associated with the SUR/Parks estimation (Beck and Katz 1995). For instance, if we have a cross-section SUR specification with a large number of cross-sections and a small number of time periods then it is quite likely that the estimated residual correlation matrix will be non-singular so that feasible GLS is not possible.

By applying panel estimation with Cross-section SUR, we could also control for heteroskedasticity and contemporaneously correlation in our equation estimations.

5.4. Data and Variables

5.4.1. Sample

Two main data sources have been used in the analysis: the Thomson One Banker and FAME (Financial Analysis Made Easy). The sample consists of an unbalanced panel of 350 U.K. companies from both financial and non-financial sectors that constitute List of the FTSE 350 stock index over the period 2004 to 2009. We include data not only of the CEO compensation but also the remuneration of highest paid director as well as the whole board in the company for the sample period. The CEO compensation data include base salary, bonus and the other compensation, which covers other annual compensation and long term compensation, such as: Restricted Stock, Stock Options & Rights Grant, Long-Term Incentive Plans (LTIPs). Share options are also included in other compensation. Only those companies with consecutive CEO compensation data for no less than three years between 2004 and 2009 are included in our sample. In addition, this study requires that data for explanatory variables in the model (such as board size, price volatility and financial leverage) should also be available. Since the compensation for the highest paid director may not always coincide with that for the CEO in a company (Girma et al. 2007), we will adopt both and if required can treat one as the check of robustness for the other.

5.4.2. Compensation Variables

The CEO compensation includes annual base salaries, bonus, and other cash and long term compensation that is paid by the firm to the officer on a long term basis. This includes the values of restricted stock, stock options and rights grand, long-term incentive plans (LTIPs) and all other compensation. Compared to the CEO pay in the U.S., the share option grants plays a much less important role in the total compensation package of a typical British CEO (10% in the U.K. vs. 42% in the U.S. in 1997). Meanwhile, the CEOs in the U.S. own much larger fractions of their firm’s stock (0.29% in 1997) than do CEOs in the U.K. (0.05% in 1997) (Conyon and Murphy 2000). Coyon and Murphy (2000) also show that although the cash compensation has been growing at about the same rate since mid-1990s, the prevalence of option plans has been increasing in the U.S. while it has been decreasing in the U.K. Thus, in this analysis, we only focus on the CEO cash compensation (salary and bonus), and the total compensation and total remuneration only for the highest paid director and the whole board of directors.

Table 5-1 in Appendix I provides the statistics of the pay variables including mean, median, and standard deviation, respectively, for the whole sample period. It can be observed that the mean of all the variables are greater than the corresponding median, implying that the pay variables are right skewed, which is consistent to the results of the previous studies (e.g. Gregg et al.(2005)). This happens mainly because some firms pay their directors extraordinarily high salaries. Also, such large values of standard deviations suggest the considerable differences of compensation across firms over the sample period, 2004 to 2009.

Figure 5-1: Mean of CEO pay

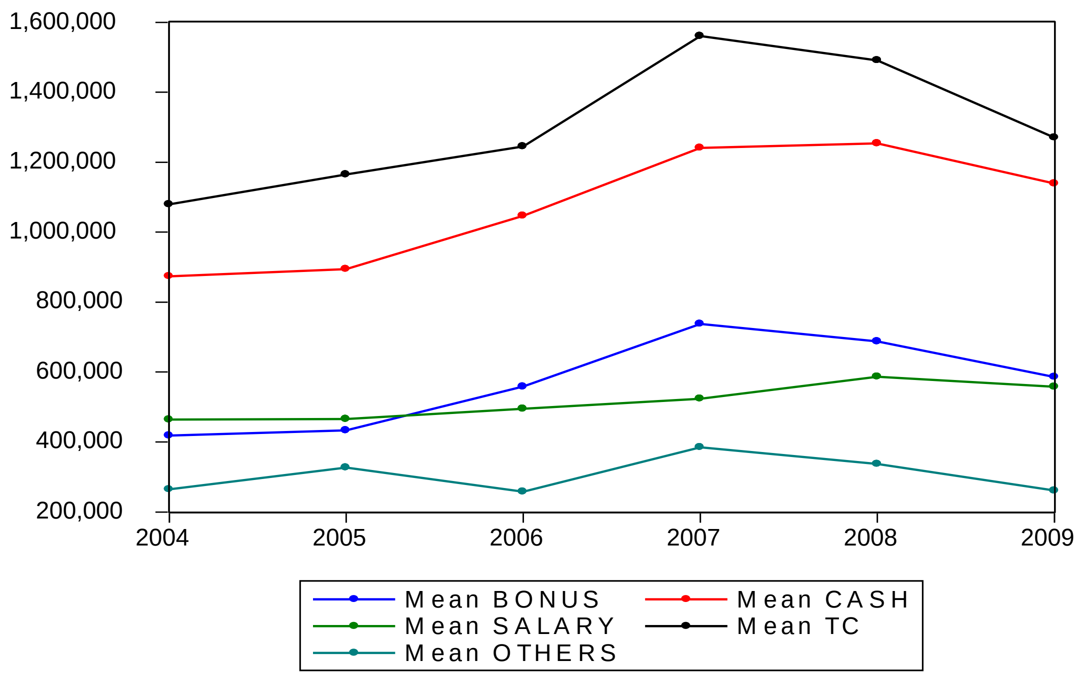
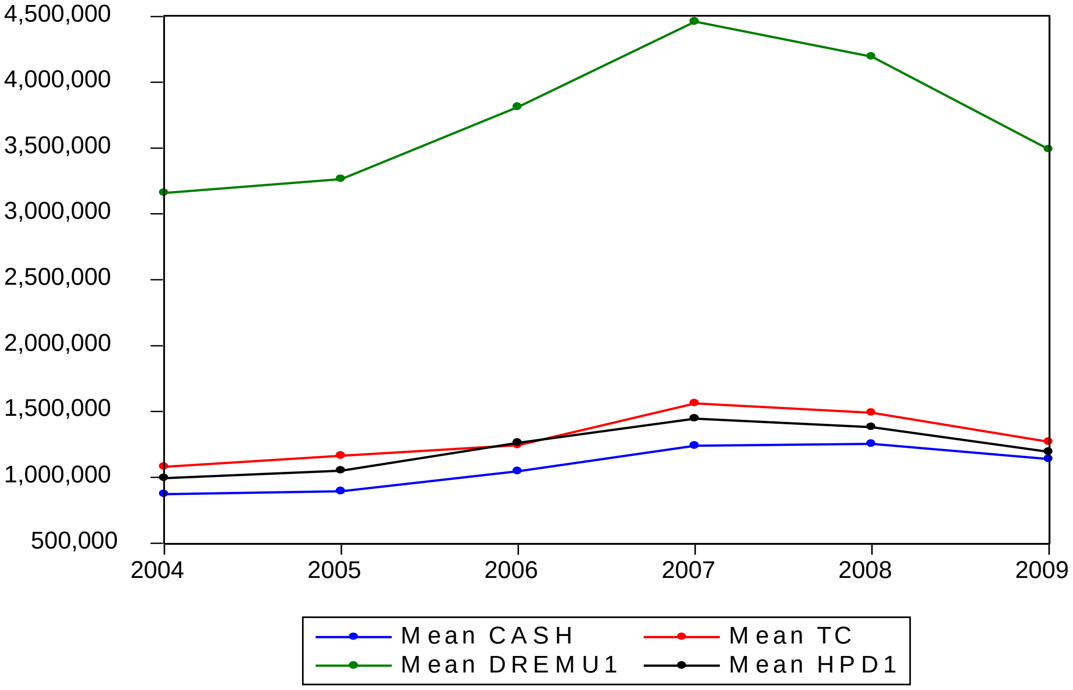
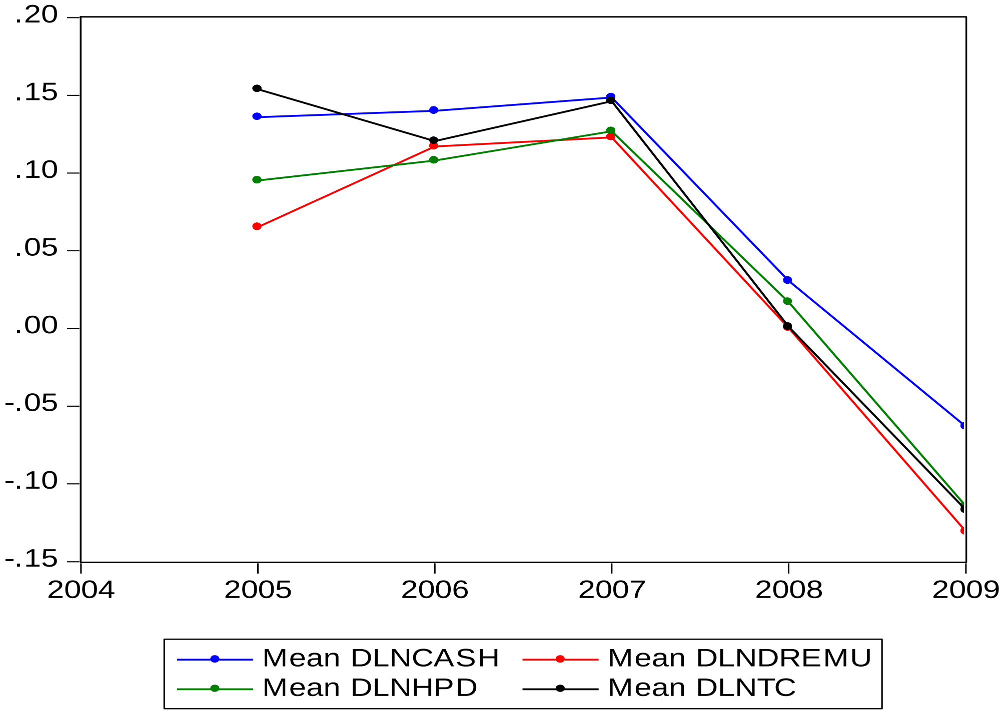


Figure 5-2: Mean and percentage change of the directors' pay





Figures 5-1 and the first part of Figure 5-2 plot the changes in the mean values of CEO pay, the pay for highest paid director, and the total board remuneration over the sample period, 2004-2009. The second part of Figure 5-2 plots the mean of the percentage change in the corresponding pay for CEO, highest paid director and the total board, respectively. It is clear that although all of the pay-offs have a similar trend of general increase during the whole period, they all peak at 2007 (which is the year that financial crisis arrived) before falling afterwards. For instance, CEO total compensation rises overall by approximately 16%; however, in the years immediately before the financial crisis it increased by 44% (i.e. from 2004 to 2007). The CEO cash compensation peaked in 2008, the lag of adjustment might have caused this because the CEO base pay is usually predetermined. In addition, the movements of CEO pay and the pay for highest paid director are different, which is consistent with the claim in the previous literature that the CEO and highest paid director may not always be the same person in a firm.

5.4.3. Performance and Other Control Variables

5.4.3.1. Firm Performance

One of the most widely used measures of the corporate performance is the Return on the Total Assets (ROA), which is equal to the ratio of profit (loss) to the value of total assets. Some alternative accounting measures of performance are used in the U.K. research literature, such as: Return On Shareholders Funds (ROSF), Return On Capital Employed (ROCE), and Earnings Per Share (EPS). However, little evidence of relative performance evaluation has been found (Gregg et al. 2005). Total stock returns can be treated as one proxy for corporate performance, but it will be appropriate for all-equity firms (Mehran 1995). Meanwhile, Tobin’s q, which has also been used in the literature, is argued to be a better proxy for the growth opportunity of a firm. In our analysis in this study we will adopt ROA as one of the measures of the firm performance because accounting returns are highly important in determining executive compensation; for example, Antle and Smith (1986), Jensen and Murphy(1990), Mehran (1995). In addition to the ROA this study will also use another measure of return, which is calculated using the methodology of principal component analysis. Although different measurements of returns are argued to have their own shortcomings, they are still highly correlated with each other (Mehran 1995). It is, therefore, important to use the principal components of returns to analyse the relationship between pay and performance because it captures the variations in alternative measures of returns into account simultaneously.

