The impact of regulatory reforms on cost structure, ownership and competition in Indian banking

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Abstract:
Despite the fact that processes of deregulation and concomitant prudential re-regulation have recently been a dominant feature in financial markets of both developed and developing countries, relatively little empirical work has been done on their impact on bank competition and performance. This paper examines the impact of financial sector reforms on the cost structure characteristics and on the ownership-cost efficiency relationship in Indian banking. Following Battese and Coelli (1995) we employ a stochastic cost frontier approach on a balanced panel dataset which includes public sector, domestic private and foreign banks continuously operating in India throughout the period 1992-2004. We also examine the impact of reforms on the dynamics of competition in the lending market by estimating the persistence of the overcharge (the price-marginal cost ratio) through a partial adjustment model. Results suggest that Indian commercial banks have responded to the new regulatory environment by changing both the input mix and the output composition. The relationship between bank ownership and cost efficiency appears also to be affected. There is evidence of increased competition in the lending market in the latest stages of the reform process, at the time of the tightening of prudential norms. The coexistence of deregulation and prudential re-regulation seems to promote competition and consequently cost technology progress.

Key words: Deregulation; Re-regulation; Banking competition; Ownership; Stochastic Frontier Analysis

JEL Classification: G21; G28; G32; D24; C13

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1. Introduction

Financial deregulation and concomitant prudential re-regulation have recently been a dominant feature in financial markets of both developed and developing countries. While the deregulation process aims to improve banking sector performance via increased competition, the aim of prudential re-regulation is to foster stability and minimise excessive risk taking. Despite the fact that a deregulation-prudential re-regulation framework has widely been adopted by policy makers, relatively little empirical work has been done on the impact of such process on banks' competition and performance. This study aims to fill this gap, with particular reference to the reform of the Indian commercial banking sector during the period 1992-2004.

The Indian reform experience (see Narasimham, 1998)) is not only of interest *per se*, but is also suited to fulfil our research objectives. First, its deregulation process has been accompanied by increased prudential supervision. Second, public banks operate alongside domestic private and foreign banks, and the three ownerships are subject to a uniform regulatory framework. This offers an opportunity to investigate the impact of regulatory change on the ownership-cost efficiency relationship in a market with a level playing field. Finally, since the Indian banking system shares similar characteristics with other Asian countries, many of which have embarked on a deregulation path or are contemplating to do so, this analysis may provide useful policy suggestions to the Asian region.

In detail, this study examines the effect of deregulation and prudential re-regulation on the cost structure characteristics and on the ownership-cost efficiency relationship in Indian commercial banking. Following Battese and Coelli (1995), we employ a stochastic cost frontier approach to estimate the efficient cost structure and the determinants of cost inefficiency on a balanced panel dataset that includes public sector, domestic private and foreign banks continuously operating in India throughout the period 1992-2004. Using the marginal cost of loans derived from the stochastic cost frontier, we further examine the impact of regulatory reform on the dynamics of competition in the lending market by estimating the persistence of the overcharge (the price-marginal cost ratio) of loans through a partial adjustment model. Results suggest that Indian commercial banks have responded to the new

regulatory environment by changing both the input mix and the output composition. The relationship between bank ownership and cost efficiency appears also to be affected by the regulatory process. Finally, there is evidence of increased competition in the lending market in the latest stages of the reform process, at the time of the tightening of prudential norms. The rest of the paper is organised as follows. Section 2 reviews the general background of the Indian banking system. Section 3 discusses the existing literature on the effects of financial reforms on banks performance and competition. Section 4 describes the methodology, the data and the variables used. The empirical results are illustrated in Section 5 and Section 6 concludes.

2. The Indian banking sector and regulatory environment

The Indian government started its banking sector reform in 1992. The objective was to facilitate a diversified, efficient and competitive banking system with the ultimate target of contributing to the development of the economy. The whole reform programme was led by two Narasimham Committee reports, in 1991 and 1998 respectively. As a consequence, the reform process can be divided into two stages. The first stage relates to regulatory changes aimed at promoting competition (1992-1997). The second stage, started in 1998, aimed at strengthening financial stability.

Structural deregulation was characterised by the liberalisation of interest rates on deposits and lending; the removal of restrictions on entry and on private ownership; and the increase of the range of permissible banks' activities. From 1998 onwards, the emphasis of the reform process focussed on the stability of the banking system. For example, prudential norms on assets classification, income recognition, provisioning on non-performing loans and risk-based capital requirements became progressively more important, particularly against the backdrop of the Asian crisis. Among the major prudential policy initiatives post-1997 were the introduction of the CAMELS[1] annual supervision system in 1997, the increase of the risk-based capital adequacy requirement to 9% (effective from March 2000), and the introduction of a 90-day delinquency norm for the classification of non-performing loans.

