Liberalization, Bankers' Motivation and Productivity: A Simple Model with an Application

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Abstract:

Proponents of financial liberalization argue that deregulation motivates bankers to increase their effort and operate at a higher level of efficiency and productivity. Sceptics, however, see that liberalization engenders economic instability and banking crises, and impedes growth. Bank efficiency and productivity, following liberalization, have been extensively examined. Nonetheless, the core issue of bankers' self-motivation remains implicitly assumed and unaddressed. Does liberalization self-motivate bankers and increase their efforts and productivity? This paper models bank productivity from this perspective and evaluates what proportion of banks' total factor productivity is accounted for by the self-motivated productivity of bankers. We provide a micro-founded framework for the analyses of bankers' optimal level of effort and effort-driven productivity. Our model also captures banks' unit input-output prices, optimal wages, bank spread and the overall cost of bank services – measures that are important in evaluating reform policies. We assess the financial liberalization of Nepal as a test case and find that (i) bankers' efforts and productivity have notably improved in Nepal, although banking services have become costly, and (ii) bank spread has moderately declined in recent years. Our approach is parametric which differs from DEA, hence complements the literature. We hope this analytical framework will be useful to evaluate reform episodes elsewhere.

JEL Codes: G21, G28, O43, O53.

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1. Introduction

The world has seen sustained financial liberalization, increasing privatization and gradual loosening of capital controls since the mid-1990s. The economic thinking behind all this is that the financial entities, functioning under liberalized financial regimes, operate at higher levels of efficiency and productivity. Productivity improvements may ensue from different sources yet the notion that the private – i.e. the individual institution's – motive to maximize profit leads to productivity improvement is one of the fundamental ones. Put differently, a deregulated financial system is viewed as motivating institutions (in this instance banks) for higher levels of effort, productivity and profitability. Further, liberalization and deregulation is advocated to create a more integrated and competitive banking sector ensuring efficient allocation of bank credits to productive sectors.

These assertions made in favour of liberalization and deregulation have not gone unchallenged however. For example, Dell'Ariccia and Marqueze (2004), analysing the effect of foreign entry on credit reallocation following liberalization, show that the entry of fiercely competitive foreign banks may push local banks' lending portfolio towards low quality and high risk local borrowers. In their model the degree of information asymmetry affects bank credit allocation; and, liberalization is shown to result in credit market segmentations between foreign and domestic banks – an outcome certainly against the intended motives of deregulation. Likewise, Gehrig (1998), analysing cartelized banks, shows that financial market integration – especially in countries with a lower degree of credit market fragmentation, e.g., Europe – could worsen aggregate loan quality and increase systemic risks, which aggravate aggregate risk and poor credit allocation. Outcomes for emerging countries, where credit market fragmentation could be high, are likely to be positive however. In short, at the theoretical level, doubts have been raised on the potential benefits advocated by the proponents of banking liberalization and deregulation.

Empirically, the effects of financial liberalization and bank deregulation have been researched quite extensively on various fronts: growth, productivity and bank efficiency. For example, Bekaert et al. (2005), Mishkin (2008), Levchenko et al. (2009), Belke et al. (2016), to name but a few, report that the effects of financial liberalization on financial depth and economic growth have largely been positive. In contrast, Diaz-

Alejandro (1985), Kaminsky and Reinhart (1999), Demirguc-Kunt and Detragiache (1999), Kose et al. (2003), Ahmed (2013), among others, report that liberalization has contributed to economic instability, banking crisis and stalled growth. However, Hamdi and Jlassi (2014), analysing 58 developing countries, do not find evidence of liberalization contributing to economic instability and banking crisis. In a nutshell, empirical evidence on the effects of financial liberalization on growth, economic stability and banking crises is rather mixed.

A strand of literature (Fare et al., 1994; Humphrey and Pulley, 1997; Wheelock and Wilson, 1999; Tirtiroglu et al., 2005; Pasiouras, 2008; Brissimis et al., 2009; Delis et al., 2011; to name but a few) examines bank efficiency and productivity following reforms and regulatory changes. They are panel as well as country-specific studies which mostly employ non-parametric data envelopment analysis (DEA) to compute various efficiency decompositions – technical efficiency, scale efficiency, efficiency change (catching up or falling behind) – and productivity growth.[1] This is an extremely rich body of literature conducting rigorous empirical analyses and offering evidence if deregulations and reforms have worked, i.e. if reforms had a positive effect on banking efficiency and productivity. Again, the overall evidence is mixed: bank efficiency and productivity have improved following deregulation in some countries but not in others.

One common theme (implicit assumption) across all empirical studies (cited above) − as well as the premise of financial liberalization − is that, following liberalization, financial institutions (banks) become self-motivated to improve their productivity and profitability. The anticipation is that reforms and liberalization avail opportunities to optimize, and bankers react by increasing their efforts and productivity. However, to the best of our knowledge, the literature, so far, does not grapple with the issues of bankers' self-motivated efforts following liberalization. Do bankers react by increasing their effort following liberalization? Does their self-motivated effort lead to increase in banking sector productivity? The effects of financial deregulation on bankers' motivation, banking sector productivity and the cost of bank services (unit price of bank output) are important policy issues.

This paper aims to contribute to the literature by analysing, among other things, bankers' optimal efforts (self-motivated incentive) and effort-driven productivity following deregulations and reforms. Our objectives are twofold. First, we develop a theoretical model of bankers' optimal level of effort and effort-driven productivity applicable under a liberalized environment; it is hoped that our model serves as a simple yet general framework for assessing such issues. Second, as a test case, we implement (estimate and simulate) our proposed model to assess the effects of financial liberalization in Nepal.

Our contribution to the literature is that our approach differs from DEA in that we model banks as profit-cum-utility maximizing firms. We directly model bankers' optimal level of productivity rather than relative productivity, as is done under DEA. A conceptual clarity is worth emphasizing. Throughout the paper, we use bankers' incentive or motivation in the sense of bankers' self-motivated response (efforts) to optimize productivity and profitability following liberalization. This is precisely the raison d'être of financial liberalization and reforms. We do not imply incentive in the sense of bankers' compensation packages. The literature outside of the banking area documents that reforms-led private incentive (effort) is key in enhancing productivity and growth. McMillan et al. (1989) examine the case of Chinese agricultural reforms that replaced "communal decision making" by the "responsibility system" which incentivized (rewarded) individual farmers. The Chinese agriculture sector grew by 61% between 1978 and 1984 and McMillan et al. (ibid.) attribute 78% of productivity gains to the strengthened individual incentives following reforms; they state "rewarding individual effort yields large benefit" (ibid., p 783). In this context, a related and pertinent question would be to ask if financial liberalization and banking deregulation motivate bankers to increase their efforts and productivity accordingly. We model bankers' efforts and effort-driven productivity in the spirit of McMillan et al (ibid.). We focus on three fundamental issues: (i) whether bankers have become self-motivated and increased their levels of effort in augmenting banking sector productivity, (ii) whether banking sector productivity has increased, and (iii) what has been the impact of liberalization on bank spread (the difference between banks' input and output unit prices) and the overall cost of banking services.

Our theoretical model combines banks' production technology with their optimizing behaviour. Banks' technical production function is that of the Cobb-Douglas technology which is standard in the literature (Clark, 1984, 1988; Humphrey, 1991). We augment banks' technical production function by effort and risk parameters. We derive banks' optimal feasible production function, which embeds banks' profit-cum-utility maximizing optimal levels of effort following liberalization. In this setup, banking sector productivity becomes endogenous to bankers' optimal level of effort, relative input-output prices and some technical and risk parameters.

As a test case, we use our model to scrutinize Nepalese financial liberalization and reforms by employing cutting-edge econometric methods, calibrations and simulations. Nepal is one of the least developed and poorest countries of the world which went through deep financial sector reform from 1992-1994. However, due to Maoists' armed insurgency (People's War) starting in 1996, economic and financial activities were largely dormant until Maoists entered into dialogue for peace in 2000. Financial activities soared post-2000 exploiting the liberal regime and ushering fundamental changes into the country's financial sector (see Section 3). This makes the Nepalese banking sector an interesting test case as to whether financial reforms have produced anticipated productivity improvements.