Figure 5-3: Firm performance

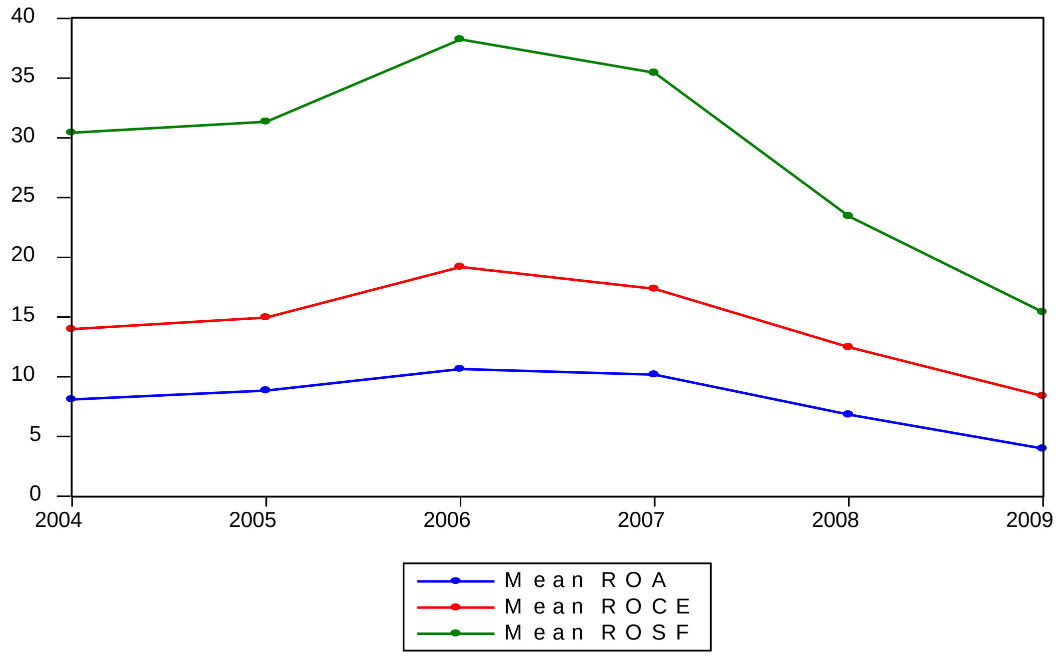


Figure 5-3 shows the different measures of returns which are commonly used as a proxy for firm performance. It can be seen from this illustration that the economy boomed till 2006 to 2007, and the returns reached their highest level in 2006. Following the financial crisis the economy crashed and the returns of the FTSE 350 companies went down dramatically. By 2009 the levels were below those of 2004. Meanwhile, it is also noticeable that all of the measures of returns are highly correlated, hence, ROA is used as one proxy for firm performance following the previous studies. In addition, the principal components of these returns are adopted as an additional measure of firm performance in our analysis. The first principal component captures the main trend and explains more than 76% of the variation in these three returns (i.e. ROA, ROCE and ROSF). The methodology of principal component has not yet been applied in the analysis of executive compensation and firm performance, and it can be seen as one of the refinements of this current study. By using the principal component, as well as ROA, this study is able to check the robustness of the pay-performance relationship.

5.4.3.2. Control Variables

The control variables in this analysis include firm size, financial leverage, stock price volatility, and the board size. In this current study firm size is measured by the sales of the company, which is consistent with the most of the prior studies. In the literature firm size is found to be one of the most important determinants in constructing the directors' compensation. There are also several studies which use market capitalisation as an alternative proxy for firm size; however, the problem is that it will be correlated with the shareholders return (Gregg et al. 2005). Accordingly, the previous research has shown a tendency of a negative relationship between firm size and performance. Table 5-2 in Appendix I shows the different measures of firm size that have been used in previous studies. In this current study sales is chosen to be the proxy for firm size because it is highly skewed with considerably large range, which eliminate the firm size bias.

Other control variables used in this chapter are financial leverage (which is equal to the ratio of company debts over total assets) and stock price volatility (which is a stock's average annual price movement to a high and low from a mean price for each year). The board size is taken into consideration because the numbers of directors on the board are different among firms and it may influence not only the remuneration of the whole board but also the compensation of the executives. Intuitively, the total board will increase as more directors are hired simply because there are more people to pay on the board. Also, more directors on the board implies the company is larger in size and more complex in structure; hence, it may need more capable directors and it will, consequently, have to pay them more. However, it is hard to predict the influence of board size on the compensation of the CEO and the highest paid director. On one hand, as mentioned above, the larger the board size is then the larger and more complicated the firm will be, and this will need a more highly paid CEO or highest paid director because they will have to take more responsibility and make more effort to run the company. According to Core et al. (1999), CEOs get higher cash and total remuneration when the board is relatively larger. On the other hand, the Cadbury (1992) report recommended that the power has to be distributed among executives, hence, larger board sizes indicates more directors to share the roles and the CEO or the highest paid director will have less to do and will consequently receive lower compensation. The Greenbury (1995) and Hampel (1998) reports also emphasised the monitoring role of the board.

5.4.3.3. Industry Structure

In order to control for the difference among industries, this study follow the example of Conyon and Murphy (2000) and adopt four groups of industries: mining and manufacturers, utilities, financial services and others. There are other criteria that have been used to sort industries; for instance, the FTSE actuarial industry groups and industry groups following SIC code (Gibbons and Murphy 1992). However, these categories include too many industry groups and this results in relatively fewer observations in each group, which will weaken the power of interpretation for different groups.

Besides the industry dummies, this study takes into account other criteria and asks questions such as: What is the difference of the directors' compensation determination between those firms listed on the FTSE 100 and those who are not? What are the consequences if these firms have different dividend payout policies?

5.5. Modelling Framework

5.5.1. Compensation

Usually, the relationship between directors' compensation and corporate performance is estimated with a relatively simple reduced form equation rather than principal-agent model (Conyon 1995). The model used to analyse the pay-performance relationship follows Murphy's (1999) baseline model. However, our model is dynamic, different from Murphy's by including the compensation level in the previous period to control the consistency, and it also adopts fixed effects panel estimation controlling for both period- and cross-sectional-specific effects, more specifically:

(5.5.1)

$$\ln(Compensation)_{it} = \delta \ln(Compensation)_{it-1} + \beta(Performance)_{it} + \lambda(Controls)_{it} + \alpha_i + \gamma_t + \varepsilon_{it}$$

The CEO cash and total compensation pay for the highest paid director and the total board are examined, respectively. α_i captures the firm specific effect that varies across different firms and which is constant across time, such as a firm's specific technical structure or organizational culture. γ_t refers to a time trend which is invariant across different firms; for instance, the macroeconomic shocks which are common to all firms. ε_{it} is the error term.

Two measurements of firm performance are implied: the first is Return On Assets (ROA), which is widely used in previous studies; the second is the Principal Component (PC) of different measures of returns. This is another of the contributions of this study because none of the previous research, so far as we are aware, has used PC of returns as a proxy of a firm's return and by using it this study is able to avoid the arbitrary decision of focusing on just one single measure of corporate returns. Additionally, it is possible to check the robustness of the pay-performance relationship by using these two measurements of corporate returns. Control variables include firm size, board size, financial leverage, stock market risk, and some relative dummies.

Furthermore, the existence of the relationship between pay and performance is tested for the equation in first difference specification, which can be estimated by Equation (5.5.2):

(5.5.2)

$$\Delta \ln(Compensation)_{it} = \delta\Delta \ln(Compensation)_{it-1} + \beta\Delta(Performance)_{it} + \lambda\Delta(Controls)_{it} + \gamma_t + \varepsilon_{it}$$

Where Δ is defined as a first difference operator that $\Delta x_{it} = x_{it} - x_{it-1}$. The first difference equation specification is used here for the first time in research in this area and it is consistent with the counterpart level equation, which implicitly controls for the firm specific effects but which estimates the influence of the growth of the company's performance on the growth of the executives' pay.

It is argued that a fixed effects bias exists in level modelling procedure and that this bias arises from the problem of omitted variables. One important feature of first difference models is that the estimate of β is free from a company fixed effects bias (Murphy 1985). In a more specific example, the managerial talent could be one of the omitted variables because it is hard to measure and interpret. Thus, it is possible that the β estimate in the level equation reflects the effect of managerial talent on pay variable rather than the impact of corporate return. However, if managerial talent is reasonably assumed to be relatively constant over time, then the first difference model could eliminate the bias and make the β estimate reflect performance effect only (Conyon and Sadler 2001).

In this chapter both levels and first differences regressions are performed on CEO cash as a dependent variable as well as on the CEO total compensation, the pay of highest paid director, and the remuneration of the whole board, respectively. In Equation (5.5.1) we include industry-specific effects as well as time-effects, which is consistent with the prior studies. However, for Model (5.5.2) only time-specific effects are included as firm-specific effects are eliminated by taking first differences. Moreover, both specifications allow for persistence in the compensation variable by adding in a lagged dependent variable, thus coefficient δ estimates the degrees of persistence in the compensation variables in levels and first differences equations, respectively, and their significance implies the validity of the implicit restriction of $\delta = 0$ in most of the previous literature.

5.5.2. Firm Performance

Following Mehran (1995), the model for evaluating the impact of the directors' remuneration on corporate performance can be specified as in Equation (5.5.3) below:

(5.5.3) $$(Performance)_{it} = \beta \ln(Compensation)_{it} + \lambda(Controls)_{it} + \alpha_i + \gamma_t + \varepsilon_{it}$$

Two aspects of dependent variable 'performance' are considered in this chapter: the first is the return, which is commonly used as the proxy for corporate performance; the second is the firm's growth opportunity, which can be measured by Tobin's q. All of the compensation items are taken into account for the CEO, the highest paid director, and the total board, respectively.

5.6. Empirical Results

The regression estimates for the relationship between directors' remuneration and firm performance are reported in Table 5-3 to Table 5-22 in Appendix I at the end of this chapter. CEO cash and total compensation, remunerations for highest paid director, and the whole board are estimated separately in both levels and first differences specifications. The regression estimates, which reveal the influence of directors' pay on firm performance, are contained in Table 5-23 in Appendix I. The impacts of compensation on both a firm's performance and its growth opportunities are discussed. In order to check the robustness of the results (eliminating the bias from limited and unbalanced observations) the bootstrapping coefficients are calculated and the corresponding results are reported in Tables 5-24 and Table 5-25 in Appendix I.

5.6.1. Regression Results for Compensation

Table 5-3 shows the regression results for CEO total compensation. Two proxies for firm performance have been introduced to examine its effect on CEO total compensation. The coefficient estimates for both proxies, ROA and PC of returns, are reported in adjacent columns in Table 5-3. One could observe that all the relative coefficients reflecting pay-performance relationship have predicted signs and are statistically significant at a 1% level. Moreover, the method of cross-section SUR is adopted to control for heteroskedasticity and cross-section correlation. The coefficient estimates on the performance terms are still positive and statistically significant. The positive and statistically significant relationship between CEO pay and company performance supports the principal-agent theory, indicating that firms with higher level of returns pay higher compensation to their CEOs.

In addition, one could also find that CEO total pay is positively and significantly related to firm size, which is consistent with the expectation that large companies with more complex structures tend to set up higher compensation to attract more capable and talented CEOs. This result is also consistent with previous studies; for instance, Ozkan (2007) finds the same trend where larger firms pay greater CEO compensation. Moreover, the coefficient estimate for price volatility is negative and significant, suggesting that CEOs get higher pay once they keep the stock prices of their companies more stable. The CEO compensation level moves in the opposite direction to financial leverage, which is measured as the company's total debts to total assets ratio. The coefficient estimate for financial leverage is also negative and significant, which indicates that the higher the percentage of debts in total assets are then the lower the CEO will be paid in their total compensation package because a higher leverage exposes a firm to greater risk. However, the number of directors on the board does not have a significant effect on CEO total compensation according to the regression results of the corresponding insignificant coefficient estimates. However, analytically the effect of board size on CEO pay is conflicting. On the one hand, to have a larger board means that the firm either has a relatively more complex structure or is simply larger in size. Intuitively, the CEOs in these firms need to take more responsibility and make more effort, hence, they should get higher pay. Ozkan (2007) finds a positive and significant relationship between CEO total compensation and board size. However, on the other hand, a large board has more directors to share the power and responsibilities, especially after the publication of the Cadbury (1992) report which recommended power sharing among the executives. Thus, CEOs in firms with a larger board will possibly take fewer jobs and, therefore, get fewer emoluments. Hence, it is difficult to say if there is a clear relationship between CEO pay and board size. Our findings are consistent with Gregg et al. (2005), who also reports an insignificant effect of the size of board on executive compensation.