[1] CAMELS refer to supervision of Capital adequacy, Asset quality, Management quality, Earnings, Liquidity and System evaluation.

The whole reform process aimed to create a level playing field among different ownership; regulatory policies relating to interest rates, prudential norms and reserve requirements were applied uniformly across banking groups. However, priority sector credit requirements are still in place, with different targets for domestic and foreign banks[2]. The entire reform process was defined as "gradualist" because policy measures were taken in a step-by-step fashion after consultation with experts and market participants.

Table 1 illustrates the changing structure of the Indian banking sector over the reform period, with reference to scheduled commercial banks[3] (excluding regional rural banks). At the end of 2004, the 27 public sector (state-owned) banks accounted for 75% of the market share in terms of total assets (their market share in terms of total lending and total deposits is again greater than 70%), a decrease of 19% compared to 1992. Due to the reforms opening up the sector to private ownership, both domestic private and foreign banks increased in number[4]. Their relative market share also increased, although foreign banks still remain rather marginal. In terms of concentration ratios, both the CR5 and the Herfindahl-Hirschman Index (HH) show a decreasing trend over the sample period. The high CR5 but rather low HHI indicate the inequality of market shares across scheduled commercial banks, as confirmed when looking at the changes in bank numbers and respective concentration values, and at the decreasing variance in market shares, indicative of a reduction in their inequality over time.

<Insert Table 1>

Table 2 provides some descriptive statistics of selected banking indicators. The spread, measured both as the difference between the implicit credit rate and deposit rate, and as the gap between the implicit credit rate and the average price of loanable funds, is decreasing over time, which is consistent with increased competition fostered by the reform process. The data also reveal a growing preference for safer, more liquid other earning assets, especially

[2] The Indian government requires banks to allocate a specified portion of their lending (40% for domestic banks and 32% for foreign banks) to priority sectors. Priority sectors are defined by the Reserve Bank of India and include, among others, agriculture, small scale industries, education and housing.

[3] Scheduled commercial banks refer to those banks that have paid up capital and reserve of no less than Rs 500,000 and other conditions specified by the Banking Regulation Act of 1965. Scheduled commercial banks consist of public, private, foreign and regional rural banks.

[4] Between 1994 and 2001, nine new domestic private and twenty six new foreign private banks entered the Indian banking sector.

government securities. Lending, as a ratio of total earning assets, decreases whilst investment increases. Moreover, the ratio of government and other approved securities to deposits (the statutory liquidity ratio, or SRL) remains higher than the prescribed minimum level over the whole sample period[5]. The incentive for Indian banks to hold other earning assets could reflect their decisions on portfolio composition in view of the high non-performing loans inherited from the pre-reform period, the increasing risk exposure in a deregulated environment and the increasing pressure imposed by the maintenance of capital adequacy and the compliance with the norms on asset classification. Finally, the data show that the ratio of fee-based income to total income increased from 13.4% in 1992 to 23.7% in 2004. This may suggest an attempt of banks to reduce the impact of the decreasing spread on profits by shifting the business focus from traditional on balance sheet business towards fee-based, non-traditional off-balance sheet business, which has become available owing to the removal of the restriction on activities in the deregulated operational environment. It also could result from banks' capital saving consideration in the risk-based capital regulatory regime (De Young and Roland, 2001; Berger *et al.,* 1995).

<Insert Table 2>

3. Literature review

According to microeconomic theory, deregulation should positively affect the efficiency and productivity of the banking industry as it reduces the regulatory cost imposed on market participants. In addition, increased competition fostered by deregulation may induce banks to minimise costs to maintain market shares and to keep profitability. However, the empirical evidence is mixed: deregulation seems to have had a positive effect on the banking sectors in some countries but not in others (Berger *et al.,* 2000). Controversy is not only related to the overall efficiency and productivity improvements, but also to the manner in which these improvements take place: in some countries deregulation mainly promotes efficiency, whilst in others it appears to stimulate technological progress (Zhao *et al.*, 2007). Indeed, the

[5] The prescribed SRL was 38.5% in 1991-1992 and was progressively reduced to 25% from 1997 onwards.

outcome of deregulation policies may reflect several country-specific demand and supply conditions of the banking industry prior to deregulation. Further, the reduction of regulatory costs may not result in improvements in the absence of increased competition (Arestis and Demetriades, 1999).

Whilst several studies investigate the link between market structure indicators (such as concentration ratios) and performance in the traditional Structure-Conduct-Performance (SCP) context, such studies typically do not explicitly incorporate the effect of regulation, nor do they analyse whether regulatory changes strengthen or weaken this link (Gilbert, 1984). There is no conclusive evidence on how regulatory changes in the late 1990s have affected the structure, conduct and performance relationship in the financial sector. The New Empirical Industrial Organization (NEIO) literature, on the other hand, departs from the SCP paradigm and attempts to infer the degree of competition in the market by analysing firms' conduct.