We find that bankers' optimal level of effort, optimal bank productivity and bank profitability have considerably improved in Nepal following financial liberalization. Formal tests show that bankers' efforts significantly explain bank productivity. We also find that in recent years the bank spread has slightly reduced, indicating competitive pressure, yet banking services have become more costly (higher unit price of bank output). On the whole, financial reforms and liberalization appear to have been a fruitful experience in Nepal.

The rest of the paper is organized as follows. We present our analytical model in the following section; Section 3 briefly outlines the financial regimes of Nepal and argues why Nepal is an interesting test case; econometric specification and data are discussed in Section 4; empirical methodologies are discussed in Section 5; empirical results are presented in Section 6; calibrations and simulation of optimal effort and productivity are discussed in Section 7; and Section 8 concludes the paper.

2. **Model**

Financial liberalization, among other things, frees prices. Interest (deposit and lending) rates, bankers' wages, CEOs' pay and other incentives, such as bonuses, are competitively determined but there are always entry and exit restrictions in the banking industry. These restrictions are maintained by the Central Bank which may be motivated by its concerns over financial fragility and/or some notional optimal size of the banking industry in the economy. Restrictions to entry and exit have important implications because they allow banks to earn positive economic profits, even in the long run.

We construct a partial equilibrium model where a representative banker, following liberalization, operates within a competitive environment and minimizes its cost function to achieve the maximum feasible level of profit.[2] The representative banker is a decision making unit (DMU) and has full flexibility and freedom in decision making.

In order to model banking sector productivity, we need to specify banks' production function. There are alternative ways to measure bank inputs and output in the literature. Prominent ones are the *production approach* (Berger and Humphrey, 1992) and the *intermediation approach* (Sealy and Lindley, 1997; Aly et al., 1990; Delis et al., 2011). As in Wheelock and Wilson (1999), "a mutually exclusive distinction" between inputs and output is vital for modelling productivity, hence we follow the intermediation approach. We specify that banks use three inputs, namely, labour (banking hours of staff, N), total fixed assets (F), and total deposits (D) to produce their output (Q). Labour is measured by the number of hours devoted to provide banking services; total fixed assets is the book value of premises and other fixed assets, which is equivalent to physical capital stock. Fixed assets for a bank include premises, land, assets on lease and furniture, fixtures and fittings. Deposits are the total deposit liabilities. Bank output is measured by total credits and investment.[3] We specify a technical constant returns to scale (CRTS) Cobb-Douglas production function for bank output as:

$$Q = (a_0\delta)(\varepsilon N)^{a_1}(F)^{a_2}(D)^{a_3} \tag{1}$$

where $a_0 \in (0,\infty)$; $a_i \in [0,1], i = 1,2,3$ are the share parameters such that $\sum_{i=1}^{3} a_i = 1$. εN is the self-motivated incentive (effort) augmented labour hours and a_0 captures the banking technology. The parameter ε denotes the level of effort or the level of self-motivation of a representative banker which may change in response to changes in policies. The idea is that, following liberalization, bankers become more motivated and increase their level of effort (quality of work). Bankers' efforts may include their willingness to embark on new types of lending, investments and services which might have been restricted and/or barred hitherto. It is plausible to think that the quality of N and F may also improve due to the hiring of more qualified staff, more efficient utilization of working hours, computerization and the opening up of new branches in more strategic locations. We assume the quality of inputs and the level of effort to be positively correlated. In other words, bankers invest in quality inputs in order to increase their effort level (or make their effort more effective).

The term δ in (1) captures banks' levels of risk following liberalization. The general perception is that deregulation increases banks' risks. However, conceptually the level of risk could go either way – an aggressive lending by the banker, following liberalization, may increase the level of risk, whereas a prudent lending may do just the opposite. Since our focus is on the outcome of liberalization and deregulation – i.e. whether reforms motivated bankers and increased banking sector productivity – the analysis is essentially an *ex post* one. Hence, we can conveniently sidestep the issue of uncertainty and capture the level of bank risk exposure through the ratio of performing to total loans; the δ term precisely captures this. The higher the δ the lower tends to be the risk exposure and vice versa. Given that the production function (1) is homogeneous of degree one, the inclusion of δ simply scales the productivity. A high proportion of non-performing loans implies $\delta \to 0$, which scales down the total factor productivity; whereas a high proportion of performing loans entails $\delta \to 1$ and scales the productivity up; when non-performing loans are zero then $\delta = 1$.

We assume that there exists a continuum of identical bankers who own the banking technology specified in (1). This approach to modelling the banking production function is analogous to the representative agent model contained in Gillman and Kejak (2011). The bankers spend N hours in banking; their effort augmented labour input to producing output is (εN), for which they earn wages. From (1), the production function in per-banking hour terms can be expressed as:

$$q = (a_0\delta)(\varepsilon)^{a_1}(f)^{a_2}(d)^{a_3} \qquad (2)$$

where q, f, and d represent output, total fixed assets and total deposit per-banking hour, respectively. The representative banker chooses the level of inputs, such that the total cost (TC) of renting these inputs (i.e. the opportunity cost of owning these factors) is minimized. Let us denote the unit cost of these three inputs by $w_i, i = 1,2,3$. The banker chooses the input set (εN , F and D) in order to minimize:

$$TC = w_1(\varepsilon N) + w_2(F) + w_3(D) \qquad (3)$$

The consolidated first order condition associated with this cost minimization problem, subject to (1), is:

$$\frac{w_1(\varepsilon N)}{a_1 Q} = \frac{w_2(F)}{a_2 Q} = \frac{w_3(D)}{a_3 Q} \tag{4}$$

Equation (4) is the standard result in cost minimization, which states that the ratio of marginal cost to marginal revenue or its reciprocal should be the same across all the inputs employed. Substituting (4) into (3) and imposing the CRTS condition, with some algebraic manipulation, the optimal total cost function is given by:

$$TC^* = \xi \left\{ \prod_i w_i^{a_i} \right\} Q \tag{5}$$

where $\xi = \frac{1}{(a_0 \delta) a_1^{a_1} a_2^{a_2} a_3^{a_3}}$. TC^* is the minimum value function of TC in (3) subject to (1) which depends on unit input costs, the level of output and share parameters. The optimum cost of production per banking hour is therefore:

$$tc^* = \hat{\xi} \left\{ \prod_i w_i^{a_i} \right\} q \tag{6}$$

Let p denote the market-clearing price per unit of credit. Then, the total revenue per banking hour is:

$$tr = pq \tag{7}$$

Input and output prices that banks face tend to differ and they are likely to change differently following liberalization. We capture this by $\omega \equiv \frac{\prod_i w_i^{a_i}}{p}$, the ratio of the observed weighted input to output prices. From (6) and (7) and utilizing ω, the profit per banking hour is given by:

$$\pi = p(1 - \xi\omega)q \tag{8}$$

The bank's profit is defined by $\Pi = pQ - w_1(\varepsilon N) - w_2(F) - w_3(D)$. Since the representative banker is a cost minimizer, the cost minimizing level of wages in equilibrium is: $w_1 = a_1 p \frac{Q}{\varepsilon N}$. The total wage income earned by the representative banker is: $w_1(\varepsilon N) = a_1 pQ$. Dividing both sides of this (last) expression by the total number of hours spent in banking, N, gives the effort augmented banker's wage rate per hour as, $w_1 \varepsilon = a_1 pq$. The representative banker likes income, which is the sum of profits and wages, but dislikes effort. He is mindful of the trade-off between income and the utility cost of effort. The banker's utility from working in the bank is defined over profit and wage income and effort levels as:

$$u(\pi, w_1, \varepsilon) = \pi + w_1\varepsilon - \sigma\mu(\varepsilon)^{\frac{1}{\sigma}} \tag{9}$$

where parameter $\sigma \in (0,1)$ is the elasticity of substitution between profit and effort. The marginal utility of profit is constant but the marginal disutility of effort is increasing with the higher level of effort. The relative risk aversion equivalent coefficient of this utility function is given by $\frac{\sigma-1}{\sigma}$. The μ is the disutility parameter; its value ensures that the utility function is jointly strictly quasi-concave. The representative banker's utility maximization problem is:

$$\begin{aligned} \max_{\{\varepsilon\}} \quad & u(\pi, w_1, \varepsilon) \\ s.t. \quad & \pi = p(1-\xi\omega)q \\ & w_1\varepsilon = a_1 pq \\ & q = a_0(\varepsilon)^{a_1}(f)^{a_2}(d)^{a_3} \end{aligned}$$