The econometric results for CEO compensation in first differences are contained in Table 5-4. It can be observed from this that (through equation estimation of the first differences specification model for CEO total compensation) there is a positive and statistically significant relationship between changes in CEO total compensation and firm performance. This implies that the growth of a firm's return (both ROA and PC of returns) significantly improves the CEO's pay rise.

Meanwhile, the change of stock price volatility has been found to have a significant but negative effect on the change of CEO total compensation. Likewise, the change of financial leverage has a negative and significant effect on the change of CEO total compensation, while taking ROA as a proxy for performance; however, the coefficient estimates are negative but statistically insignificant with PC of returns acting as the measurement of corporate performance. Additionally, the change of CEO total compensation in the previous period significantly decreases the change of CEO total pay in the current period. Weak links are also found between CEO total pay change and the changes of both firm and board sizes, which is reasonable because one could reckon that the board size, for example, is relatively stable over time.

Slope dummies are applied in the CEO total compensation analysis and Table 5-5 in Appendix I provides the results of this. Following Conyon and Murphy (2000), these FTSE 350 companies can be split into four industry groups: mining and manufacturers, utilities, financial services and others. The coefficient estimates for the cross terms of ROA multiplied by industry dummies for different industries indicate the different impacts of corporate performance on CEO total pay between the selected industry and the other industries. Thus, the first four columns show the different relationships between CEO total compensation and ROA among firms in different industries. It can be observed that the coefficient estimates for the slope dummies for industries of mining and manufacturers and utilities are statistically significant but negative, while that for financial services industry is significant and positive. This demonstrates that, for instance, when compared to the other industries the ROA has a slightly smaller effect on the CEO compensation of the mining and manufacturers industrial sector. Companies in the financial industry have the strongest link between CEO total compensation and corporate performance.

The fifth column in Table 5-5 provides the difference in pay-performance relationship between companies in the FTSE 100 index and the FTSE 350. This demonstrates that the effects of ROA on CEO total compensation is much weaker for FTSE 100 firms than that for companies in the FTSE 350, and the difference is statistically significant. In addition, the coefficient estimate for the slope dummy of the dividend payout ratio is reported in the last column. The dividend payout ratio provides an idea of how well the earnings support the dividend payments. More mature companies tend to have a higher payout ratio. Accordingly, the statistically significant but negative coefficient estimate for the dividend payout dummy demonstrates that those firms with a higher payout ratio have a weaker link between CEO total pay and performance. The regression results for the first difference specification are similar and reported in Table 5-6 in Appendix I.

The regression results for CEO cash compensation (defined as the sum of base salary and annual bonus) are reported in Tables 5-7 to Table 5-10 in Appendix I. These results are similar to those for CEO total pay except for some small differences. One of these small differences is that there is a statistically significant but negative impact of board size on CEO cash compensation with cross-section SUR controlling heteroskedasticity and cross-section correlation. This indicates that firms with more directors on the board tend to pay their CEO less. One possible interpretation of this result is that firms with a larger board have more directors to take care of their business and to monitor their CEOs.

According to results provided in Table 5-9, the differences in pay-performance relationship for CEO cash compensation among industries are not as great as those for CEO total pay. In addition, there is no significant difference in the relationship between CEO cash compensation and a firm’s performance, either between companies within the FTSE 100 and those elsewhere or between firms with high and low dividend payout ratios. Meanwhile, the CEO cash compensation in the previous period has little influence on that in the current period in both level and change specifications, while the corresponding coefficient estimate is significant only in the first difference specification for CEO total compensation.

In addition to the examination of the link of CEO pay and firm performance, the same pay-performance analyses are implemented for both highest paid directors and the whole board. It is discussed in the literature that the CEO and highest paid director is not always the same person in the company (e.g. the chairman of board can sometimes be the highest paid director). It is reasonable, therefore, to also examine the pay-performance relationship for the highest paid director and, to some extent, it can be treated as one alternative and used to check the robustness of CEO pay-performance relationship.

The results in Tables 5-11 to 5-14 in Appendix I show a very similar pattern for the highest paid director with those for CEO, with only a few differences which appear for control variables and slope dummies. In comparison to the CEO regression results, financial leverage plays a more important role in determining the remuneration package for highest paid director. The estimated coefficients for financial leverage in both levels and first differences regressions are negative and significant. As to slope dummies, for the ROA associated with FTSE 100 dummy and dividend payout dummy are statistically insignificant, showing that there is little difference in pay-performance relationship for the highest paid director between firms in FTSE 100 index and FTSE 250. It also shows that a firm’s dividend payout policy does not have significant impact on relationship between pay for highest paid director and corporate performance.

As for the total board remuneration, according to the results presented in Tables 5-15 to 5-18 in Appendix I board size becomes a crucial determinant of total board pay. The coefficient estimates for board size in either level or first difference specification is positive and significant, which suggests intuitively that firms with more directors have higher remunerations for the whole board because there are more directors who need to be paid. However, when compared to individual compensation package, the financial leverage does not have a significant influence on the total board remuneration and the dividend policy has a weak impact on the pay-performance relationship for the whole board.

Furthermore, Figure 5-1 describes the tendency of CEO compensation packages and, accordingly, all of the components of the CEO's pay to peak at year 2007. The exception to this is the CEO's base salary which has been set up in advance and which is supposed to be more stationary. This tendency can also be observed in Figure 5-2 for the remunerations of highest paid director and the whole board. This is consistent with the current economic environment: the current financial crisis erupted in mid-2007 and from then on most Western economies have dropped dramatically, and the social and political environment in many Western countries has started to fall apart following the crash. Hence, a further contribution of this chapter is to examine the effects that the financial crisis has had on the pay determination process among the largest companies in the U.K. Tables 5-19 to 5-22 in Appendix I report the regression results of the pay-performance relationship both before and after the financial crisis for CEO total and cash compensation, remuneration for the highest paid director, and for the whole board, respectively.

All in all, it can be seen that stock price volatility has become the only significant factor in these compensation determinations in the past two years after the financial crisis erupted. Little evidence of a link between compensation and firm performance could be found afterwards.

5.6.2. Regression Results for Firm Performance

Agency theory suggests that the principal chooses the directors' compensation based on the firm performance. In this section, some performance analyses are provided to reveal the efficacy of these predictions. Panels A and B of Table 5-23 in Appendix I provide the results of regressing firm performance and growth opportunity on the CEO's total and cash compensation as well as on the remuneration for highest paid director and whole board, respectively. ROA is used as a proxy for firm performance in Panel A, while Tobin's q is treated as a measurement for growth opportunity in Panel B, and both are shown to be consistent with previous literature.

Estimation in Panel A uses total assets as a proxy for firm size instead of sales because the return is calculated based on the value of sales. The coefficients for compensation variables are all positive and statistically significant in both panels, except for CEO cash compensation in Panel B. These results indicate that those companies whose compensations for CEO, highest paid director, and the whole board are relatively high tend to produce higher returns for shareholders and have more pleasant growth opportunities than those in which the relative compensations are low. For example, the coefficient for CEO total compensation in Panel A is 3.7128, which implies that the elasticity of ROA with respect to CEO total compensation is 0.4404 with the mean value of ROA equal to 8.4304. In another example, when the mean of Tobin's q is equal to 1.7867 the elasticity of firm's growth opportunity with respect to CEO total compensation is 0.0379.

In addition, most of the coefficients for the control variables in both panels are significant, suggesting that firm size, stock price volatility, and financial leverage all have an important influence on that firm's returns and growth opportunities. For instance, the coefficient for price volatility in Panel A is -29.3405, thus the point elasticity at the mean value of ROA with respect to price volatility is -1.0177.

5.6.3. Bootstrapping Results

Bootstrapping is a statistical method of resampling from an approximating distribution. Here, the bootstrapping method is applied to a standard approximating distribution, the empirical distribution of observed data. It constructs a number of resamples of observed dataset random sampling from the original dataset. Bootstrapping is a simple and straightforward method. It allows one to calculate a single statistic from one sample and then resample to gather lots of alternative versions of that statistic. Ader et al. (2008) recommend that it is possible to use the bootstrapping procedure for a situation where the sample size is insufficient for straightforward statistical inference.

In doing the compensation analysis in this study the focus has been upon the relationship between directors' pay and firm performance among U.K. large companies. However, it is not possible to get relative information for all U.K. companies, so only FTSE 350 listed companies are included in the sample. In addition, because of the lack of information the sample is an unbalanced panel dataset. From this small sample, only one estimated parameter is yielded: implying the relationship between pay and corporate performance. Thus, in order to understand how much this relationship varies the bootstrapping methodology is applied to randomly extract new samples 1,000 times to create a large number of datasets. The estimated parameter is then computed for each of these datasets. The bootstrapping results are reported in Tables 5-24 and 5-25 at the end of Appendix I, revealing the distributions of the corresponding parameter estimates.

The Monte Carlo algorithm for case resampling is applied here to yield distributions of estimated β s. This can also be seen as a robustness check for the original coefficient estimates. Table 5-24 provides the intervals of estimated β s for Model 5.5.1, which examined the effect of firm performance on different compensation measures. Table 5-25 reveals the robustness of the impact of compensation variables on a firm's return and growth opportunities. From these results it can easily be observed that the interval estimate for each β is narrow, with the original estimate being very close to the mean. Hence, one can conclude that the original estimates for pay-performance relationship are effective and robust.

5.7. Conclusion

According to Agency Theory, conflicts of interest exist between the principal (i.e. the shareholders) and the agent (i.e. the managers, especially the executive directors). The directors' remuneration packages play an important role in corporations in aligning the interests of directors to those of shareholders. Compensation packages have been recognised to act as a crucial mechanism to attract, motivate, and monitor top managers. Thus, the relationship between the directors' remuneration and corporate performance has attracted lots of public and academic attention. It is, therefore, important to understand how firms determine the directors' remuneration packages. This current empirical chpater explores the link between directors' remuneration and firm performance using a panel data set of companies taken from FTSE 350 index for the period 2004 to 2009, and it provides some evidence in addition to the previous literature.

In contrast to the previous studies which have analysed either the CEO compensation packages or the remuneration for highest paid directors, in this chapter we have introduced dynamic compensation models in order to evaluate the remuneration packages for the CEO, the highest paid director, and the whole board. The empirical results indicate that there is a positive and significant relationship between corporate performance and the directors' pay for CEO cash compensation, CEO total compensation, remuneration for highest paid director as well as the remuneration of the total board. The regression in first differences has also been examined to understand the pay-performance relationship in changes, which is for the first time in research in this area. The corresponding estimation results for first order difference specification are consistent with those of the level equation estimation. These findings suggest that the recommendations in the U.K. corporate governance reports (i.e. Cadbury (1992), Greenbury (1995), Hampel (1998) and Higgs (2003)) which advise linking the directors' remuneration more closely to firm performance have been effective in practice for both executives and the whole board. It is also found that larger firms pay their directors relatively higher remuneration, which supports the idea that larger firms need higher quality directors, especially more talented executive directors, and are willing to offer higher compensation to attract them. The sample is split into pre- and post-crisis subsamples over 2004 to 2007 and 2008 to 2009, respectively, in order to examine the impact of the recent financial crisis on the relationship between the directors' pay and firm performance. It can be seen as another major contribtuion in this chapter. Our results suggest that the link of pay-performance has been broken down since the financial crisis erupted. In addition, firms in different industries are observed to behave differently in pay-performance relationship, while the board size does not have a significant impact on the relationship between pay and performance for CEOs and highest paid directors in large UK firms. However, since there are only two-year data included for post-crisis analysis and the compensation might need time to adjust, it is not easy to make solid conclusion with limited informantion in such a short period since this financial crisis erupted.