The empirical evidence provided by NEIO studies, however, fails to identify increased competition following the rapid deregulation and liberalisation processes in the EU area (Maudos and Fernandez De Guevara, 2004; Fernandez De Guevara *et al*., 2005), or in the UK banking system (Matthews *et al*., 2007). The fact that competition does not always increase following a period of deregulation may be explained by the fact that in most countries a parallel process of prudential re-regulation has taken place. Regulatory reform is often a mixed process of deregulation and prudential re-regulation and therefore the net effect on competition is not clearly identifiable.

Both the SCP and the NEIO approaches, though, are based on static models of competitive equilibrium[6]. On the other hand, the persistence of profit (POP) hypothesis (Mueller, 1977, 1986) posits that if entry and exit are sufficiently free, this would quickly eliminate any abnormal profit and all firms' profits would tend to converge toward the same long run average. However, if abnormal profits tend to persist from year to year, then there might be barriers to entry or banks might be exploiting monopoly power. Empirical tests of the POP hypothesis in banking include Berger *et al*. (2000), who use a non-parametric measurement of persistence in

[6] A general criticism of the studies of competition using NEIO approaches is that they typically attempt to model dynamic interactions between agents, namely, reactions to each other's quantity or price strategies in a static framework, using the concept of conjectural variations. Although there are efforts to introduce dynamics into the strategic reaction among the market participants, a characteristic of dynamic models that has limited their use is the fact that they can be very difficult to solve econometrically (Sheldon and Sperling, 2003, Toolsema, 2002),

the US, and Goddard *et al*. (2004a, 2004b) who estimate a parametric model for the EU. Both studies presented some evidence of persistence of profit.

Another issue of relevance relates to the impact of regulatory reform and increased competition on the ownership structure of the banking sector. In theory, increased competition should reduce the informational asymmetry between owners and managers, thus enhancing the precision of cross-sectional comparisons of the performance of managers (Vickers, 1995). Therefore, increased competitive pressure should provide incentives to managers to improve efficiency regardless of the type of ownership. The stronger the competitive force, the less relevant the ownership structure for productive efficiency, and vice versa (Berglof, 1997, Allen and Gale, 2000). If banks are allowed to compete freely and if regulation does not favour any specific group of banks, ownership *per se* should not be a determinant of productive efficiency (Bhaumik and Dimova, 2004).

The majority of the empirical work analysing the ownership-performance relationship has concentrated on efficiency comparisons across ownerships in a static context. Domestic private banks are often found to perform better than government-owned banks, although some disagreement remains (Megginson, 2005). Foreign banks are found to perform better than domestic banks in developing countries, while in developed countries the opposite is true (Berger *et al.*, 2000; Berger *et al.*, 2004). Empirical studies tend to highlight the impact of the changing regulatory environment on the ownership-performance relationship. Deregulation seems to increase efficiency for all banks but does not result in inter-ownership convergence (Bonaccorsi di Patti and Hardy, 2005); different ownerships react with different speeds to the change of regulatory environment (Isik and Hasan, 2003; Leightner and Lovell, 1998); ownership structure becomes neutral in terms of productivity growth and the diverse ownership structure could also provide a stimulus to market competition (Sturm and Williams, 2004).

The empirical literature analysing the impact of the substantial transformation of the Indian banking system on bank efficiency and competition following suggest a decrease in cost efficiency post-1992 (Kumbhakar and Sarkar, 2005; Sensarma, 2005). Das and Ghosh (2006) attribute the high cost inefficiency both to the under-utilisation of resources and to the scale of operations. Kumbhakar and Sarkar (2003) and Galagedera and Edirisuriya (2005) fail to

identify a significant impact of regulatory reform of total factor productivity growth. Zhao *et al*. (2007) identify sustained productivity growth in the post-reform period, driven mainly by technological progress. Empirical results also provide little evidence to suggest that public sector banks are less cost efficient than their domestic private and foreign counterparts (Sensarma, 2005; Zhao *et al*, 2007). With respect to the competitive conditions of the Indian banking market, Prasad and Ghosh (2005) estimate the H-statistic and conclude that, while the Indian banking system is characterised by monopolistic competition, there is evidence of increased competition in the period 2000-2004 compared to 1996-1999.

Our study contributes to the existing literature by providing an empirical analysis covering the whole period of Indian reforms to test their overall impact on banks cost performance and on the ownership-cost efficiency relationship; further we attempt to combine the effect of reforms on cost performance and competition dynamics in a systematic framework.