The solutions to these problems give us the optimal level of effort as:

$$\varepsilon^* = \left[\frac{1}{\mu} p\left(1-\xi\omega + a_1\right)\left(a_0\delta\right) a_1 f^{a_2} d^{a_3}\right]^{\frac{\sigma}{1-a_1\sigma}} \tag{10}$$

The variable ε^* is the optimal level of effort of a representative banker following liberalization. It depends on input and output prices, substitution parameter, technical parameters, and deposits and fixed assets per banking hour. Notice that the term $(1-\xi\omega + a_1)$ is the ratio of hourly income (profit and wages) earned to total revenue generated per hour by the representative banker, i.e., the proportion of revenue that the banker realises as income per hour.[4] We assume that bankers' motivation is positively associated with the reward they receive and the ratio $\frac{\pi + w_1\varepsilon}{pq}$ reflects this. Put differently, following liberalization, bankers are incentivized because their reward (relative income) is likely to improve, which motivates them to exert more effort. Substituting the optimal level of effort (10) into the technical production function (1), we get:

$$Q = BN^{\theta_1}F^{\theta_2}D^{\theta_3} \tag{11}$$

and the share parameters are

$$\theta_1 = \frac{a_1(1-\sigma)}{1-a_1\sigma} \quad (12)$$

$$\theta_2 = \frac{a_2}{1-a_1\sigma} \quad (13)$$

$$\theta_3 = \frac{a_3}{1-a_1\sigma} \quad (14)$$

Whereas equation (1) is a technical relationship between inputs and output, equation (11) additionally captures bankers' optimal responses (efforts) to regulatory changes. We call (11) bankers' optimally feasible production function. Although $\theta_i s$ are empirically different from a_{is}, nonetheless $\sum_{i=1}^{3}\theta_i = 1$, which continues to preserve the CRTS assumption. The parameters of the technical production function, $a_i, i = 1,2,3$, and optimally feasible production function, $\theta_i, i = 1,2,3$, are related through the substitution parameter σ.[5] The technical production function (1) contains an unobservable input, εN, whereas the optimally feasible production function (11) is defined over all observable inputs (N, F and D). The effort parameter is now embedded into the optimal productivity parameter, B, which captures the bankers' optimal response to reforms and liberalization. The banking sector's optimal productivity parameter, B, is given by:

$$B = (a_0\delta)^{\frac{1}{1-a_1\sigma}} (a_1)^{\frac{a_1\sigma}{1-a_1\sigma}} \left(\frac{1}{\mu}\right)^{\frac{a_1\sigma}{1-a_1\sigma}} \left[p(1-\xi\omega+a_1)\right]^{\frac{a_1\sigma}{1-a_1\sigma}} \quad (15)$$

In equation (15) the bankers' effort (incentive) driven productivity (B_{inc}) is captured by the term:

$$B_{inc} = \left[p(1-\xi\omega+a_1)\right]^{\frac{a_1\sigma}{1-a_1\sigma}} \quad (16)$$

B_{inc} is directly affected by the reform-induced changes in the input and output prices that shape the incentive structure of the banking sector. As discussed above, the term $(1-\xi\omega+a_1)$ – the bankers' income relative to the total revenue per hour – is the key element of incentive-driven productivity. The rest of the expression on the RHS of equation (15) is a constant term, which only has a scale effect on B_{inc}. Empirically, this scaling effect is close to unity (see below). If the banking sector productivity improves following liberalization, then we expect an evident positive trend in both B_{inc} and B.

We now proceed to implement our proposed model and extract B_{inc} and B, among other things, for a sample of Nepalese banks post-liberalization.

3. Financial Regimes and Reforms in Nepal

Nepal is one of the poorest countries of the world with a per capita income of current US$ 619. Nepal is landlocked and sandwiched between two giants of Asia, viz. China and India with over a billion populations each. Nepal has a population of 26.40 million.[6]

Nepal has a banking history of over three-quarters of a century – the country's first ever commercial bank was established in 1937 followed by the establishment of the Central Bank in 1956. However, the financial sector was under the firm grip of the authorities until the reforms that concluded in 1994. Only two commercial banks and one development bank operated until 1984 and the financial sector was largely dormant. Banking and financial sector policies were dominated by a socialist banking philosophy, similarly to those in India (Burgess and Pande, 2005).

Nepal Rastra Bank (the Central Bank of Nepal, henceforth NRB) operated a highly controlled regime of interest rate management: "there were about 20 controlled bank rates differentiated between sectors, use of funds and types of collaterals" (NRB, 1996; p 50). The term structures of interest rates were fully controlled. A liquidity requirement of at least 25% – comprising a minimum of 5% of total deposit in government securities and a further 20% of other liquid assets including reserves at the Central Bank – was in operation. Commercial banks were barred from taking foreign currency deposits. A regime of directed credit programmes existed which made it mandatory for banks to channel as high as 25% of their total lending to the State-defined Priority Sectors, encompassing agriculture, cottage industries, exports etc. Interest rates on Priority Sector lending were always set at low levels and commercial banks were penalised if they did not meet the target of directed credit of 25%.

Nepal, for the first time ever in 1984, allowed a very limited access (entry) to joint venture (in a joint investment with Nepalese investors) branches of foreign banks in the country, primarily to ease foreign transactions associated with international trade. This led to the establishment of three foreign joint venture banks under foreign management – Nepal Arab Bank Limited, Nepal Indo Swiss Bank, Nepal ANZ Grindlays Bank – making a total of five commercial banks. This was followed by the first phase of financial liberalization (1986-1989) which mainly focussed on interest rate liberalization. NRB somewhat deregulated its interest rate policy in August 1989 – banks and financial institutions were given some freedom in setting their deposit and lending rates. The first phase of liberalization, although it offered some freedom in interest rate setting, generated few discernible changes in banking activities in Nepal. The second phase of financial liberalization, which started in 1992, aimed at deep and far reaching changes. It focussed on foreign exchange liberalization and opening up of the financial sector. Nepalese currency was made fully convertible into current accounts in 1993 and measures of capital account liberalization were adopted. Commercial banks were authorized to issue credit in foreign currencies; foreign investors could expatriate 100% profit to their habitat. Most importantly, the private sector could enter into the banking and financial sector with ease and with or without foreign participation. This episode of reform concluded in 1994.

This second phase of liberalization consolidated reforms and fully opened up the financial sector, which led to deep structural changes and a restructuring of the Nepalese financial sector. The number of commercial banks increased more than threefold – from 10 in 1995 to 31 in 2013. The number of development banks reached 88 from only three in 1995. Furthermore, a whole host of new types of financial institution have proliferated which either did not exist or had no significant presence pre-1994 reform. They include 69 Finance Companies, 24 Microfinance Development Banks, 16 Savings and Credit Co-operatives, and 36 NGOs (financial intermediaries).[7] The old and large banks also went through deep restructuring. Nepal Bank Limited and Rastriya Banijya Bank, the two oldest and largest commercial banks of the country, respectively, had as high as 56% and 60% of their total loan portfolio classed as non-performing in 2002; both banks had reduced their non-performing loan to around 6% by 2012. Given the scale of structural transformation and the restructuring of the financial sector following the 1992-1994 episode of liberalization, Nepal makes an interesting test case for the financial reforms-led bankers' effort and productivity growth in the banking sector, and we examine this through our analytical model presented in section 2.

4. Econometric Specification and Data

The analytical model presented in Section 2 derives the optimal level of incentivized effort (ε^*) of a banker following liberalization, which is embedded in the optimally feasible production function (11). In order to compute bankers' incentivized optimal productivity, we need to estimate the structural parameters (θ_1, θ_2 and θ_3) of production function (11). The log-linearized auxiliary regression of (11), for a panel of banks, takes the following form:

$$\log Q_{it} = \alpha_i + \gamma_t + \theta_{1i} \log N_{it} + \theta_{2i} \log F_{it} + \theta_3 \log D_{it} + e_{it} \tag{17}$$

(i= 1,…,M; and t=1,…,T).