Moreover, the influence of directors' pay on corporate performance is also evaluated. The results show the existence of a positive and significant impact of directors' pay on firm returns and growth opportunities, which practically demonstrates the importance of the decision making in setting directors' compensation packages. In addition, the bootstrap results suggest that the positive and significant relationship between the directors' remuneration and firm performance is robust through both directions.

Appendix I

Table 5-1: Descriptive Statistics of Pay Variables

Variable	No. of Obs	Mean	Std. Dev.	Median
CEO Salary	986	509236.4	250257.9	450000.0
CEO Bonus	986	597987.8	811924.1	377000.0
CEO Others	986	239592.4	709336.7	65546.50
CEO Total Compensation	986	1346946.	1286865.	958500.0
Total Compensation for Highest Paid Director (th)	1216	1225.667	1151.485	919.0000
Director's Remuneration (th)	1243	3755.738	3540.999	2682.000

Table 5-2: Descriptive Statistics of Firm Size

Firm Size Variables				
Variable	**No. of Obs**	**Mean**	**Std. Dev.**	**Median**
Market Capitalisation (mil)	1288	4939.922	13632.49	1111.000
Sales (th)	1432	3755913.	12049384	856800.0
Total Assets (th)	1332	18633484	110000000	1365550.
Turnover (th)	1259	3874684.	13019020	953900.0

Table 5-3: Dependent variable is ln(CEO Total Compensation)

	Fixed Effects OLS		**Fixed Effects W. D.**		**Fixed Effects Cross-section SUR (PCSE)**	
ln(sales)	0.1500**	0.1452**	0.1500**	0.1452**	0.1500***	0.1452***
	(0.0667)	(0.0691)	(0.0633)	(0.0671)	(0.0445)	(0.0512)
ROA	0.0079***		0.0079***		0.0079***	
	(0.0021)		(0.0022)		(0.0011)	
Return		0.0704***		0.0704***		0.0704***
		(0.0192)		(0.0174)		(0.0095)
Board size	-0.0052	-0.0065	-0.0052	-0.0065	-0.0052	-0.0065
	(0.0106)	(0.0111)	(0.0087)	(0.0091)	(0.0061)	(0.0060)
lag total compensation	0.0886*	0.0890*	0.0886	0.0890	0.0886	0.0890
	(0.0502)	(0.0518)	(0.0995)	(0.1036)	(0.1921)	(0.1915)
Price Volatility	-1.4739***	-1.4483***	-1.4739***	-1.4483***	-1.4739**	-1.4483**
	(0.5000)	(0.5208)	(0.4608)	(0.4787)	(0.6225)	(0.6394)
Financial Leverage	-0.4519***	-0.4104*	-0.4519***	-0.4104*	-0.4519***	-0.4104
	(0.1743)	(0.2260)	(0.1541)	(0.2113)	(0.1714)	(0.2591)
constant	11.2854***	11.3866***	11.2854***	11.3866***	11.2854***	11.3866***
	(1.0757)	(1.1074)	(1.4095)	(1.4692)	(2.4343)	(2.4522)
Cross-section Effects	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Time Effects	[0.0011]	[0.0007]	[0.0011]	[0.0007]	[0.0011]	[0.0007]
Adjusted-R^2	79.21%	79.05%	79.21%	79.05%	79.21%	79.05%
S.E.	0.3074	0.3113	0.3074	0.3113	0.3074	0.3113
N	211	210	211	210	211	210
T	5	5	5	5	5	5

Standard errors in parenthesis; * significant at 10%; ** significant at 5%; * significant at 1%**

Table 5-4: Dependent variable is Dln(CEO Total Compensation)

	Fixed Effects OLS		Fixed Effects W. D.		Fixed Effects Cross-section SUR (PCSE)	
Dln(sales)	0.1392*	0.1307	0.1392*	0.1307	0.1392	0.1307
	(0.0766)	(0.0807)	(0.1029)	(0.1144)	(0.0848)	(0.0927)
DROA	0.0080***		0.0080**		0.0080***	
	(0.0022)		(0.0032)		(0.0026)	
DReturn		0.0735***		0.0735***		0.0735***
		(0.0201)		(0.0264)		(0.0221)
D(Board size)	-0.0063	-0.0057	-0.0063	-0.0057	-0.0063	-0.0057
	(0.0105)	(0.0111)	(0.0095)	(0.0100)	(0.0105)	(0.0112)
D(lag total compensation)	-0.2865***	-0.2871***	-0.2865***	-0.2871***	-0.2865**	-0.2871**
	(0.0499)	(0.0516)	(0.0827)	(0.0856)	(0.1261)	(0.1316)
D(Price Volatility)	-2.4590***	-2.3561***	-2.4590***	-2.3561***	-2.4590***	-2.3561***
	(0.6225)	(0.6472)	(0.7612)	(0.7990)	(0.6632)	(0.6921)
D(Financial Leverage)	-0.3383*	-0.2302	-0.3383	-0.2302	-0.3383*	-0.2302
	(0.1733)	(0.2317)	(0.2085)	(0.2801)	(0.1941)	(0.2966)
constant	0.0927***	0.0941***	0.0927***	0.0941***	0.0927***	0.0941***
	(0.0213)	(0.0226)	(0.0249)	(0.0272)	(0.0265)	(0.0290)
Adjusted-R^2	16.84%	16.18%	16.84%	16.18%	16.84%	16.18%
S.E.	0.3824	0.3869	0.3824	0.3869	0.3824	0.3869
N	191	185	191	185	191	185
T	4	4	4	4	4	4

Standard errors in parenthesis; * significant at 10%; ** significant at 5%; * significant at 1%**

Table 5-5: Dependent variable is ln(CEO Total Compensation)

	Fixed Effects Cross-section SUR (PCSE)					
ln(sales)	0.1585***	0.1488***	0.1797***	0.1495***	0.1390***	0.1472***
	(0.0437)	(0.0486)	(0.0476)	(0.0442)	(0.0436)	(0.0499)
ROA	0.0098***	0.0101***	0.0034***	0.0094***	0.0113***	0.0128***
	(0.0015)	(0.0017)	(0.0013)	(0.0019)	(0.0021)	(0.0028)
Board size	-0.0046	-0.0051	-0.0055	-0.0056	-0.0067	-0.0069
	(0.0061)	(0.0062)	(0.0058)	(0.0061)	(0.0061)	(0.0067)
lag total compensation	0.0819	0.0867	0.0388	0.0865	0.0826	0.0909
	(0.1924)	(0.1894)	(0.1789)	(0.1902)	(0.1907)	(0.1894)
Price Volatility	-1.5354**	-1.3309**	-1.6322***	-1.5041**	-1.4631**	-1.5146**
	(0.6219)	(0.6080)	(0.6177)	(0.6269)	(0.5813)	(0.6125)
Financial Leverage	-0.4656***	-0.4581**	-0.4214**	-0.4384***	-0.4707***	-0.4467**
	(0.1756)	(0.1801)	(0.1666)	(0.1603)	(0.1757)	(0.1969)
ROA*Mining & Manufacturers	-0.0068***					
	(0.0023)					
ROA*Utilities		-0.0124***				
		(0.0031)				
ROA*Financials			0.0291***			
			(0.0075)			
ROA*Others				-0.0038		
				(0.0040)		
ROA*FTSE100					-0.0106***	
					(0.0032)	
ROA*Dividend Payout						-0.0060*
						(0.0035)
Constant	11.2941***	11.2850***	11.6103***	11.3228***	11.5515***	11.3084***
	(2.4264)	(2.3774)	(2.2497)	(2.4137)	(2.4048)	(2.5289)
Adjusted-R^2	79.28%	79.39%	80.53%	79.20%	79.45%	78.55%

Standard errors in paranthesis; * significant at 10%; ** significant at 5%; * significant at 1%**

Table 5-6: Dependent variable is Dln(CEO Total Compensation)

	Fixed Effects Cross-section SUR (PCSE)					
Dln(sales)	0.1497**	0.1369	0.1698**	0.1396*	0.1176	0.1003
	(0.0750)	(0.0846)	(0.0752)	(0.0792)	(0.0794)	(0.0885)
DROA	0.0104***	0.0119***	0.0038*	0.0077***	0.0142***	0.0163***
	(0.0023)	(0.0029)	(0.0020)	(0.0020)	(0.0032)	(0.0044)
D(Board size)	-0.0065	-0.0067	-0.0079	-0.0064	-0.0094	-0.0088
	(0.0072)	(0.0073)	(0.0069)	(0.0073)	(0.0070)	(0.0078)
D(lag total	-0.2901	-0.2850	-0.2936	-0.2867	-0.2866	-0.2811
compensation)	(0.2188)	(0.2160)	(0.1917)	(0.2204)	(0.2143)	(0.2144)
D(Price Volatility)	-2.5533***	-2.2110***	-2.4198***	-2.4516***	-2.2045***	-2.2176**
	(0.8409)	(0.8461)	(0.7658)	(0.8544)	(0.7863)	(0.8987)
D(Financial	-0.3617	-0.3176	-0.2884	-0.3407	-0.3416	-0.2531
Leverage)	(0.2489)	(0.2606)	(0.2383)	(0.2378)	(0.2597)	(0.2635)
DROA*Mining &	-0.0082***					
Manufacturer	(0.0029)					
DROA*Utilities		-0.0126***				
		(0.0037)				
DROA*Financials			0.0425***			
			(0.0119)			
DROA*Others				0.0010		
				(0.0064)		
DROA*FTSE100					-0.0141***	
					(0.0040)	
DROA*Dividend						-0.0120**
Payout						(0.0053)
Constant	0.0906***	0.0979***	0.1002***	0.0927***	0.0977***	0.1109***
	(0.0252)	(0.0256)	(0.0238)	(0.0252)	(0.0245)	(0.0260)
Adjusted-R^2	17.31%	18.00%	24.11%	16.67%	18.76%	19.70%

Standard errors in parenthesis; * significant at 10%; ** significant at 5%; * significant at 1%**

Table 5-7: Dependent variable is ln(CEO Cash Compensation)

	Fixed Effects OLS		**Fixed Effects W. D.**		**Fixed Effects SUR (PCSE)**	**Cross-section**
ln(sales)	0.0832	0.0737	0.0832	0.0737	0.0832**	0.0737*
	(0.0629)	(0.0651)	(0.0540)	(0.0565)	(0.0370)	(0.0385)
ROA	0.0039**		0.0039**		0.0039***	
	(0.0020)		(0.0020)		(0.0010)	
Return		0.0353**		0.0353**		0.0353***
		(0.0177)		(0.0174)		(0.0119)
Board size	-0.0132	-0.0142	-0.0132	-0.0142	-0.0132*	-0.0142*
	(0.0098)	(0.0102)	(0.0084)	(0.0087)	(0.0076)	(0.0082)
lag cash	0.0497	0.0671	0.0497	0.0671	0.0497	0.0671
compensation	(0.0552)	(0.0565)	(0.0876)	(0.0908)	(0.1831)	(0.1828)
Price	-1.7718***	-1.8881***	-1.7718***	-1.8881***	-1.7718***	-1.8881***
Volatility	(0.5063)	(0.5206)	(0.5289)	(0.5516)	(0.6758)	(0.6631)
Financial	-0.2811*	-0.2363	-0.2811**	-0.2363	-0.2811**	-0.2363
Leverage	(0.1442)	(0.1934)	(0.1279)	(0.1813)	(0.1270)	(0.1451)
constant	12.7189***	12.6546***	12.7189***	12.6546***	12.7189***	12.6546***
	(1.0804)	(1.1102)	(1.3744)	(1.4311)	(2.5851)	(2.5820)
Cross-section Effects	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Time Effects	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Adjusted-R^2	84.40%	84.47%	84.40%	84.47%	84.40%	84.47%
S.E.	0.2338	0.2357	0.2338	0.2357	0.2338	0.2357
N	192	189	192	189	192	189
T	5	5	5	5	5	5