4. Methodology

4.1 General model specification

This section has two objectives. First, it presents the general model specification employed to analyse the two main research questions of this paper: to investigate the impact of deregulation and prudential re-regulation on the characteristics of the cost structure and the ownership-cost efficiency relationship; and to analyse the effect that deregulation and re-regulation have on the dynamics of competition in the lending market. Second, it attempts to make the case for using a stochastic cost frontier to study cost performance and to examine the persistence of the overcharge (i.e. the ratio of price over marginal cost) to test the dynamics of competition. Following Battese and Coelli (1995)[7] we estimate a stochastic cost frontier simultaneously with the modelling of the determinants of inefficiency, using a one-step ML estimation.

There are several reasons for the choice of this model. Firstly, as pointed out by the NEIO literature, a detailed representation of costs is appropriate to evaluate market structure because the former are a potential driver of the latter (Paul, 1999). In conventional microeconomic theory, regulatory restrictions come as an additional cost imposed on market participants, and

[7] Fries and Taci (2005) review the advantages of using a one-step estimation of the determinants of inefficiency over the alternative two step estimation. See also Kumbhakar and Lovell (2003) for a complete methodology review on incorporating exogenous influence on efficiency.

therefore the dynamic changes of the cost structure are expected to be closely related to the changes in incentives and constraints associated with structural and institutional reforms (Fries and Taci, 2005). The choice of a cost frontier as opposed to an average response cost function is related to the central aim of estimating (in)efficiency, which in turn is explicitly allowed to depend on a set of explanatory variables.

The effectiveness of regulatory reform is largely dependent on an understanding of the behaviour characteristics of banks (Klein, 1971). Incorporating both the behaviour of the "best practices" and the other practices the model provides a more complete picture of the dynamics of banks cost performance associated with the changing regulatory environment.

In very general terms the model is specified in log-linear form as[8]:

$$\ln VC_{it} = f(X_{it};\beta) + v_{it} + u_{it} \qquad (1)$$

and

$$u_{it} = \delta' Z_{it} + \varepsilon_{it} \qquad (2)$$

where the subscript *it* indicates bank *i* observed at time *t*. In (1), total variable cost VC is a function of a set of independent variables X (inputs prices, output levels and other exogenous factors), and β is a vector of technological parameters to estimate.

Random errors are represented by $v_{it} \sim iidN(0,\sigma_v^2)$, so that $f(X;\beta)+v$ is the stochastic cost efficient frontier. Cost inefficiency is represented by u_{it}, which is non-negative and assumed to be independently but not identically distributed (as is apparent from the specification in (2)) and follows a truncated-normal distribution with constant variance, that is $u_{it} \sim N^+(\delta' Z_{it}, \sigma^2_u)$. The distribution of v_{it} is assumed to be independent of the Xs as well as of u_{it}.

Equation (2) further specifies the determinants of inefficiency, a set of bank-specific explanatory variables Z, with parameters δ to be estimated. The random error component $\varepsilon_{it} \sim N(0,\sigma^2_\varepsilon)$ is truncated at the variable point $-\delta' Z_{it}$ to allow for the non-negativity constraint on u_{it}, so that $\varepsilon_{it} \geq -\delta' Z_{it}$. The errors are assumed to be independently but not necessarily

[8] For a complete summary of both the theory and techniques used in frontier production, cost and profit analysis, see Kumbhakar and Lovell (2003).

identically distributed, nor are required to be non-negative.

To examine the dynamics of competition, we use a partial adjustment model in line with the "persistency of profitability" (POP) literature in industrial organization[9]. In view of the inadequacy of static models to reveal competition intensity, the POP literature argues that competition is a reflection of the continuous process in which economic agents seek new development opportunities in a world with constant change, and proposes that competitive dynamics may be better captured by examining the persistence of corporate rates of return. Persistence of profitability becomes less likely with increased competition because abnormal profits would be quickly eroded by competitors. The widely used first-order auto-regressive (AR(1)) specification in the POP literature is regarded as a reduced form of a larger, more elaborate, but unspecified, structural model, and the estimated persistence parameter has the virtue of containing any unobservable variable that maps the competitive dynamics (Geroski, 1990; Glen *et al.,* 2003). In line with the simple univariate specification of the POP literature, we are going to investigate the persistence of the overcharge through an AR (1) model, controlling for macro and industry level external shocks. As indicated by the NEIO literature, the gap between price and marginal cost provides the basis for the analysis of market power and the nature of competition. If competition is not perfect, firms would be able to set the price above marginal cost. The magnitude of the overcharge depends on the elasticity of demand they face. The higher the elasticity of demand for the firm's product at its profit-maximizing price, the closer that price will be to the marginal cost. Under perfect competition, the elasticity of demand is infinite and the firms set the price equal to marginal cost. (Paul, 1999; Landes and Posner, 1981). While the estimated persistence parameter of the AR(1) process is explained as a signal for the strength of competition as in the POP literature, our analysis of the persistence of the overcharge directs the unspecified structural model of the POP literature to the profit maximizing behaviour of banks and thus provides us with a stronger theoretical basis for the empirical representation of competitive dynamics. Details of this model are provided in the next subsection.