Specification (17) is a fixed effects panel model. The subscripts "i" and "t" denote the cross-sectional and time series dimensions, respectively; α_i captures the bank-specific fixed effects and γ_t captures the time effects. Since the regression is specified in logarithms, the parameters are elasticities. Equation (17) specifies parameters as bank (panel unit) specific. In the estimation we allow both for the heterogeneity (bank-specific) and the homogeneity (industry-wide) of parameters across panel units. All parameters are expected to resume positive signs *a priori* and one would expect the point estimate (elasticity) of total deposit liabilities to be by far the largest in a bank's production function.

We have obtained complete and consistent quarterly data for 12 major commercial banks of Nepal directly from the office of the Governor of NRB. Although, there were 31 commercial banks in operation in 2013, most of them were small and very new; all 19 banks excluded from the analyses came into operation post-2007. Their short life (data span) precluded them from any credible econometric analysis. Of the 12 sample banks, seven started their operation around the mid-1990s.[8] Due to the short lifespan of the majority of banks in the sample, it is not possible to split the sample between the pre- and post-liberalization periods. Moreover, it is important to note that our analytical model presumes a liberalized and deregulated environment. Banks do not have a free hand to maximize their profitability under a regulated (repressed) regime. Therefore, computations of optimal effort and productivity that we derived analytically in Section 2 are only appropriate under a fully deregulated banking system – i.e., the post-1994 regime in Nepal. Our sample of 12 banks accounts for well over 66% of the banking activities of the country, hence deemed sufficient to discern whether reforms and liberalization have increased bankers' efforts and banking sector productivity in Nepal. Data series include individual banks' total deposits (D), total loans and advances (L), investments (I), fixed assets (F), interest expenses on deposits (RE), interest income (RY), bank staff (NB), staff expenses (NE), other operating expenses (OE) and operating profit (π). The relevant nominal variables are deflated by CPI as the deflator.[9] We have an unbalanced panel of 420 quarterly observations covering a period of 11 years – 2002(Q1) to 2012(Q1).

We would have liked to cover the period from 1994, when the second phase of liberalization concluded, but data constraints became binding. The NRB stated that quarterly data for all banks did not go that far back and made data available since 2002(Q1). Further, as discussed above, banking activities remained lacklustre until 2000 due to Maoist insurgency, which had launched an armed rebellion (People's War) in 1996. When Maoist rebels entered into dialogue for peace post-2000, financial activities soared, ushering fundamental changes into the country's financial sector. Hence, our sample arguably covers the most intense period of financial activities in post-liberalization Nepal.

5. **Empirical Methodology**

Macro-panel data of this nature are widely reported to be non-stationary (unit root) processes (see, among others, Luintel et al., 2008), requiring an application of non-stationary panel data econometrics in estimating the parameters of (17). Panel unit root and panel cointegration tests are shown to have better power properties than the time series tests in small or moderate samples.

A number of panel unit root tests are proposed in the literature which can be summarized as the first and second generation tests. The former assume cross-sectional independence – a prickly issue in macro panel data – while the latter allow for cross-sectional dependence. The frequently applied first generation panel unit root tests in the empirical literature include those of Im, Pesaran and Shin (2003; hereafter IPS), Fisher-ADF (Maddala and Wu, 1999) and Hadri (2000). The IPS test tests the null of a unit root for each cross-sectional unit against the alternative that only a fraction of cross-sectional units may contain a unit root. This test does not maintain stationarity across all groups under the alternative hypothesis. Further, it also allows for the heterogeneity of persistence, dynamics and error variance across groups.

The Fisher-ADF test employs the p-values of a unit root test. Under the null of a unit root for all M (cross-sectional) units, the quantity: $\sum_{i=1}^{M}\log(\psi_i)$ is asymptotically χ^2_{2M}; where ψ_i is the p-value of the unit root test on the ith series of the ith panel unit. Hadri's test tests the null of stationarity against the alternative of a unit root; a common persistence parameter is assumed across all cross-sectional units. Hadri also derives autocorrelation and heteroskedasticity consistent LM tests under the null of stationarity. Hlouskova and Wagner (2006), however, warn that Hadri's tests suffer from size distortion in the presence of autocorrelations.

The second generation tests are relatively new and are gaining momentum in empirical applications for obvious reasons. Gengenbach et al. (2010) show that the cross-sectionally augmented IPS (CIPS) test (Pesaran, 2007) is one of the powerful second generation panel unit root tests. This test accounts for both cross-sectional dependence and residual serial correlation while testing for the null of a unit root. For the sake of robustness, we employ IPS, Fisher-ADF, Hadri and the truncated CIPS tests on each of the data series of our panel.

Pedroni (1999) and Kao (1999), among others, propose panel cointegration tests to explore if non-stationary panel data form a linear cointegrating (long-run equilibrating) relationship. They are residual-based tests of cointegration – extensions of the time series tests of Engle and Granger (1987) on panel settings. Pedroni (ibid.) proposes seven tests of panel cointegration – four of them are within-dimension tests that assume homogeneous cointegrating vectors across panel units and the remaining three are between-dimension tests (referred to as Group Mean Statistics), which allow for heterogeneous cointegrating vectors across panel units. The between-dimension estimators exhibit lower size distortions than the within-dimension estimators and the group t-statistic is shown to be the most powerful one amongst the three between-dimension panel cointegration tests (Pedroni, 2004). The Kao (1999) test is similar to Pedroni's tests except that Kao allows for heterogeneous intercepts but assumes homogeneous slope parameters across panel units. We report a range of cointegration tests proposed by Pedroni (1999) and Kao (1999) so that we could reach a robust conclusion on the cointegrating relationship vis-à-vis our institutional production function.

The OLS level regressions, employed to test cointegration in the panel, are not informative of the significance or otherwise of the cointegrating vectors because of the well-known inference problems (cf. Engle and Granger, 1987). Therefore, we estimate the cointegrating parameters through Fully Modified OLS (FMOLS; Phillips and Hansen, 1990) and Dynamic OLS (DOLS; Stock and Watson, 1993; Kao et al., 1999).

6. Empirical Results

Results of panel unit root tests are reported in Table 1. The first three columns pertain to the first generation of panel unit root tests. The IPS and ADF-Fisher tests do not reject the null of a unit root for any of the level series in the panel. Hadri's test decisively rejects the null of level stationarity. Both types of first generation tests (those testing the null of a unit root and the null of stationarity) reveal that our panel data are non-stationary. This is further confirmed by the CIPS – a second generation – test which accounts for cross-sectional dependence. CIPS tests cannot reject the null of unit root for any of the data series in our panel. The results in Table1 are based on the most general specifications, which include cross section-specific intercepts and linear trends. All individual series in the panel are found to be first-difference stationary, signifying that our panel data series are unit root processes.[10]

Table 1 about here

Table 2 reports the results of panel cointegration tests on bankers' optimally feasible production function (11). Both the between-dimension and the within-dimension tests proposed by Pedroni (1999) are reported. These tests are performed under two deterministic settings: (i) bank-specific constant only, and (ii) bank-specific constants and linear time trend. We also report the panel cointegration tests proposed by Kao (1999) for the sake of robustness. We attach more importance to the between-dimension tests and, particularly, the $t_{Pedroni} - test$, which is shown to have better power properties.

Table 2 about here

The null of non-cointegration of bankers' log linearized institutional production function (17) is decisively rejected by all the tests reported in Table 2. The precision of these tests is very high and the results are robust to different test methods that vary considerably in their underlying assumptions. Overall, there is strong empirical support for the bankers' optimally feasible production function as a long-run equilibrium relationship.