Standard errors in parenthesis; * significant at 10%; ** significant at 5%; * significant at 1%**

Table 5-8: Dependent variable is ln(CEO Cash Compensation)

	Fixed Effects OLS		Fixed Effects W. D.		Fixed Effects Cross-section SUR (PCSE)	
Dln(sales)	0.0909	0.0770	0.0909	0.0770	0.0909*	0.0770
	(0.0712)	(0.0751)	(0.0701)	(0.0770)	(0.0549)	(0.0594)
DROA	0.0042**		0.0042		0.0042***	
	(0.0019)		(0.0026)		(0.0015)	
DReturn		0.0470***		0.0470**		0.0470***
		(0.0178)		(0.0232)		(0.0132)
D(Board size)	-0.0119	-0.0128	-0.0119	-0.0128	-0.0119	-0.0128
	(0.0101)	(0.0107)	(0.0088)	(0.0093)	(0.0082)	(0.0090)
D(lag cash	-0.3031***	-0.2981***	-0.3031***	-0.2981***	-0.3031	-0.2981
compensation)	(0.0561)	(0.0581)	(0.0888)	(0.0936)	(0.2083)	(0.2129)
D(Price	-2.9094***	-2.9228***	-2.9094***	-2.9228***	-2.9094***	-2.9228***
Volatility)	(0.6281)	(0.6429)	(0.7612)	(0.7890)	(0.8632)	(0.8949)
D(Financial	-0.3523**	-0.2120	-0.3523***	-0.2120	-0.3523***	-0.2120
Leverage)	(0.1426)	(0.1948)	(0.1348)	(0.2073)	(0.1203)	(0.1553)
constant	0.1108***	0.1150***	0.1108***	0.1150***	0.1108***	0.1150***
	(0.0204)	(0.0215)	(0.0187)	(0.0204)	(0.0282)	(0.0317)
Adjusted-R^2	19.54%	18.11%	19.54%	18.11%	19.54%	18.11%
S.E.	0.2946	0.2967	0.2946	0.2967	0.2946	0.2967
N	155	148	155	148	155	148
T	4	4	4	4	4	4

Standard errors in parenthesis; * significant at 10%; ** significant at 5%; * significant at 1%**

Table 5-9: Dependent variable is ln(CEO Cash Compensation)

	Fixed Effects Cross-section SUR (PCSE)					
ln(sales)	0.0928**	0.0914**	0.0910**	0.0880**	0.0817**	0.0663*
	(0.0358)	(0.0359)	(0.0354)	(0.0356)	(0.0373)	(0.0391)
ROA	0.0019*	0.0063***	0.0030**	0.0058***	0.0058***	0.0075***
	(0.0010)	(0.0015)	(0.0014)	(0.0021)	(0.0016)	(0.0023)
Board size	-0.0128	-0.0128*	-0.0138*	-0.0136*	-0.0138*	-0.0130
	(0.0079)	(0.0077)	(0.0076)	(0.0076)	(0.0075)	(0.0081)
lag cash	0.0606	0.0536	0.0371	0.0441	0.0504	0.0600
compensation	(0.1820)	(0.1803)	(0.1806)	(0.1793)	(0.1822)	(0.1816)
Price Volatility	-1.6907**	-1.6403**	-1.7724**	-1.8005***	-1.7486***	-1.6012**
	(0.6902)	(0.6832)	(0.6865)	(0.6816)	(0.6714)	(0.6798)
Financial	-0.2524*	-0.2841**	-0.2743**	-0.2649**	-0.2926**	-0.2848**
Leverage	(0.1293)	(0.1262)	(0.1268)	(0.1249)	(0.1293)	(0.1400)
ROA*Mining&	0.0114***					
Manufacturers	(0.0030)					
ROA*Utilities		-0.0095***				
		(0.0035)				
ROA*Financials			0.0067			
			(0.0075)			
ROA*Others				-0.0042		
				(0.0036)		
ROA*FTSE100					-0.0048	
					(0.0031)	
ROA*Dividend						-0.0041
Payout						(0.0036)
Constant	12.3525***	12.5013***	12.7905***	12.7246***	12.7360***	12.7440***
	(2.6131)	(2.4842)	(2.4978)	(2.5602)	(2.5769)	(2.6536)
Adjusted-R^2	84.64%	84.57%	84.44%	84.%42	84.43%	84.78%

Standard errors in parenthesis; * significant at 10%; ** significant at 5%; * significant at 1%**

Table 5-10: Dependent variable is Dln(CEO Cash Compensation)

	Fixed Effects Cross-section SUR (PCSE)					
Dln(sales)	0.0973*	0.0989*	0.1061**	0.0932*	0.0813	0.0489
	(0.0559)	(0.0554)	(0.0519)	(0.0550)	(0.0568)	(0.0605)
DROA	0.0026*	0.0083***	0.0026	0.0050**	0.0075***	0.0116***
	(0.0015)	(0.0022)	(0.0019)	(0.0023)	(0.0026)	(0.0028)
D(Board size)	-0.0109	-0.0125	-0.0138*	-0.0117	-0.0133	-0.0124
	(0.0085)	(0.0084)	(0.0081)	(0.0081)	(0.0083)	(0.0089)
D(lag cash	-0.2976	-0.2902	-0.3030	-0.3046	-0.2939	-0.2852
compensation)	(0.2092)	(0.2048)	(0.1969)	(0.2060)	(0.2049)	(0.2032)
D(Price Volatility)	-2.8065***	-2.7186***	-2.8387***	-2.9145***	-2.8246***	-2.5478***
	(0.9057)	(0.8480)	(0.8037)	(0.8629)	(0.8272)	(0.8134)
D(Financial	-0.3271***	-0.3401***	-0.3351***	-0.3447***	-0.3572***	-0.3335***
Leverage)	(0.1197)	(0.1269)	(0.1228)	(0.1188)	(0.1270)	(0.1283)
DROA*Mining &	0.0081**					
Manufacturers	(0.0041)					
DROA*Utilities		-0.0102***				
		(0.0036)				
DROA*Financials			0.0173			
			(0.0110)			
DROA*Others				-0.0026		
				(0.0040)		
DROA*FTSE100					-0.0061	
					(0.0043)	
DROA*Dividend						-0.0103***
Payout						(0.0034)
Constant	0.1115***	0.1143***	0.1122***	0.1104***	0.1133***	0.1214***
	(0.0284)	(0.0283)	(0.0270)	(0.0285)	(0.0281)	(0.0281)
Adjusted-R^2	20.06%	20.97%	21.21%	19.40%	19.94%	22.12%

Standard errors in parenthesiss; * significant at 10%; ** significant at 5%; * significant at 1%**

Table 5-11: Dependent variable is ln(Highest Paid Director Compensation)

	Fixed Effects OLS		Fixed Effects W. D.		Fixed Effects SUR (PCSE)	Cross-section
ln(sales)	0.1815***	0.1802***	0.1815***	0.1802***	0.1815***	0.1802***
	(0.0612)	(0.0631)	(0.0654)	(0.0680)	(0.0553)	(0.0588)
ROA	0.0072***		0.0072***		0.0072***	
	(0.0017)		(0.0014)		(0.0008)	
Return		0.0578***		0.0578***		0.0578***
		(0.0150)		(0.0132)		(0.0059)
Board size	0.0070	0.0060	0.0070	0.0060	0.0070	0.0060
	(0.0094)	(0.0098)	(0.0083)	(0.0087)	(0.0092)	(0.0099)
Lag hpd	-0.0491	-0.0373	-0.0491	-0.0373	-0.0491	-0.0373
compensation	(0.0413)	(0.0440)	(0.0595)	(0.0660)	(0.1911)	(0.2035)
Price	-1.5428***	-1.5237***	-1.5428***	-1.5237***	-1.5428***	-1.5237***
Volatility	(0.4401)	(0.4589)	(0.4034)	(0.4191)	(0.4032)	(0.4506)
Financial	-0.2308	-0.3611*	-0.2308**	-0.3611**	-0.2308*	-0.3611**
Leverage	(0.1444)	(0.1849)	(0.1145)	(0.1585)	(0.1354)	(0.1663)
constant	5.2102***	5.2841***	5.2102***	5.2841***	5.2102***	5.2841***
	(0.8650)	(0.8915)	(0.7940)	(0.8069)	(1.2633)	(1.2844)
Cross-section Effects	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Time Effects	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Adjusted-R^2	78.06%	77.69%	78.06%	77.69%	78.06%	77.69%
S.E.	0.3012	0.3051	0.3012	0.3051	0.3012	0.3051
N	198	198	198	198	198	198
T	5	5	5	5	5	5

Standard errors in parenthesis; * significant at 10%; ** significant at 5%; * significant at 1%**

Table 5-12: Dependent variable is Dln(Highest Paid Director Compensation)

	Fixed Effects OLS		Fixed Effects W. D.		Fixed Effects Cross-section SUR (PCSE)	
Dln(sales)	0.2048***	0.2099***	0.2048**	0.2099**	0.2048**	0.2099**
	(0.0730)	(0.0767)	(0.0984)	(0.1053)	(0.0856)	(0.0937)
DROA	0.0089***		0.0089***		0.0089***	
	(0.0018)		(0.0016)		(0.0012)	
DReturn		0.0744***		0.0744***		0.0744***
		(0.0169)		(0.0164)		(0.0097)
D(Board size)	-0.0010	-0.0018	-0.0010	-0.0018	-0.0010	-0.0018
	(0.0090)	(0.0095)	(0.0089)	(0.0095)	(0.0112)	(0.0112)
D(lag hpd	-0.3646***	-0.3668***	-0.3646***	-0.3668***	0.3646**	-0.3668*
compensation)	(0.0385)	(0.0412)	(0.0721)	(0.0800)	(0.1824)	(0.1950)
D(Price	-1.6407***	-1.5743***	-1.6407**	-1.5743**	-1.6407**	-1.5743**
Volatility)	(0.5582)	(0.5818)	(0.6691)	(0.6983)	(0.6447)	(0.7029)
D(Financial	-0.3429***	-0.5253***	-0.3429***	-0.5253***	-0.3429**	-0.5253**
Leverage)	(0.1470)	(0.1934)	(0.1170)	(0.1834)	(0.1404)	(0.1887)
constant	0.0882***	0.0925***	0.0882***	0.0925***	0.0882***	0.0925***
	(0.0176)	(0.0187)	(0.0180)	(0.0194)	(0.0238)	(0.0245)
Adjusted-R^2	22.46%	22.05%	22.46%	22.05%	22.46%	22.05%
S.E.	0.3628	0.3672	0.3628	0.3672	0.3628	0.3672
N	184	179	184	179	184	179
T	4	4	4	4	4	4

Standard errors in parenthesis; * significant at 10%; ** significant at 5%; * significant at 1%**

Table 5-13: Dependent variable is ln(Highest Paid Director Compensation)

	Fixed Effects Cross-section SUR (PCSE)					
ln(sales)	0.1831***	0.1836***	0.1961***	0.1818***	0.1792***	0.1926***
	(0.0552)	(0.0576)	(0.0507)	(0.0531)	(0.0549)	(0.0595)
ROA	0.0076***	0.0074***	0.0039***	0.0103***	0.0078***	0.0071***
	(0.0009)	(0.0009)	(0.0010)	(0.0010)	(0.0008)	(0.0011)
Board size	0.0070	0.0059	0.0067	0.0074	0.0071	0.0085
	(0.0092)	(0.0090)	(0.0092)	(0.0093)	(0.0093)	(0.0097)
lag hpd compensation	-0.0491	-0.0474	-0.0512	-0.0521	-0.0496	-0.0497
	(0.1911)	(0.1894)	(0.1882)	(0.1890)	(0.1908)	(0.1908)
Price Volatility	-1.5575***	-1.5072***	-1.6042***	-1.5251***	-1.5302***	-1.5888***
	(0.3991)	(0.3930)	(0.4090)	(0.4109)	(0.4007)	(0.4129)
Financial Leverage	-0.2304*	-0.2377*	-0.2048	-0.2107	-0.2355*	-0.2858**
	(0.1359)	(0.1387)	(0.1309)	(0.1320)	(0.1344)	(0.1444)
ROA*Mining & Manufacturers	-0.0013					
	(0.0017)					
ROA*Utilities		-0.0129				
		(0.0112)				
ROA*Financials			0.0105***			
			(0.0030)			
ROA*Others				-0.0074***		
				(0.0020)		
ROA*FTSE100					-0.0024	
					(0.0021)	
ROA*Dividend Payout						0.0041
						(0.0025)
Constant	5.1950***	5.1823***	5.0461***	5.1952***	5.2442***	5.0830***
	(1.2553)	(1.2397)	(1.2077)	(1.2570)	(1.2469)	(1.2193)
Adjusted-R^2	78.03%	78.06%	78.42%	78.25%	78.04%	77.39%