[9] For a review of the application of the persistence of profitability in banking see Goddard et al. (2004).

4.2 Full model specification, variables and data

Broadly following the intermediation approach, we use a two-input, three-output specification. We specify the book value of performing loans, measured as the difference between total loans and non-performing loans, as the first output, to control for loan quality, given the existence of high levels of non performing loans in the Indian banking system and the heterogeneity in the quality of loans among individual banks. The imputed price of loans is calculated as the ratio of interest received on loans over total performing loans[10]. We define "other earning assets"[11] as the second output to catch the increased holding of other earning assets on banks' balance sheet. Finally, we define fee-based income as the third output to accommodate the shift of banks' business focus from traditional on-balance-sheet activities to non-traditional off-balance-sheet activities. Noticeably, the three outputs differ in terms of their inherent risk content and have different requirements for the mix of inputs. Specifically, loans are both risk and funding-intensive, and thus are expected to incur the highest screening and monitoring and interest expenditure. Other earning assets are considered a less risky but funding-intensive production; and fee-based income is the least funding-consuming but skill-intensive output.

Two inputs are selected to match the characteristics of the three specified outputs. The first input - total loanable funds - sums deposits and money market funding, and its price is calculated as the ratio of total interest expenditure to total loanable funds. The second input - non-interest operating costs - aggregates the expenditure associated with labour and physical capital; its price is given by the ratio between non-interest operating cost and total assets.

The data, collected from the Reserve Bank of India, cover continuously operating Indian commercial banks (excluding regional rural banks) throughout the period 1992-2004, encompassing the whole reform experience. Given our interest in the behavioural characteristics of banks, along with the substantial changes in the operational environment during the reform, focusing on banks that were continuously operating is all the more important. If banks merged during the period of observation, we chose to aggregate their financial statements and treat them as a single composite bank for the entire period. The data

[10] According to the accounting practice followed by the Indian banking sector post-1992, income accrual would cease once the loan is recognized as non-performing. Therefore, the interest received on loans recorded in the loss and profit account is associated with the performing loans.

[11] The other earning assets aggregates government securities, other approved securities, share, debentures and bonds, subsidiaries and joint ventures and other investment outside India (i.e. total investment).

set contains 13 years of accounting data for 65 banks (27 public, 20 domestic private and 18 foreign), for a total of 845 observations. All data were deflated using the GDP deflator using 1991 as the base year.

For the estimation of the stochastic cost frontier we choose a translog functional form, which provides a second order approximation to an arbitrary twice continuously differentiable cost function satisfying linear homogeneity in input prices at any point of an admissible domain (Diewert and Wales, 1987). Moreover, the number of free parameters of the translog functional form is adequate to present the economically relevant information that exhaustively characterises the behaviour of economic agents (Chamber, 1988). The final model is specified as:

$$\begin{aligned}\ln VC_{it} &= \beta_0 + \sum_{m=1}^{3}\alpha_m \ln y_{mit} + \sum_{n=1}^{2}\beta_n \ln w_{nit} + 1/2\sum_{m=1}^{3}\sum_{j=1}^{3}\alpha_{mj}\ln y_{mit}\ln y_{jit} + 1/2\sum_{n=1}^{2}\sum_{k=1}^{2}\beta_{nk}\ln w_{nit}\ln w_{kit} \\ &+ \sum_{n=1}^{2}\sum_{m=1}^{3}\gamma_{nm}\ln w_{nit}\ln y_{mit} + \theta T + 1/2\lambda T^2 + \sum_{m=1}^{3}\theta_m T\ln y_{mit} + \sum_{n=1}^{2}\zeta_n T\ln w_{nit} \\ &+ a_r R + \sum_{m=1}^{3}\ell_m R\ln y_{mit} + \sum_{n=1}^{2}\rho_n R\ln w_{nit} + \alpha_T RT + v_{it} + u_{it}\end{aligned} \tag{3}$$

In (3), VC is total variable cost, y_m are the three outputs and w_n are the two inputs prices. Linear homogeneity of degree one in input prices is obtained by dividing VC and w_1 by w_2 before taking logs. Young's symmetry applies. Following standard practice, we normalise each output quantity and input price variable by its geometric mean. In this way, the estimated first-order coefficients can be explained directly as the cost elasticity at the sample mean. T is a time trend variable, introduced quadratically as a proxy for a non-monotonic pattern of the changes in cost technology.