Estimates of the cointegrating parameters (vectors) are reported in Table 3. Results show that two covariates of institutional production function, namely the bank staff and the total deposit liabilities, appear positively signed and highly significant across all specifications, which is consistent with *a priori* expectations. The stock of total fixed assets, however, shows mixed results. It appears positive and statistically significant under pooled (within-dimension) estimators but insignificant under Grouped (between-dimensions) estimators. The insignificance of total fixed assets is somewhat surprising but this may be partly explained by the relative constancy (the lack of sufficient variation) of fixed assets in these banks.[11]

Table 3 about here

One of the fundamental assumptions of our analytical model is that the bankers' production function follows CRTS. We explicitly test this restriction and report the results in row $\Re_1$. In no case is the CRTS restriction rejected by the data. We re-estimate two (Grouped) specifications by dropping the insignificant $\log F_{it}$ variable and re-assessing the CRTS assumption. Results show that CRTS is maintained.

On balance, one would prefer the between-dimension FMOLS estimates of industry-wide parameters because they allow share parameters to differ across individual banks. The within-dimension (Pooled) estimates treat the share parameters as being the same across all banks. In view of the significance of all three covariates, we report simulation results based on the pooled FMOLS estimates; however, the qualitative nature of our simulation results is robust, irrespective of the set of parameters used.

It is important to note that although the CRTS is not rejected statistically, the sum of the point estimates of the within-dimension estimates under FMOLS amounts to 1.049 rather than 1.0 but we need parameters to sum exactly to unity for simulations. Since the sum of these point estimates is 4.9% higher than unity, we scaled down all three parameters by 4.9% each and tested whether this restriction is data acceptable. Indeed, we find the scaled down parameters of $\theta_1 = 0.057$, $\theta_2 = 0.027$ and $\theta_3 = 0.916$, which sum to unity, are data acceptable – a test of these parametric restrictions as the cointegrating vector generates a p-value of $\chi^2(3) = 0.110$ under the null. We use these data congruent parameters which pass CRTS restrictions and sum to unity for simulations.[12]

7. Bankers' Incentive and Bank Productivity

In order to simulate the bankers' optimal level of effort (10) and the incentivized optimal productivity (15), we need solutions for the parameters of technical production function (1) – $a_{0,}a_1, a_2, a_3$; the elasticity of substitution, σ; the disutility parameter, μ; and the series of input and output prices – w_1, w_2, w_3 and p. We use the CRTS consistent estimates of $\theta_1 = 0.057$, $\theta_2 = 0.027$ and $\theta_3 = 0.916$ as the structural parameters of production function (11). Given the restriction $\sigma \in (0,1)$, some iterations reveal that for $\sigma \in [0.40, 0.55]$ the system robustly converges, hence we report the simulations pertaining to $\sigma = 0.51$. The parametric value of $\sigma = 0.51$ combined with equations (12), (13) and (14) and the point estimates of $\theta_i s$ provide solutions to the technical parameters: $a_1 = 0.110$, $a_2 = 0.025$ and $a_3 = 0.865$. The remaining parameters ξ and a_0 are related through the equilibrium condition $\xi = \dfrac{1}{a_0 a_1^{a_1} a_2^{a_2} a_3^{a_3}}$. Since all denominators are constants, we set $a_0 = 1$ which gives $\xi = 1.586$. [13] The disutility parameter has a scale effect on the optimal level of effort (ε^*) and productivity (B). Simulations conveniently converge for $\mu \in [0.09, 0.4]$ hence we employ $\mu = 0.10$. Iterations reveal that for wide-ranging values of $0.01 \le \mu \le 10$ the simulated values of ε^* and B remain fairly robust.

The marginal cost of bank staff (w_1) is proxied by the average hourly wage rate of a banker in 12 sample banks. Each bank employee is assumed to work 40 hours per week and there are 48 bank working weeks per year giving, on average, 12 bank working weeks per quarter.[14] However, the simulated results remain robust to hourly wages based on 36-44 working hours per week and/or 13 weeks per quarter. The unit cost (shadow price) of total fixed assets (w_2) for the i[th] bank is taken to be the deposit weighted market (market for the i[th] bank is defined as all the banks in the sample except the i[th] bank) interest (one year fixed deposit) rate. The unit cost of deposits (w_3) is the average deposit rate (total interest payment on deposits/total deposits) for each bank. The unit output price (p) is computed as the ratio of loan interest income to total bank loan (i.e. the average unit price of a bank loan). Using the above parameter values and input-output prices, we simulate, among others, bankers' optimal level of effort, effort-driven productivity, average input cost and revenue per unit of bank output, and the spread for the banking industry.

Figure 1 plots the banking sector's average input cost per unit of output, average output price and the bank spread (banks' unit output price minus the unit input price). This is also the measure of bank profit per unit of aggregate bank output. The average input cost per unit of output is calculated as $\xi\{\prod_i w_i^{a_i}\}$ from equation (6) and the average output price (p) is as defined above. These average unit cost-price measures are per Nepalese rupee of bank output (i.e. the rental cost of inputs to produce one rupee of bank output and the price of that output).[15] Commercial banks' average cost and average revenue (price per unit of output) have changed over the years – both have increased. Plots indicate that the bank spread declined during 2003(Q3) - 2004(Q4); it then slightly picked up in 2005(Q1) and remained at a higher level until 2006(Q4); subsequently it narrowed down a little until 2010(Q4) and again slightly opened up thereafter. Our calculations show an average spread of 3.25 percentage points for the whole period (2003-2011); 3.3 percentage points for 2003-2008 and 3.17 percentage points for 2009-2011. Nepalese commercial banks' spread appears to have narrowed down in recent years indicating competitive pressure. One striking feature is that since 2008(Q4) the bank spread has become smaller than the input cost per unit of output. This suggests that while banks have managed to hold on to their spread by transmitting costs to their customers, the banking services in general have become considerably more expensive in Nepal in recent years. The overall cost of banking, measured by the average cost and price per unit of bank output, shows a positive upward trend in recent years.

Bankers' optimal effort index, plotted in Figure 2, shows some fluctuations, but the overall trend is clearly an upward one. During the initial years (2004-2006), the optimal effort index shows a sharp rise but it decelerates quite sharply for a brief period from 2007(Q1) - 2007(Q4). The effort index then recovers and shows a rapid rise since 2009(Q3). Overall, the optimal level of bankers' effort appears to have increased by 43% by the end of 2011 compared to its level in 2004. Plots also reveal that the banks' actual profit increases sharply, peaking at 70% higher in 2010 than its 2004 level. The index of actual output (loans and investment) peaks during 2008-2009 at 46% higher than its 2004 level. The bank output index decelerates during 2009(Q3) - 2010(Q1) and then shows signs of slow recovery thereafter. The profit index takes a dip in 2010(Q3). These recent declines in output and profit indices are due to the slump in Nepal's real estate market which began in 2008 and has yet to turn its corner. Despite some dents in profitability, the optimal effort index shows a continuous rise.

The banking sector's total optimal incentivized productivity (B) is plotted in Figure 3. We also plot the unscaled component of B , which is B_{inc} , just to illustrate that scaling really does not matter in capturing the productivity trend. In fact, the scaling factor on the RHS of equation (15) resumes a value of 1.013, which implies that the role of technical parameters in our measure of incentive (effort) driven optimal productivity is virtually nil (these parameters are treated as fixed). The optimal productivity shows a clear positive trend during the whole period of post-liberalization under analyses with a sharp blip in 2006(Q1). This sharp rise in productivity is credited to the Peace Accord of 2005 between the war waging Maoists and the political parties of Nepal which effectively ended the People's War. The cessation of Maoists' insurgency reduced uncertainty which led a sharp upturn in banking activity (also see Figure 2) and productivity.[16] During the post-liberalization period under analysis, the Nepalese banking sector's productivity appears to have increased by around 1% a year, on average.

The derivation of incentive-driven optimal productivity (B) treats technical parameters as constants.[17] However, technology changes over time. It is, therefore, important to establish what proportion of the banking sector TFP (total factor productivity), measured by Solow Residuals using the CRT consistent θ_s, is accounted for by the bankers' incentive-driven optimal productivity. Figure 4 plots the proportion of TFP accounted for by the incentive-driven productivity (B); the plot shows that this proportion is quite oscillatory. The proportion of TFP accounted for by B increased from around 41% to 47% during 2003-2008 however it then dropped to around 39% in 2010 and recovered somewhat thereafter – the sample average is 43%.