Standard errors in parenthesis; * significant at 10%; ** significant at 5%; * significant at 1%**

Table 5-14: Dependent variable is Dln(Highest Paid Director Compensation)

	Fixed Effects Cross-section SUR (PCSE)					
Dln(sales)	0.2093**	0.2164**	0.2129**	0.2008**	0.2040**	0.2145**
	(0.0842)	(0.0883)	(0.0825)	(0.0857)	(0.0848)	(0.0905)
DROA	0.0099***	0.0093***	0.0061***	0.0102***	0.0091***	0.0095***
	(0.0015)	(0.0012)	(0.0016)	(0.0013)	(0.0013)	(0.0020)
D(Board size)	-0.0009	-0.0023	-0.0012	-0.0010	-0.0011	-0.0006
	(0.0111)	(0.0108)	(0.0111)	(0.0112)	(0.0112)	(0.0119)
D(lag hpd	-0.3649**	-0.3611**	-0.3628**	-0.3642**	-0.3645**	-0.3623**
compensation)	(0.1822)	(0.1801)	(0.1811)	(0.1822)	(0.1824)	(0.1808)
D(Price Volatility)	-1.6484**	-1.5935**	-1.6270**	-1.6350**	-1.6320**	-1.6104**
	(0.6476)	(0.6375)	(0.6605)	(0.6467)	(0.6438)	(0.6932)
D(Financial	-0.3464**	-0.3486**	-0.3287**	-0.3317**	-0.3453**	-0.3654**
Leverage)	(0.1450)	(0.1433)	(0.1332)	(0.1354)	(0.1412)	(0.1607)
DROA*Mining &	-0.0031					
Manufacturers	(0.0021)					
DROA*Utilities		-0.0185				
		(0.0150)				
DROA*Financials			0.0084**			
			(0.0038)			
DROA*Others				-0.0036		
				(0.0027)		
DROA*FTSE100					-0.0009	
					(0.0032)	
DROA*Dividend						0.0021
Payout						(0.0044)
Constant	0.0877***	0.0869***	0.0860***	0.0882***	0.0882***	0.0916***
	(0.0237)	(0.0232)	(0.0234)	(0.0238)	(0.0238)	(0.0238)
Adjusted-R^2	22.42%	22.66%	23.06%	22.46%	22.33%	22.75%

Standard errors in parenthesis; * significant at 10%; ** significant at 5%; * significant at 1%**

Table 5-15: Dependent variable is ln(Total Board Remuneration)

	Fixed Effects OLS		**Fixed Effects W. D.**		**Fixed Effects SUR (PCSE)**	**Cross-section**
ln(sales)	0.1652***	0.1584**	0.1652***	0.1584***	0.1652***	0.1584***
	(0.0598)	(0.0616)	(0.0459)	(0.0469)	(0.0410)	(0.0459)
ROA	0.0040**		0.0040***		0.0040***	
	(0.0016)		(0.0013)		(0.0011)	
Return		0.0356**		0.0356***		0.0356***
		(0.0146)		(0.0116)		(0.0085)
Board size	0.0423***	0.0410***	0.0423***	0.0410***	0.0423***	0.0410***
	(0.0091)	(0.0095)	(0.0081)	(0.0084)	(0.0092)	(0.0101)
Lag board remuneration	0.0827**	0.0941**	0.0827	0.0941	0.0827	0.0941
	(0.0397)	(0.0415)	(0.0591)	(0.0628)	(0.1974)	(0.2028)
Price Volatility	-1.5269***	-1.5323***	-1.5269***	-1.5323***	-1.5269***	-1.5323***
	(0.4240)	(0.4413)	(0.4521)	(0.4691)	(0.3279)	(0.3765)
Financial Leverage	0.0693	0.0376	0.0693	0.0376	0.0693	0.0376
	(0.1414)	(0.1808)	(0.1158)	(0.1565)	(0.1167)	(0.1537)
constant	4.9577***	5.0327***	4.9577***	5.0327***	4.9577***	5.0327***
	(0.8389)	(0.8637)	(0.6615)	(0.6777)	(1.2084)	(1.2267)
Cross-section Effects	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Time Effects	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Adjusted-R^2	81.68%	81.49%	81.68%	81.49%	81.68%	81.49%
S.E.	0.2963	0.3000	0.2963	0.3000	0.2963	0.3000
N	203	203	203	203	203	203
T	5	5	5	5	5	5

Standard errors in parenthesis; * significant at 10%; ** significant at 5%; * significant at 1%**

Table 5-16: Dependent variable is Dln(Total Board Compensation)

	Fixed Effects OLS		Fixed Effects W. D.		Fixed Effects Cross-section SUR (PCSE)	
Dln(sales)	0.1619**	0.1662**	0.1619**	0.1662**	0.1619**	0.1662***
	(0.0709)	(0.0740)	(0.0628)	(0.0669)	(0.0628)	(0.0636)
DROA	0.0055***		0.0055***		0.0055***	
	(0.0018)		(0.0019)		(0.0018)	
DReturn		0.0450***		0.0450***		0.0450***
		(0.0164)		(0.0164)		(0.0145)
D(Board size)	0.0222**	0.0192**	0.0222***	0.0192**	0.0222**	0.0192
	(0.0087)	(0.0092)	(0.0078)	(0.0083)	(0.0110)	(0.0118)
D(lag board	-0.2361***	-0.2472***	-0.2361***	-0.2472***	-0.2361	-0.2472
compensation)	(0.0383)	(0.0398)	(0.0906)	(0.0954)	(0.1946)	(0.1985)
D(Price	-1.6050***	-1.5674***	-1.6050**	-1.5674**	-1.6050***	-1.5674***
Volatility)	(0.5317)	(0.5500)	(0.6980)	(0.7170)	(0.5740)	(0.6031)
D(Financial	-0.0001	-0.1038	-0.0001	-0.1038	-0.0001	-0.1038
Leverage)	(0.1442)	(0.1884)	(0.1252)	(0.1954)	(0.1484)	(0.1961)
constant	0.0528***	0.0578***	0.0528***	0.0578***	0.0528***	0.0578***
	(0.0170)	(0.0179)	(0.0167)	(0.0178)	(0.0179)	(0.0197)
Adjusted-R^2	15.57%	16.78%	15.57%	16.78%	15.57%	16.78%
S.E.	0.3571	0.3596	0.3571	0.3596	0.3571	0.3596
N	188	183	188	183	188	183
T	4	4	4	4	4	4

Standard errors in parenthesis; * significant at 10%; ** significant at 5%; * significant at 1%**

Table 5-17: Dependent variable is ln(Total Board Remuneration)

	Fixed Effects Cross-section SUR (PCSE)					
ln(sales)	0.1616***	0.1680***	0.1713***	0.1646***	0.1608***	0.1585***
	(0.0406)	(0.0431)	(0.0420)	(0.0403)	(0.0409)	(0.0496)
ROA	0.0033**	0.0042***	0.0025**	0.0063***	0.0050***	0.0042***
	(0.0014)	(0.0011)	(0.0012)	(0.0015)	(0.0011)	(0.0014)
Board size	0.0422***	0.0410***	0.0423***	0.0425***	0.0424***	0.0441***
	(0.0092)	(0.0091)	(0.0092)	(0.0093)	(0.0094)	(0.0095)
lag board remuneration	0.0841	0.0822	0.0806	0.0831	0.0829	0.0870
	(0.1977)	(0.1973)	(0.1967)	(0.1963)	(0.1972)	(0.1976)
Price Volatility	-1.4936***	-1.4896***	-1.5618***	-1.5191***	-1.5065***	-1.5770***
	(0.3139)	(0.3263)	(0.3178)	(0.3263)	(0.3227)	(0.3347)
Financial Leverage	0.0684	0.0611	0.0800	0.0841	0.0609	0.0382
	(0.1132)	(0.1177)	(0.1173)	(0.1129)	(0.1191)	(0.1243)
ROA*Mining & Manufacturers	0.0029					
	(0.0023)					
ROA*Utilities		-0.0149***				
		(0.0053)				
ROA*Financials			0.0045			
			(0.0035)			
ROA*Others				-0.0056***		
				(0.0020)		
ROA*FTSE100					-0.0043***	
					(0.0013)	
ROA*Dividend Payout						0.0006
						(0.0030)
Constant	4.9817***	4.9395***	4.9023***	4.9426***	5.0177***	5.0332***
	(1.2044)	(1.1828)	(1.1887)	(1.2060)	(1.2034)	(1.1728)
Adjusted-R^2	81.67%	81.70%	81.71%	81.76%	81.70%	80.84%

Standard errors in parenthesis; * significant at 10%; ** significant at 5%; * significant at 1%**

Table 5-18: Dependent variable is Dln(Total Board Remuneration)

	Cross-section SUR (PCSE)					
Dln(sales)	0.1636**	0.1726***	0.1666**	0.1584**	0.1579**	0.1528**
	(0.0640)	(0.0645)	(0.0656)	(0.0631)	(0.0635)	(0.0685)
DROA	0.0058**	0.0058***	0.0037*	0.0064***	0.0065***	0.0056**
	(0.0023)	(0.0018)	(0.0021)	(0.0020)	(0.0017)	(0.0022)
D(Board size)	0.0222**	0.0210**	0.0221**	0.0222**	0.0217*	0.0241**
	(0.0110)	(0.0106)	(0.0109)	(0.0110)	(0.0111)	(0.0113)
D(lag board	-0.2369	-0.2363	-0.2352	-0.2335	-0.2360	-0.2332
remuneration)	(0.1950)	(0.1941)	(0.1932)	(0.1960)	(0.1938)	(0.1945)
D(Price Volatility)	-1.6080***	-1.5688***	-1.6005***	-1.6007***	-1.5573***	-1.6549***
	(0.5702)	(0.5692)	(0.5794)	(0.5726)	(0.5615)	(0.6057)
D(Financial	-0.0012	-0.0051	0.0078	0.0075	-0.0142	-0.0187
Leverage)	(0.1511)	(0.1504)	(0.1461)	(0.1457)	(0.1538)	(0.1615)
DROA*Mining &	-0.0011					
Manufacturers	(0.0033)					
DROA*Utilities		-0.0173**				
		(0.0068)				
DROA*Financials			0.0052			
			(0.0049)			
DROA*Others				-0.0027		
				(0.0032)		
DROA*FTSE100					-0.0050**	
					(0.0020)	
DROA*Dividend						0.0005
Payout						(0.0040)
Constant	0.0527***	0.0519***	0.0516***	0.0527***	0.0525***	0.0565***
	(0.0178)	(0.0175)	(0.0178)	(0.0179)	(0.0177)	(0.0182)
Adjusted-R^2	15.45%	15.75%	15.75%	15.52%	15.66%	15.78%

Standard errors in parenthesis; * significant at 10%; ** significant at 5%; *** significant at 1%

Table 5-19: Dependent variable is ln(CEO Total Compensation)