The interaction between T and the price and outputs variables models non-neutral and scale augmenting technology change respectively. Technological biases are more likely to occur in the case of multiple inputs - multiple outputs production[12] (Balk, 2001) and their presence is well documented in the literature on the banking industry (see Altunbas *et al.*, 1999 among

[12] Fare *et al*., (1997) state the stringent conditions under which those biases would not exist.

others). This can have significant consequences in the context of a changing regulatory environment (Stevenson, 1980; Paul, 1999).

To investigate the impact of the shift of policy focus (from 1997 onwards) on the efficient cost structure, we specify a bilateral policy-shift dummy R, which takes value 0 for 1992-1997 and value 1 for 1998-2004. Moreover, following Gollop and Roberts (1983) we allow the policy shift dummy to interact with input prices and output quantities to evaluate the response of the "best practices" in terms of output composition and input mix associated with the shift of policy focus. Differing from the non-neutral and scale augmenting technological change, these interactive terms are linked to the change of policy focus rather than time elapsing. v_{it} and u_{it} are as defined before.

As explained above, the determinants of cost inefficiency are estimated along with the technological parameters of the cost function in a single-step procedure. Efficiency and productivity studies in the banking sector attempt to link bank-specific explanatory variables that may be related to the quality of the managerial selection and incentives at the bank level, to differences in cost efficiency. Our study pays attention to the association between ownership structure and cost efficiency.

The cost inefficiency model is specified as:

$$\begin{aligned} u_{it} &= \delta_0 + \delta_1 D_F + \delta_2 D_P + \delta_3 D_F T + \delta_4 D_P T + \delta_5 T + \delta_6 R + \delta_7 RT + \delta_8 RD_F \\ &+ \delta_9 RD_P + \delta_{10} RD_F T + \delta_{11} RD_P T + \delta_{12} T^2 + \varepsilon_{it} \end{aligned} \qquad (4)$$

Equation (4) includes 12 explanatory variables to reflect the time effect, the effect of the change of policy focus, the ownership effect and their interactive terms. The introduction of the interactive terms facilitates the examination of the inter-ownership cost efficiency differences and their change over time. D_F is a dummy with value 1 for a foreign bank and zero otherwise. D_P takes value 1 for a domestic private bank and zero otherwise. Public sector banks are the reference ownership category. R is the policy-shift dummy defined above and T is a time trend. ε_{it} is as defined before.

Departing from the typical first-order auto-regressive model for corporate profitability, the following partial adjustment model is used to address the dynamics of competition. We concentrate the analysis on the lending market, implicitly assuming that credit intermediation still represents the predominant activity of banks. We assume that banks are price setters and set the price to maximize their profits. Changes in price reflect banks' perception of changes in competitive conditions in the lending market: an increase in the perceived intensity of competition forces banks to adjust the overcharge. Ultimately, if competition were perfect price would equal marginal cost, so the ratio would be equal to one. Taking the marginal cost as the benchmark price under perfect competition, the adjustment of the overcharge towards unity indicates the dynamic evolution from imperfect toward perfect competition. Our partial adjustment model is given by:

$$(\ln \mathrm{mk}_{it} - \ln \mathrm{mk}_{i(t-1)}) = \beta(\ln \mathrm{mk}_{it}^{*} - \ln \mathrm{mk}_{i(t-1)}) + \delta_r \mathrm{R}(\ln \mathrm{mk}_{it}^{*} - \ln \mathrm{mk}_{i(t-1)}) + \lambda_T \mathrm{TD} + \varepsilon_{it} \quad (5)$$

In (5), mk_{it} is the overcharge on performing loans at time *t*, defined as the ratio of their imputed price over their marginal cost (as estimated from (3))[13], $\mathrm{mk}_{i(t-1)}$ is the overcharge at time *t-1*. mk_{it}^{*} is the overcharge under perfect competition, i.e. unity (and therefore zero when taking logs). TDs are time dummies used to capture exogenous external industry and macro level variables such as the growth of demand for bank loans, competitive pressure on the banking industry as a whole imposed by other segments of the financial market, monetary policy and macroeconomic shocks, the opacity of the informational environment in the credit market, etc. These variables might cause asymmetric changes in costs and in the profit maximizing price and thus need to be controlled for. ε_{it} is the disturbance term, and $\varepsilon_{it} \sim \mathrm{iid}(0, \sigma^2)$. R is the bilateral policy-shift dummy, which takes value 0 for 1992-1997 and value 1 for 1998-2004. β is the adjustment parameter, measuring the speed of adjustment towards a

[13] As indicated above, the imputed price of loans is calculated as the ratio of interest received on loans over total performing loans. Thus, we are considering the aggregate average interest rate on loans and do not consider the impact of non-price loan characteristics, such as different maturity structures, different amounts, etc., on the interest rate charged on loans. However, as we are interested in the evolution of the ratio of price over marginal cost, rather than in the absolute level of price, this omission should not have a significant impact on our findings. A similar approach was followed by Pinho (2000).

value of unity of the overcharge, with $0 < \beta < 1$. The interaction term between R and $(\ln mk_{it}^{*} - \ln mk_{it})$ allows for a change in the speed of adjustment between 1992-1997 and 1998-2004; again $0 < \beta + \delta_T < 1$. A significant positive δ_T would imply a faster adjustment speed towards perfectly competitive prices in 1998-2004, when the policy focus was changed, therefore indicating stronger competition. Finally, the vector λ_T measures the impact of the external macro-level variables on the change of overcharge.