A comparison of the optimal effort index (in Figure 2) and optimal bank productivity (in Figure 3) reveals that during the initial years (2004-2006) both bankers' efforts and bank productivity went hand-in-hand; they increased. However, during 2007(Q1) - 2007(Q4), the effort index declines rather sharply, which coincides with the flat bank productivity. However, the effort index shows a rapid rise since 2009(Q3) which again coincides with a positive productivity trend, albeit somewhat less steep. One possible explanation of the relatively slower productivity growth is that after some initial years of productivity push, bankers' effort may have focussed on quantity (volume). This is borne out by the sharp rise in the volumes of deposits and credits post 2010(Q2) which are plotted in Figure 5. These sharp rises in deposits and credits are at the backdrop of the fall in their volumes during 2008(Q3) - 2009(Q4).

Finally, we formally test if the bankers' effort statistically explains the incentivized productivity by regressing the index of optimal total productivity on the index of bankers' effort. Both OLS and Instrumental Variables estimates reveal that bankers' effort significantly explains the optimal bank productivity. A 1% increase in bankers' effort increases the banking sectors' optimal total productivity by roughly 0.33%.[18]

8. Conclusion

A large body of literature examines whether banking sector efficiency and productivity improves following financial deregulation and reforms, as the proponents of such policies claim. The literature mainly employs non-parametric DEA to investigate some of these issues. We model commercial banks as profit-cum-utility maximizing firms in a parametric approach. Our approach differs from DEA, hence complements the literature. We provide a micro-founded general framework for the analyses of bankers' optimal level of effort (self-motivated incentive) and effort-driven productivity following financial liberalization and deregulation of banks. We proxy *ex post* bank risk through the ratio of non-performing bank loans. Our analytical model also captures issues such as unit prices of banks' inputs and output, optimal wages, bank spread and the overall cost of bank services. They are issues of relevance in judging the successes and/or failures of liberalization and reform policies.

As a test case, we empirically implement our model to scrutinize a panel of Nepalese commercial banks and evaluate if deregulations and reforms have worked in Nepal. Nepal concluded her deep financial reforms in 1994, which has profoundly transformed the country's banking and financial system. Using the analytical tools of our model, we find that financial liberalization has made Nepalese bankers more effort oriented – evidence shows a clear rise in the level of bankers' efforts following liberalization. Nepalese bankers' optimal level of effort has increased considerably (by 43% during the period under analysis) and appears on an upward trajectory, albeit at a slower pace. Likewise, the banking sector's effort (incentive) driven productivity has also risen by 1% a year, on average, post-liberalization (2003-2012). The association between the optimal levels of effort and optimal productivity seemed very close in the early years of liberalization but appeared somewhat opaque in later years. *Prima facie* evidence suggests that after the initial years of productivity push, bankers might have focussed on quantity (volume) rather than quality (productivity). Nonetheless, formal tests show that the bankers' optimal effort significantly explains the banking sector's optimal productivity in Nepal. Our calculations show that effort-driven productivity accounts for slightly over 40% of banking sector TFP (measured by Solow Residuals) in Nepal. Remarkably, the overall proportion of performing loans to total loans has increased from 76% in 2003 to over 96% in 2012.[19]

Finally, we find that Nepalese banks earned an average bank spread (profit per unit of bank output) of 3.25 percentage points during the sample period but this has slightly declined in recent years (3.17 percentage points), perhaps reflecting the competitive pressure. However, a downside is that the banking services in Nepal have become costly in recent years – the average cost and price per unit of bank output has increased notably. The latter is, however, not unexpected, given that deregulation abolishes authorities' control on interest rates and various concessionary lending programmes. Overall, financial liberalization and reforms have been a good experience for Nepal, especially from the perspectives of more incentivized (effort-oriented) bankers, increased optimal productivity and higher volume of deposits, credit and bank profitability. We hope our proposed model (analytical framework) and the test case study prove useful and motivating for extending this strand of research.

Table 1: Results of Panel Unit Root Tests

	IPS [W-Stat]	ADF-Fisher [Chi-Square]	Hadri [Consistent Z-stat]	CIPS
lnQ	0.898	0.374	0.000	-0.246
lnN	0.914	0.930	0.000	-0.164
lnF	0.326	0.401	0.000	-0.360
lnD	0.542	0.369	0.000	-0.371

For all tests, except for the CIPS, P-values under the null are reported. For CIPS t-ratios are reported. The 5% critical value for the CIPS test for T/M (200/15) is -2.25; where T is the sample size and M is the cross-section units. The null under all test statistics, except that of Hadri, is unit root; the latter tests the null of stationarity. The sample consists of 420 unbalanced panel observations. In all tests, constant and linear time trends are included as exogenous variables. Given the quarterly data, the lag length is set to 4 for all tests except the CIPS where second order lag is used. CIPS requires lead and lag augmentations. W-Stat is the standardized $\bar{t}_{NT}$ test of IPS. ADF-Fisher tests are χ^2 (24)-distributed. The Hadri test is computed using Newey-West bandwidth selection and Bartlett kernel; heteroskedasticity-consistent Z-statistics are reported. CIPS is the cross-sectionally augmented IPS tests (a second generation test). The variable mnemonics are: lnQ = log of real total loan and investment (output measure), lnN = log of number of bank staff, lnF = log of total fixed assets in real terms, lnD = log of total deposits in real terms.

Table 2: Results of Panel Cointegration Tests

	Between Dimension (Group Mean)		Within Dimension (Pooled)	
	α_i	α_i & γ_t	α_i	α_i & γ_t
$\rho_{Pedroni} - test$	-4.835(0.000)[a]	-2.995(0.001)[a]	-6.146(0.000)[a]	-4.817(0.000)[a]
$t_{Pedroni} - test$	-11.922(0.000)[a]	-12.732(0.000)[a]	-9.755(0.000)[a]	12.839(0.000)[a]
$t_{KAO} - test$	NA	NA	-19.183(0.000)[a]	NA

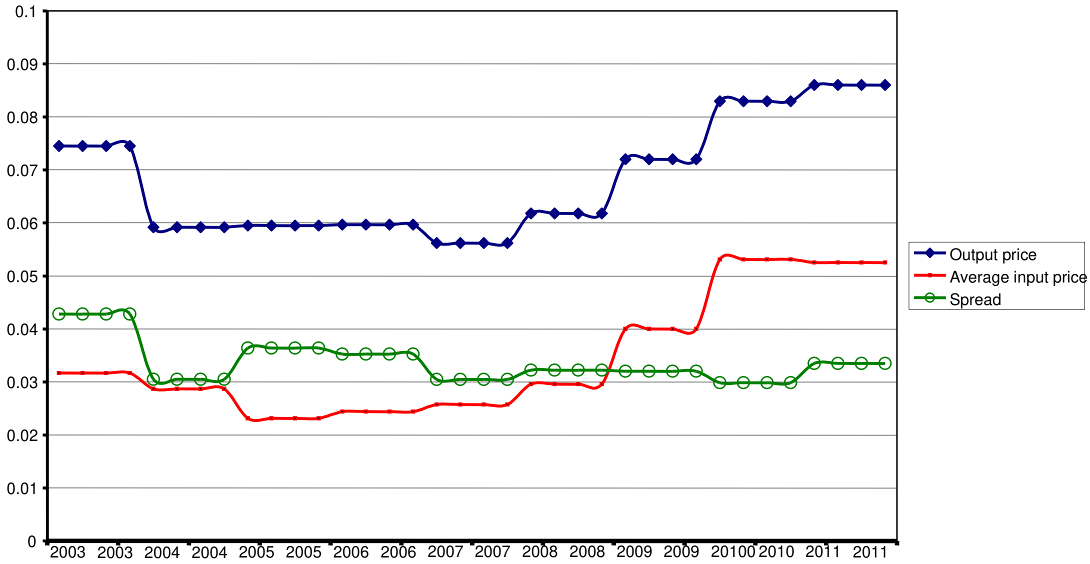
$\rho_{Pedroni} - test$ and $t_{Pedroni} - test$ are panel rho- and ADF-statistics of Pedroni (1999); $t_{KAO} - test$ is the ADF_t-statistic of Kao (1999). Columns α_i and α_i & γ_t indicate the deterministic component in the model, namely, constants (fixed effects) only, and constants and linear time trends. Lag lengths are based on SIC information criteria. Superscripts "a" denote significance at 1% or better. Kao test statistics are a within-dimension test which allows fixed effects only, hence NAs in three columns.