	Fixed Effects 2004-2009	**Fixed Effects 2004-2009**	**Fixed Effects W.D. 2004-2009**	**Fixed Effects W.D. 2004-2009**	**Fixed Effects 2004-2006**	**Fixed Effects 2004-2006**	**Fixed Effects W.D. 2004-2006**	**Fixed Effects W.D. 2004-2006**	**Fixed Effects 2008-2009**	**Fixed Effects 2008-2009**	**Fixed Effects W.D. 2008-2009**	**Fixed Effects W.D. 2008-2009**
ln(sales)	0.1869***	0.1692***	0.1869***	0.1692***	0.1582*	0.1142	0.1582**	0.1142*	-0.0698	-0.0904	-0.0698	-0.0904
	(0.0468)	(0.0503)	(0.0414)	(0.0487)	(0.0815)	(0.0861)	(0.0643)	(0.0628)	(0.2099)	(0.2138)	(0.0924)	(0.0884)
ROA	0.0071***		0.0071***		0.0063		0.0063		0.0022		0.0022	
	(0.0018)		(0.0019)		(0.0041)		(0.0067)		(0.0049)		(0.0027)	
Return		0.0565***		0.0565***		0.0644*		0.0644		0.0318		0.0318
		(0.0155)		(0.0146)		(0.0353)		(0.0469)		(0.0388)		(0.0219)
Board size	-0.0010	-0.0021	-0.0010	-0.0021	-0.0150	-0.0101	-0.0150	-0.0101	-0.0037	-0.0092	-0.0037	-0.0092
	(0.0087)	(0.0091)	(0.0075)	(0.0080)	(0.0168)	(0.0177)	(0.0140)	(0.0153)	(0.0270)	(0.0289)	(0.0121)	(0.0122)
Price	-1.3888***	-1.4007***	-1.3888***	-1.4007***	-1.8056*	-1.7796*	-1.8056	-1.7796	-3.0258**	-3.0049**	-3.0258**	-3.0049**
Volatility	(0.3925)	(0.4043)	(0.3949)	(0.4058)	(1.0780)	(1.0775)	(1.4335)	(1.3943)	(1.3987)	(1.4911)	(1.4406)	(1.4813)
Financial	-0.2371*	-0.2666	-0.2371*	-0.2666	-0.2230	-0.0480	-0.2230	-0.0480	-0.0864	-0.1218	-0.0864	-0.1218
Leverage	(0.1303)	(0.1715)	(0.1248)	(0.1778)	(0.1909)	(0.2854)	(0.1951)	(0.2849)	(0.5697)	(0.6132)	(0.4127)	(0.4260)
constant	11.7549***	12.0873***	11.7549***	12.0873***	12.3514***	12.8229***	12.3514***	12.8229***	15.8702***	16.2540***	15.8702***	16.2540***
	(0.6653)	(0.6978)	(0.5913)	(0.6555)	(1.2260)	(1.2659)	(1.1315)	(1.1054)	(2.9969)	(3.0894)	(1.2304)	(1.2218)
Adjusted-R^2	80.23%	80.18%	80.23%	80.18%	83.60%	83.82%	83.60%	83.82%	83.82%	83.54%	83.82%	83.54%
S.E.	0.3000	0.3030	0.3000	0.3030	0.2641	0.2641	0.2641	0.2641	0.2704	0.2769	0.2704	0.2769
N	211	210	211	210	182	179	182	179	202	196	202	196
T	6	6	6	6	3	3	3	3	2	2	2	2

Standard errors in parenthesis; * significant at 10%; ** significant at 5%; * significant at 1%**

Table 5-20: Dependent variable is ln(CEO Cash Compensation)

	Fixed Effects 2004-2009	Fixed Effects 2004-2009	Fixed Effects W.D. 2004-2009	Fixed Effects W.D. 2004-2009	Fixed Effects 2004-2006	Fixed Effects 2004-2006	Fixed Effects W.D. 2004-2006	Fixed Effects W.D. 2004-2006	Fixed Effects 2008-2009	Fixed Effects 2008-2009	Fixed Effects W.D. 2008-2009	Fixed Effects W.D. 2008-2009
ln(sales)	0.1013**	0.0897**	0.1013***	0.0897**	0.0812	0.0368	0.812*	0.0368	-0.1011	-0.1225	-0.1011	-0.1225
	(0.0405)	(0.0438)	(0.0359)	(0.0396)	(0.0735)	(0.0781)	(0.0497)	(0.0480)	(0.2682)	(0.2794)	(0.1293)	(0.1305)
ROA	0.0044***		0.0044**		0.0023		0.0023		0.0052		0.0052	
	(0.0017)		(0.0018)		(0.0040)		(0.0062)		(0.0056)		(0.0032)	
Return		0.0341**		0.0341**		0.0471		0.0471		0.0547		0.0547**
		(0.0142)		(0.0142)		(0.0356)		(0.0449)		(0.0424)		(0.0242)
Board size	-0.0095	-0.0102	-0.0095	-0.0102	-0.0329**	-0.0344**	-0.0329**	-0.0344**	-0.0131	-0.0212	-0.0131	-0.0212*
	(0.0073)	(0.0077)	(0.0066)	(0.0070)	(0.0153)	(0.0162)	(0.0130)	(0.0138)	(0.0308)	(0.0338)	(0.0130)	(0.0125)
Price	-1.3997***	-1.5189***	-1.3997***	-1.5189***	-2.4628**	-2.6450***	-2.4628**	-2.6450**	-1.5200	-1.7776	-1.5200	-1.7776
Volatility	(0.3448)	(0.3547)	(0.3482)	(0.3589)	(0.9901)	(0.9855)	(1.2050)	(1.1694)	(1.9852)	(2.1352)	(1.2251)	(1.2929)
Financial	-0.0885	-0.0954	-0.0885	-0.0954	-0.1458	0.0167	-0.1458	0.1667	0.0461	-0.0297	0.0461	-0.0297
Leverage	(0.1055)	(0.1453)	(0.1110)	(0.1504)	(0.1692)	(0.2630)	(0.1564)	(0.2463)	(0.6249)	(0.7026)	(0.4619)	(0.4412)
constant	12.8168***	13.0543***	12.8168***	13.0543***	13.6334***	14.2191***	13.6334***	14.2191***	15.7448***	16.3008***	15.7448***	16.3008***
	(0.5749)	(0.6034)	(0.5058)	(0.5453)	(1.0923)	(1.5231)	(0.8499)	(0.8121)	(3.8147)	(3.9971)	(1.8254)	(1.8739)
Adjusted-R^2	85.21%	85.17%	85.21%	85.17%	85.94%	86.37%	85.94%	86.37%	80.00%	79.38%	80.00%	79.38%
S.E.	0.2284	0.2307	0.2284	0.2307	0.2194	0.2174	0.2194	0.2174	0.2589	0.2666	0.2589	0.2666
N	200	199	200	199	171	169	171	169	171	165	171	165
T	6	6	6	6	3	3	3	3	2	2	2	2

Standard errors in parenthesis; * significant at 10%; ** significant at 5%; * significant at 1%**

Table 5-21: Dependent variable is ln(Highest Paid Director)

	Fixed Effects 2004-2009	**Fixed Effects 2004-2009**	**Fixed Effects W.D. 2004-2009**	**Fixed Effects W.D. 2004-2009**	**Fixed Effects 2004-2006**	**Fixed Effects 2004-2006**	**Fixed Effects W.D. 2004-2006**	**Fixed Effects W.D. 2004-2006**	**Fixed Effects 2008-2009**	**Fixed Effects 2008-2009**	**Fixed Effects W.D. 2008-2009**	**Fixed Effects W.D. 2008-2009**
ln(sales)	0.1678***	0.1615***	0.1678***	0.1615***	0.1209	0.0865	0.1209**	0.0865	-0.1959	-0.2255	-0.1959	-0.2255
	(0.0482)	(0.0517)	(0.0434)	(0.0481)	(0.0871)	(0.0914)	(0.0575)	(0.0605)	(0.2587)	(0.2633)	(0.1701)	(0.1675)
ROA	0.0083***		0.0083***		0.0050		0.0050		0.0081		0.0081**	
	(0.0016)		(0.0014)		(0.0040)		(0.0042)		(0.0051)		(0.0032)	
Return		0.0668***		0.0668***		0.0669*		0.0669**		0.0843**		0.0843***
		(0.0146)		(0.0131)		(0.0342)		(0.0299)		(0.0399)		(0.0230)
Board size	0.0124	0.0124	0.0124	0.0124	0.0356**	0.0371**	0.0356**	0.0371**	-0.0227	-0.0303	-0.0227	-0.0303
	(0.0088)	(0.0092)	(0.0078)	(0.0082)	(0.0169)	(0.0175)	(0.0140)	(0.0150)	(0.0280)	(0.0295)	(0.0200)	(0.0202)
Price	-0.9741**	-0.9714**	-0.9741***	-0.9714***	0.0921	0.0715	0.0921	0.0715	-1.3807	-1.2568	-1.3807	-1.2568
Volatility	(0.3941)	(0.4088)	(0.3622)	(0.3743)	(1.0536)	(1.0532)	(1.0566)	(1.0315)	(1.4675)	(1.5513)	(1.5509)	(1.5890)
Financial	-0.1152	-0.2216	-0.1152	-0.2216	-0.2788	-0.2955	-0.2788**	-0.2955	0.0609	-0.0750	0.0609	-0.0750
Leverage	(0.1289)	(0.1678)	(0.1075)	(0.1484)	(0.2010)	(0.2941)	(0.1292)	(0.1935)	(0.5348)	(0.5575)	(0.4208)	(0.3738)
constant	4.7436***	4.9588***	4.7436***	4.9588***	4.8595***	5.3650***	4.8595***	5.3650***	10.3183***	10.9324***	10.3183***	10.9324***
	(0.6888)	(0.7218)	(0.6323)	(0.6781)	(1.2914)	(1.3304)	(0.9309)	(0.9453)	(3.6990)	(3.7994)	(2.3098)	(2.3082)
Adjusted-R^2	77.67%	77.30%	77.67%	77.30%	79.41%	79.61%	79.41%	79.61%	79.99%	79.69%	79.99%	79.69%
S.E.	0.3092	0.3132	0.3092	0.3132	0.2913	0.2911	0.2913	0.2911	0.2811	0.2861	0.2811	0.2861
N	209	209	209	209	190	188	190	188	194	188	194	188
T	6	6	6	6	3	3	3	3	2	2	2	2

Standard errors in parenthesis; * significant at 10%; ** significant at 5%; * significant at 1%**

Table 5-22: Dependent variable is ln(Total Board Remuneration)

	Fixed Effects 2004-2009	**Fixed Effects 2004-2009**	**Fixed Effects W.D. 2004-2009**	**Fixed Effects W.D. 2004-2009**	**Fixed Effects 2004-2006**	**Fixed Effects 2004-2006**	**Fixed Effects W.D. 2004-2006**	**Fixed Effects W.D. 2004-2006**	**Fixed Effects 2008-2009**	**Fixed Effects 2008-2009**	**Fixed Effects W.D. 2008-2009**	**Fixed Effects W.D. 2008-2009**
ln(sales)	0.2041***	0.1947***	0.2041***	0.1947***	0.0771	0.0182	0.0771	0.0182	-0.0113	-0.0616	-0.0113	-0.0616
	(0.0491)	(0.0527)	(0.0392)	(0.0419)	(0.0806)	(0.0844)	(0.0583)	(0.0500)	(0.2224)	(0.2282)	(0.1117)	(0.1034)
ROA	0.0057***		0.0057***		0.0166***		0.0166***		0.0017		0.0017	
	(0.0017)		(0.0014)		(0.0037)		(0.0039)		(0.0043)		(0.0024)	
Return		0.0510***		0.0510***		0.1437***		0.1437***		0.0416		0.0416**
		(0.0150)		(0.0121)		(0.0317)		(0.0294)		(0.0342)		(0.0193)
Board size	0.0481***	0.0468***	0.0481***	0.0468***	0.0392**	0.0399**	0.0392***	0.0399***	-0.0011	-0.0085	-0.0011	-0.0085
	(0.0089)	(0.0093)	(0.0076)	(0.0079)	(0.0152)	(0.0158)	(0.0114)	(0.0123)	(0.0239)	(0.0254)	(0.0159)	(0.0161)
Price	-0.7343*	-0.7095*	-0.7343*	-0.7095	-0.0221	0.4105	-0.0221	0.4105	-2.2413*	-2.0767	-2.2413	-2.0767
Volatility	(0.4009)	(0.4160)	(0.4177)	(0.4363)	(0.9393)	(0.9369)	(0.7471)	(0.7377)	(1.2653)	(1.3467)	(1.4396)	(1.4707)
Financial	0.1277	0.0862	0.1277	0.0862	-0.1724	-0.0410	-0.1724	-0.0410	0.7127	0.7607	0.7127**	0.7607**
Leverage	(0.1326)	(0.1728)	(0.1159)	(0.1504)	(0.1856)	(0.2707)	(0.1414)	(0.1876)	(0.4632)	(0.4891)	(0.3559)	(0.3419)
constant	4.7231***	4.9382***	4.7231***	4.9382***	6.4215***	7.1503***	6.4215***	7.1503***	8.4131***	9.1616***	8.4131***	9.1616***
	(0.6983)	(0.7330)	(0.5625)	(0.5854)	(1.1966)	(1.2294)	(0.9111)	(0.8194)	(3.1853)	(3.2971)	(1.4297)	(1.3380)
Adjusted-R^2	79.11%	78.82%	79.11%	78.82%	84.85%	85.12%	84.85%	85.12%	86.87%	86.47%	86.87%	86.47%
S.E.	0.3190	0.3235	0.3190	0.3235	0.2711	0.2702	0.2711	0.2702	0.2452	0.2513	0.2452	0.2513
N	209	209	209	209	190	188	190	188	199	193	199	193
T	6	6	6	6	3	3	3	3	2	2	2	2