Rearranging equation (5), we get:

$$\ln mk_{it} = (1-\beta)\ln mk_{i(t-1)} + (-\delta_p)R\ln mk_{i(t-1)} + \lambda_T TD + \varepsilon_{it} \qquad (6)$$

Let $1-\beta = \alpha$, and $-\delta_p = \gamma_p$, equation (6) can be rewritten as:

$$\ln(mk_{it}) = \alpha\ln(mk_{i(t-1)}) + \gamma_p R\ln(mk_{it-1}) + \lambda_T TD + \varepsilon_{it} \qquad (7)$$

In (7) the value of α = (1-β) measures the persistence of mk_{it-1} into mk_{it}. A significantly negative value for γ_p, corresponding to a significantly positive δ_p, would suggest a reduction in the persistence of the overcharge in the period 1998-2004 compared to 1992-1997, which in turn could indicate an increase in the intensity of competition.

5. Empirical results and policy implications

The simultaneous Maximum Likelihood estimation of equations (3) and (4) was performed using the programme FRONTIER 4.1 (Coelli, 1996). A series of hypotheses related to the nature of the frontier model[14] and to the consistency of the cost function with its theoretical

[14] The following hypotheses were tested: the adequacy of a more restrictive Cobb-Douglas functional form; the existence of technological change; the existence of non-neutral technological change; whether technology is homothetic; the significance of a policy-shift effect; the significance of a policy-shift bias towards one particular input or output; the significance of inefficiency; the stochastic nature of inefficiency; the overall significance of the inefficiency model.

properties[15] was then tested on the first set of results by means of LR tests. The null hypothesis was rejected at a 1% level of significance in all cases except for the joint significance of the interaction between the policy-shift dummy and the input prices and output quantities variables. Moreover, the presence of these interactive terms appeared to be inconsistent with the regularity conditions of the function with respect to the input prices at the sample mean. We therefore decided to withdraw these variables and re-estimate equations (3) and (4). The new estimations passed all the tests and the results are reported in Table 3, which shows that 19 out of the 22 parameters of the cost frontier and 11 out of the 13 parameters of the cost inefficiency model are significant at 10% level[16].

<Insert Table 3>

5.1 The characteristics of the estimated efficient cost function and cost efficiency-ownership relationship

Looking at Table 3, total cost output elasticity at the sample mean is 0.989, going from a value of 0.984 in 1992 to one of 0.006 in 2004 indicating that overall banks are enjoying very mild, though statistically non significant, economies of scale that get exhausted with the passing of time. Looking at the output-specific results, the cost elasticity of performing loans is the largest (0.539), indicating that performing loans have a bigger impact on total variable costs than the two other outputs. As mentioned before, the results on the scale augmenting technology change suggest that the slight economies of scale at the sample mean are exhausted over time. The overall minimum efficient production scale is decreasing over time (i.e. $\theta_1+\theta_2+\theta_3>0$) but this is attributable only to the production of other earning assets, as their coefficient of time variation, θ_2, is the only positive one. This decrease in the minimum efficient production scale of other earning assets could seem to contradict the increase in their holdings on banks balance sheets, as showed in Table 2, although the effect is quantitatively very small (0.016%). It is possible that banks incentives to increase the proportion of other earning assets may be attributable to a wider cost-benefit analysis of banks portfolio composition in the changing regulatory environment. In particular, the implementation of

[15] Lack of consistency would lead to draw biased policy implications, as suggested by Salvanes and Tjotta (1998). The hypotheses tested include a non-negative marginal cost and the monotonicity and concavity in input prices. Homogeneity with respect to input prices is imposed prior to estimation.

[16] Lower levels of significance on the translog are not uncommon due to the presence of the quadratic and interactive terms.

prudential norms, along with the deregulation process, presumably plays a very important role in banks decisions on their portfolio composition.

With regards to the possible non-neutral technology change, the negative and significant ζ parameter implies technological progress, thus suggesting that the estimated efficient cost share of loanable funds relative to other non-interest operating cost decreases over time. Total variable cost seems more sensitive to the price of loanable funds, possibly as a consequence of banks' expectations of an increase in the price of loanable fund induced by increased competition. This result is consistent with the shift of business focus from funding-intensive traditional activities to skill-intensive fee-based activities, illustrated in Table 2. As a corollary of the decrease of the cost share of loanable funds, the increased share of non-interest operating cost may also reflect the increasing effort of banks to clean up their balance sheet, in line with the implementation of prudential norms.