Table 3: Estimated Cointegrating Parameters

	$\log Q_{it} = \alpha_i + \gamma_t + \theta_1 \log N_{it} + \theta_2 \log F_{it} + \theta_3 \log D_{it} + e_{it}$ (11)					
	FMOLS			DOLS		
	Grouped		Pooled	Grouped		Pooled
θ_1	0.146[a] (0.000)	0.115[a] (0.005)	0.060[b] (0.050)	0.214[a] (0.002)	0.136[a] (0.005)	0.060[b] (0.041)
θ_2	-0.013 (0.673)	-	0.028[b] (0.039)	-0.053 (0.240)	-	0.033[a] (0.010)
θ_3	0.888[a] (0.000)	0.891[a] (0.000)	0.961[a] (0.000)	0.800[a] (0.000)	0.848[a] (0.000)	0.937[a] (0.000)
$\Re_1$	0.686	0.900	0.126	0.625	0.758	0.344

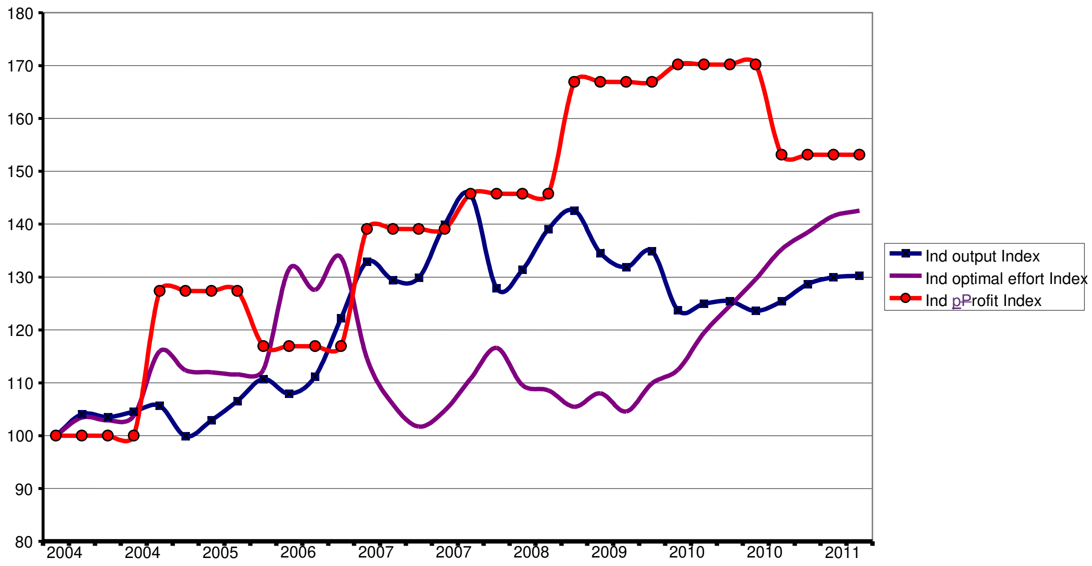
FMOLS is the fully Modified OLS of Phillips and Hansen (1990) as shown in Panel setting by Pedroni (2001). DOLS is the Dynamic OLS as described in Kao et al. (1999). Given their significance, both deterministic terms (bank specific constants and linear time trends) are retained in the estimation. Figures within parentheses (.) are p-values under the null. $\Re_1$ reports the P-values of the test of the null of CRTS, i.e., $\theta_1 + \theta_2 + \theta_3 = 1$; the test statistic is $\chi^2(1)$ distributed. Under the between-dimension specifications $\log F_{it}$ appears insignificant; we also report results excluding this insignificant covariate. Superscripts "a" and "b" denote significance at 1% and 5% or better.

Figure 1: Average input cost, output price and spread (industry)



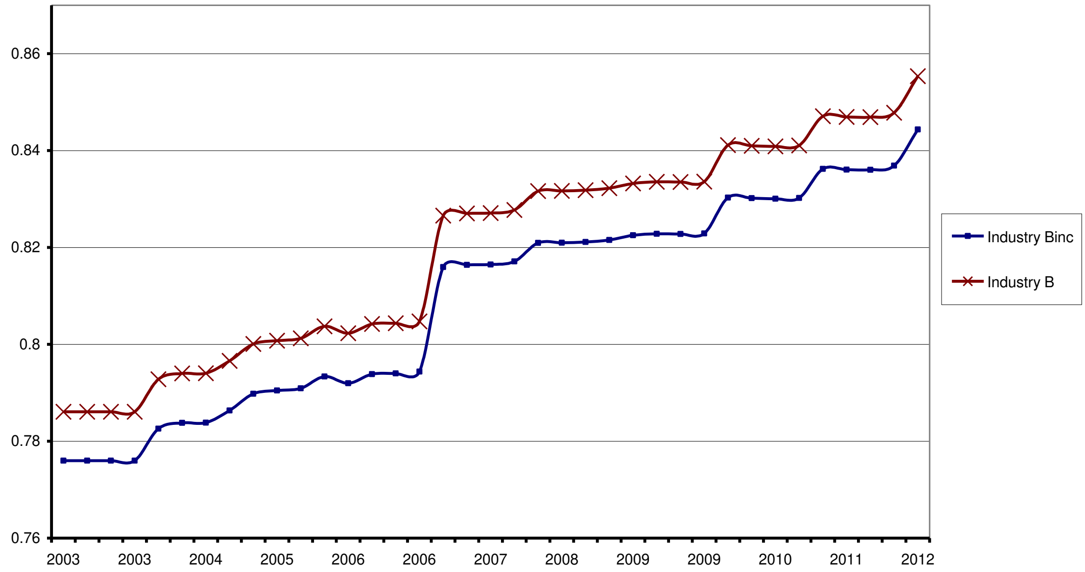
Industry implies the banking sector, comprised of 12 sample banks. The average input cost per unit of output is calculated as $\xi\{\prod_i w_i^{a_i}\}$ from equation (6). The average output price is the average loan rate computed as the ratio of loan interest income over total bank loan. The average input cost, output price and spread (profit) are per unit of bank output. In the vertical axis 0.1 means ten paisa. One Nepalese rupee consists of 100 paisa.

Figure 2: Industry optimal effort index (2004=100), actual output index and actual profit Index.



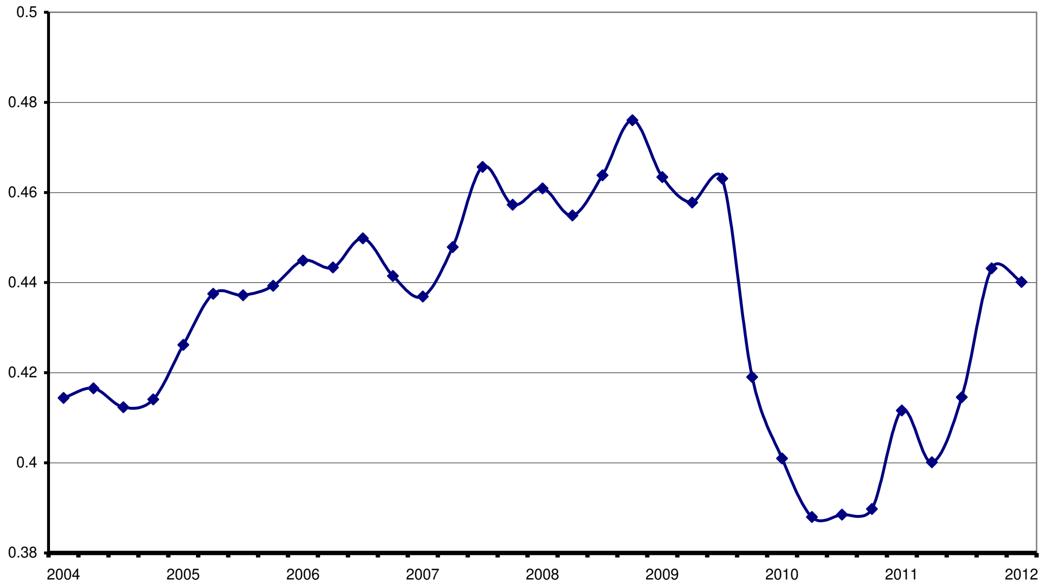
Industry implies the banking sector, comprised of 12 sample banks. Output and profit index are actual figures for the banking sector. The optimal effort index is the simulated series, equation (10).