Standard errors in parenthesis; * significant at 10%; ** significant at 5%; * significant at 1%**

Table 5-23: Regression of performance on compensation

	Panel A: Dependent Variable: ROA				Panel B: Dependent Variable: Tobin's q			
ln(CEO cash compensation)	3.2952***				0.0808			
	(0.9071)				(0.0780)			
ln(total CEO compensation)		3.7128***				0.0678**		
		(0.5652)				(0.0335)		
ln(highest paid director)			4.7088***				0.0815**	
			(0.6936)				(0.0356)	
ln(total board remuneration)				3.1687***				0.0774*
				(0.7073)				(0.0419)
Board size	-0.1836	-0.2634	-0.3861*	-0.5183**	0.0064	0.0044	0.0099*	0.0031
	(0.1707)	(0.1953)	(0.2165)	(0.2277)	(0.0097)	(0.0069)	(0.0057)	(0.0061)
ln(sales)					-0.3378***	-0.2555***	-0.2759***	-0.2783***
					(0.0742)	(0.0657)	(0.0779)	(0.0761)
ln(total assets)	-3.2430***	-2.2047**	-1.5173	-1.0419				
	(0.9403)	(1.0607)	(1.3650)	(1.4677)				
Price Volatility	-29.3405***	-48.4134***	-54.8823***	-56.6389***	-1.2209**	-1.1408**	-1.1720**	-1.2227**
	(8.8152)	(8.7473)	(12.0128)	(12.5530)	(0.5785)	(0.5615)	(0.5305)	(0.5315)
Financial Leverage	-5.2706*	-7.6386**	-11.8540**	-13.1331**	0.8369***	0.8840***	0.7369***	0.7157***
	(2.9805)	(3.5783)	(5.0484)	(5.0934)	(0.2657)	(0.2575)	(0.2194)	(0.2198)
constant	24.5601	10.7564	25.1852	28.3650	5.0627***	4.0508***	4.7147***	4.7980***
	(18.6599)	(15.6409)	(19.2117)	(20.6102)	(1.5397)	(1.0241)	(1.0895)	(1.0794)
Adjusted-R^2	56.60%	57.53%	56.41%	55.95%	75.04%	76.44%	78.215	78.41%
S.E.	5.8738	6.4796	7.1065	7.1849	0.4215	0.4255	0.3986	0.3965
N	202	213	210	210	200	211	209	209
T	6	6	6	6	6	6	6	6

Standard errors in parenthesis; * significant at 10%; ** significant at 5%; * significant at 1%**

Table 5-24: Bootstrapping results with replications of 1000 times

Dependent Variable	Estimated relationship with ROA	Lower Bound 95%	Upper Bound 95%	In/Out	Bias-corrected Lower Bound 95%	Bias-corrected Upper Bound 95%	In/Out
lntc	0.0079	0.00120	0.01259	In	0.00206	0.01384	In
lncash	0.0039	-0.00264	0.00878	In	-0.00147	0.01047	In
lnphd	0.0072	0.00188	0.00971	In	0.00216	0.00987	In
lndremu	0.0040	0.00092	0.00785	In	0.00150	0.00848	In

Table 5-25: Bootstrapping results with replications of 1000 times

Panel A: Dependent variable: ROA

Compensation	Estimated Coefficient	Lower Bound 95%	Upper Bound 95%	In/Out	Bias-corrected Lower Bound 95%	Bias-corrected Upper Bound 95%	In/Out
lntc	3.7128	1.49220	4.94221	In	1.57283	5.07194	In
lncash	3.2952	0.34309	5.42552	In	0.36933	5.39376	In
lnphd	4.7088	1.62637	6.31914	In	1.97921	6.75858	In
lndremu	3.1687	1.03830	4.65868	In	1.07177	4.73862	In

Panel B: Dependent variable: Tobin's q

Compensation	Estimated Coefficient	Lower Bound 95%	Upper Bound 95%	In/Out	Bias-corrected Lower Bound 95%	Bias-corrected Upper Bound 95%	In/Out
lntc	0.0678	-0.05839	0.15499	In	-0.05226	0.16293	In
lncash	0.0808	-0.21158	0.17980	In	-0.23442	0.16269	In
lnphd	0.0815	-0.03687	0.14932	In	-0.03689	0.15385	In
lndremu	0.0774	0.00544	0.16145	In	0.00896	0.16432	In

Chapter 6 **Conclusion**

This study concentrates on exchange rates, the term structure of interest rates, as well as security risk and corporate finance on executive compensation. In the exchange market the forward rate biasedness and forward premium puzzle are considered as two of the most important anomalies. It has been suggested that these puzzles could be solved by using better econometric and statistical procedures. Maynard (2003) further argues that the negative coefficient in the forward premium regression cannot be fully explained using the time series characteristics of variables. Thus, this study applies improved econometric methodologies and incorporates panel data constructions into the empirical investigation.

The forward-spot relation is examined through regressions in both levels and returns using information from thirty-one developed and emerging economies. The empirical results from regressions in levels demonstrate a robust cointegrating relation, which indicates a solid long-run relationship between the forward and corresponding future spot exchange rates. This robustness is confirmed through different cointegration tests, and by using data in both weekly and daily frequencies. Moreover, the forward rate unbiasedness hypothesis of zero intercept and slope of unity in the regression of the logarithm of the spot rate on the forward rate could not be rejected for most developed and emerging markets with daily data over the last two decades. Meanwhile, the previous empirical research regarding the forward premium anomaly is based on evidence which is mainly obtained from developed economies. This study adds evidence to the empirical literature to show that the forward premium puzzle might not be a pervasive phenomenon by using information from twenty emerging economies. Furthermore, a more strong and significant link is obtained between currency depreciation and the forward premium using ARCH/GARCH models to capture the volatility clustering, although they are not able to solve this puzzle. The regressions of the changes of the spot rate on the forward premium are also well estimated under panel construction in order to provide a complete picture. The slope coefficient estimates from rolling regressions using shorter samples are widely dispersed, especially for the developed economies, and some of them are positive and significantly greater than one.

This study also investigates the relationship between the exchange rate and the term structure of interest rates by regressing the log of real exchange rate on the three-month interest rate differential and normalised one-month interest rate differential, especially for emerging economies. Both CCR and DOLS methodologies are applied in the analysis under both time series and panel construction. The empirical results of this analysis suggest that the term structure of interest rates plays an important role in determining exchange rate. Negative slope coefficient estimates are found for the long-term interest rate differentials for most emerging economies and they are found to be statistically significant. This result is consistent with the previous literature. However, the theoretical model of the exchange rate and the term structure of interest rates suggest that there is a complicated relationship between the short-term interest rate and the exchange rate. Empirically, a positive and statistically significant coefficient estimate is obtained for South Africa and the Philippines. According to the theoretical model, this indicates that the indirect complementarity between the domestic short-term bonds and foreign bonds dominates the direct substitutability. In addition, negative and significant slope coefficients are obtained under panel construction for emerging countries for both short-term and long-term interest rate differentials. Since solid relationships are identified between the real exchange rate and the term structure of interest rates, one possible way for the monetary authorities to manage their foreign exchange markets could be through the adjustments of interest rate policies. In addition, the structural breaks are taken into account since the exchange rate regime of most emerging economies has been changing during the sample period. These results support the parameter stability when regressing the real exchange rate on the three-month real interest rate differential and normalised one-month interest rate differential. This implies that this cointegrating relationship between the exchange rate and the term structure of interest rates is stable despite the changes in the exchange regimes for the emerging market.

The term structure of interest rates also has a strong forecasting power in the stock and bond markets. There is an empirical stylised fact that the time variation in the expected excess returns of the long-term bonds is persistent and positively related to the time variation in the yield spread. Viceira (2007) pushes this point further and argues that the time variation in bond risk is also positively related to the changes in the yield spread for the U.S. economy. This study provides additional empirical evidence that the time variation in bond risk (measured as realised covariance of bond returns with stock returns, bond CAPM beta, and bond return volatility) is statistically significant and positively related with the movement in the yield spread for most economies in G7 over the period January 1991 to April 2011.

In addition to the yield spread, the short-term nominal interest rate also plays an important role in forecasting the bond risk, which is measured as the second moments of the bond returns. Furthermore, this chapter provides strong evidence that the short-term interest rate has a significant effect on the time variation in bond and stock risks under a panel construction which treats the G7 as a whole economy. Meanwhile, the yield spread is also a statistically significant determinant in forecasting the time variation in the second moments of bond returns. The empirical results imply that the interest rate policy may be important in reducing market volatility. Additionally, this chapter also examines the effects of the recent financial crisis, which erupted in mid-2007, on the relationship between the time variation in security risk and the time variation in the term structure of interest rates in order to consider the stability throughout the sample period. The empirical results indicate that this relationship has significantly changed due to the economic crisis.

Lastly, this chapter studies the relationship between directors' remuneration and corporate performance, which is another interesting topic that has attracted considerable public and academic attention. According to agency theory this problem arises from the conflicts of interest existing between shareholders and executives. In order to understand how firms determine the remuneration packages to attract, motivate, and monitor top managers, especially executive directors, this study empirically explores the link between the directors' remuneration and firm performance by using a panel data set of companies taken from FTSE 350 Index over the period 2004 to 2009. The result of this analysis adds to our understanding of this problem and it provides evidence in addition to that provided by the previous literature.

In contrast to the previous studies which have analysed either CEO compensation packages or remuneration for highest paid directors, this study introduces dynamic compensation models and evaluates the remuneration packages for the CEO, the highest paid director, and the total board. The empirical results suggest that there is a positive and statistically significant relationship between corporate performance and the directors' pay for: the CEO's cash compensation, the CEO's total compensation, and for the remuneration for the highest paid director and the total board. The estimation results for the first order difference specification are consistent with those of the level equation estimation. In addition, these results show that larger firms pay their directors relatively higher remuneration, which confirms the intuition that larger firms need higher quality directors, especially more talented executive directors, and are willing to offer higher compensation to attract them. Moreover, two subsamples (i.e. 2004 to 2006 and 2008 to 2009) are estimated separately in order to evaluate the impact of the recent financial crisis on the relationship between the directors' pay and firm performance. This is an interesting point to analyse because large firms have faced sharp decrease in their returns without similar changes taking places in their executives' remuneration packages. The empirical results suggest that the link between pay and performance has been broken due to the crisis. Additionally, firms in different industries are observed to behave differently in the pay-performance relationship, the strongest link between pay and performance could be found in those firms from financial industry.

On the other hand, a positive and significant influence of directors' pay on firm performance is also confirmed and this result is consistent with the previous literature. This result demonstrates the importance of decision making in setting the directors' compensation packages. Lastly, the results from bootstrapping procedures indicate that this positive and significant relationship between the directors' remuneration and corporate performance is robust through both directions.

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