Figure 3: Banking Sector's Optimal Productivity: (B) and (B_{inc})



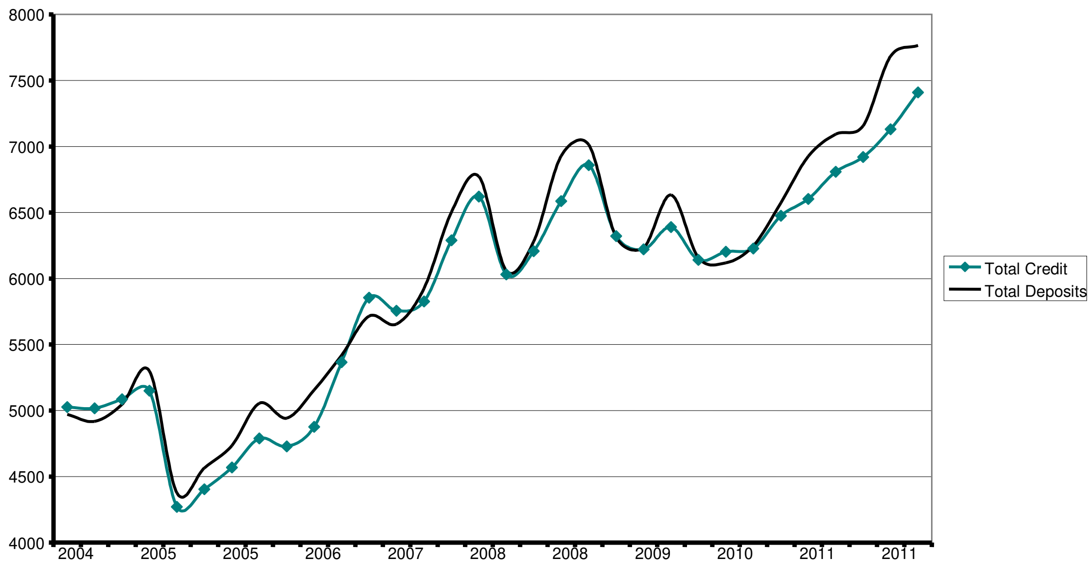
The banking industry implies 12 sample banks. The banking sector's optimal productivity (B) is as in equation (15) and unscaled, B_{inc} , as in equation (16). Plots are absolute figures not indices.

Figure 4: Proportion of TFP (measured by Solow Residuals) explained by the incentive-driven productivity (B).



The industry implies the banking sector comprised of 12 sample banks. The banking sector's Solow Residual-based TFP is computed using the θ parameters of institutional production function (equation (11)). The incentive-driven optimal total productivity, B, is defined in equation (15).

Figure 5: Total Credits and Deposits of Commercial Banks, Millions of Rupees (2004-2012).



The industry implies a banking sector comprised of 12 sample banks. Plots are actual total deposits and credits of the 12 sample banks.

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[1] Some of these studies subsequently employ parametric methods to model the productivity and efficiency measures computed through DEA.

[2] The non-zero profit in the long-run raises the theoretical possibility of banks producing an infinite amount of output. While we acknowledge this theoretical possibility, we do not regard it as being of much practical relevance.

[3] Lack of data prevented us from using the off-balance-sheet items in our measure of bank output. However, our measure of bank output is consistent with those of Delis et al. (2011), among others.

[4] To see this, equation (8) gives per hour profit to total revenue ratio, $\frac{\pi}{pq} = 1 - \xi\omega$. And from $w_1\varepsilon = a_1 pq$, one can derive the per hour effort augmented wage income to total revenue ratio, $\frac{w_1\varepsilon}{pq} = a_1$. Hence, the term $(1 - \xi\omega + a_1)$ is simply equal to $\frac{\pi + w_1\varepsilon}{pq}$, i.e. the ratio of per hour income to per hour total revenue.

[5] It is trivial to show from (12), (13) and (14) that: $a_1 = \frac{\theta_1}{1 - \sigma(1 - \theta_1)}$,

$a_2 = \theta_2\left[1 - \left(\frac{\theta_1}{1 - \sigma(1 - \theta_1)}\right)\sigma\right]$ and $a_3 = \theta_3\left[1 - \left(\frac{\theta_1}{1 - \sigma(1 - \theta_1)}\right)\sigma\right]$.

[6] Data on GDP per capita in current US dollars are for 2011 and obtained from the World Bank at http://www.worldbank.org/en/country/nepal; accessed in Oct 2013. Population figures are from the 2011 census, Nepal.

[7] Figures on the growth of financial institutions are taken from Banking and Financial Statistics, mid-July, 2012, No. 58, NRB.

[8] The 12 commercial banks covered are: Bank of Kathmandu Ltd. (1995), Everest Bank Ltd. (1994), Global Bank Ltd. (2007), Himalayan Bank Ltd. (1993), Kumari Bank Ltd. (2001), Laxmi Bank Ltd. (2002), Machhapuchchhre Bank Ltd. (2000), Nabil Bank Ltd. (1984), Nepal Bank Ltd. (1937), Nepal Investment Bank Ltd.

(1986), Rastrya Banijya Bank Ltd. (1966) and Standard Chartered Bank Nepal Ltd. (1987). Figures within parentheses (.) indicate the date of bank operation.

[9] Data on quarterly GDP deflator are not available in Nepal.

[10] Results of first difference stationarity are not reported, to conserve space, but are available on request.

[11] The fixed assets of banks tend to change slowly compared to bank output, employment and total deposit liabilities.

[12] The parameter estimates of the last column of DOLS results reported in Table 3 sum to 1.03. A reduction of 3.0% of each parameter to make them sum to unity is also not rejected by the test. The p-value of the test is $\chi^2(3) = 0.194$. The Grouped parameters under FMOLS and DOLS sum to 1.006 and 0.984, respectively (columns which delete the insignificant F_{it}).

[13] Parameter a_0 is the constant term of the technical production function (equation (1)). The estimates of the constant term of the production function (11) range between 0.024 to 2.498 under different specifications (not reported in Table 3). Our simulation results are robust to values of $0 \le a_0 \le 10$.

[14] The average hourly wage rate (w_1) is calculated as follows. First, the quarterly average wage bill for staff is computed by dividing the total quarterly wage bill by the total number of staff. Then the quarterly average wage bill is divided by 40x12; where 40 represents the hours worked per week and there are 12 working weeks in a quarter.

[15] Nepalese currency is known as rupees and one rupee consists of 100 paisa.

[16] We thank seminar participants at Nepal Banker's Association, Kathmandu (2013) for this insight.

[17] A time varying approach of estimation would allow the technical parameter to be time dependent but data constraints preclude us from using it.

[18] The estimated regression is: $\log B = 3.120 + 0.331 \log \varepsilon^* - 0.003\,\mathrm{sldmy}$; where B is the index of simulated total optimal productivity, ε^* is the index of simulated optimal effort and 'sldmy' is the slope dummy for 2006(1)-(2) to capture the blip in productivity (see Figure 3). The constant term and the slope parameters resume p-values of 0.000, 0.000 and 0.402, respectively, hence are statistically highly significant except for the slope dummy. The insignificance of the slope dummy implies the productivity blip of early 2006 is not due to the bankers' effort. As discussed in page 20 (footnote 16) this is consistent with the exogenous factor – cessation of Maoist armed insurgency. The reported results pertain to the first order residual serial correlation (AR(1)) corrected IV estimates. The lagged value of ε^* is used as instrument. The R-bar square is 0.59 and DW statistic is 1.96.

[19] A time series plot of the ratio of performing to total loans and a brief commentary could be found in the earlier version of this paper listed as: "Reforms, Incentives and Banking Sector Productivity: A Case of Nepal;" Cardiff Working Paper No. E2014/14.