The results on the quadratic time trend (the parameters θ and λ) indicate technological regress, with costs increasing until 1996 and decreasing thereafter. This non-monotonic pattern could reflect the initial difficulties faced by banks to adjust the high and rigid cost structure inherited from the pre-reform period to the new operating environment. In addition, the significantly positive coefficient of the dummy variable R indicates an upward shift of the cost frontier after 1998, when the regulatory policy focus changed from fostering competition to emphasising supervision. This change of policy direction however does not seem to affect banks output composition or their input mix, since the policy-shift bias indicators were found jointly insignificant (as explained in Section 5). Recalling the consultative and gradual approach of the Indian reforms, this may reflect the groundwork that banks made for the forthcoming policy change. Further, the empirical results reported so far relate to the estimated efficient cost function, which reflects the behaviour of the "best practice banks". It may be reasonable to believe that the production process of the "best practices" is forward-looking, thus preparing well in advance for regulatory changes. Nevertheless, the once and for all upward shift of the cost frontier implies that tighter prudential re-regulation increased banks' costs.

Turning to the determinants of inefficiency, the results indicate that, at the beginning of the sample period, foreign banks have a significantly higher cost efficiency than public banks

(δ_1 = -0.779), presumably due to their relatively stronger operating background. This advantage, however, decreases over time (δ_3>0), with public banks catching up during the period 1992-1997 and eventually achieving higher cost efficiency after 1997 (δ_8>0). However, although public banks remain more cost efficient than foreign banks after 1997, their efficiency appears to be negatively affected by the shift of policy focus (δ_7>0). On the other hand, foreign banks appear to be able to take advantage of the implementation of tighter prudential norms (δ_{10}<0). Domestic private banks have a lower cost efficiency than public banks during the period 1992-1997 (δ_2>0). This result may be explained considering the particular operational situation of domestic private banks in our sample. Specifically, they are the smaller domestic private banks that remained privately owned following two rounds of nationalisation[17]. Their operating conditions were initially relatively weak and they presumably had the fear of being nationalised if they became well-established (Bhattacharya *et al.,* 1997). Their position pre-1992, therefore, would make them less cost efficient compared to public sector banks. Although domestic private banks display an improvement in cost efficiency levels during the period of 1992-1997 (δ_4<0), they do not seem to achieve significant progress (as indicated by the negative but not significant value of δ_9). Moreover, the negative effect on cost efficiency associated with policy measures post-1997 is larger for domestic private banks than for public banks (δ_{11}>0). The uneven impact of the shift of policy focus on the time pattern of cost efficiency change among ownership probably stems from their different costumer base. As pointed out by Berger *et al*. (2006), the costumer base of foreign banks is characterised by large, well established and credit-worthy firms; the main customers of domestic private banks are informationally opaque small firms (SMEs) whilst the majority of customers of public banks are state-owned firms. The finding that foreign banks benefited from the post-1997 policy measures may be attributed to the higher quality of their costumer base, as well as to their operational structure and international standards.

[17] The Indian government nationalised 14 large domestic private banks in 1969 and another 6 banks in 1980. In 1980, banks nationalisation was carried out according to a strict cut-off rule, whereby the government took control of those banks whose aggregate (all-India) deposits were greater than Rs. 2 billion.

Similarly, the finding that domestic private banks suffered the most post-1997 could be related to their SMEs customer base. Presumably, the implementation of tighter prudential norms has a negative impact on the provision of financial services to SMEs. These results are consistent with the empirical evidence on the association between the reduction in supervisory toughness and the increase in SMEs lending during the period 1993-8 in the U.S (Berger *et al.*, 2001).

To summarise, the inefficiency model indicates the existence of an ownership effect on the level and the pattern of cost inefficiency. However, our results also indicate that the external regulatory environment impacts on the ownership effect and on the level and the time pattern of cost efficiency. Particularly, our model identifies two rounds of inter-ownership reshuffle in terms of cost inefficiency. The first round (during the period 1992-1997) shows the progressive adjustment and the opportunity seeking behaviour of banks in response to the increasing functional autonomy and operational freedom. The second round (1998-2004) emphasises the different degrees of pressure perceived by different ownerships under tighter prudential norms.

5.2 The dynamics of competition in the lending market

As explained in Sections 4.1 and 4.2, the impact of deregulation and concomitant prudential re-regulation on the dynamics of competition in the lending market is analysed via the examination of the persistence of the overcharge. The assumption behind our partial adjustment model is that the pricing behaviour of bank mirrors their perception of the intensity of competition in the market place, so that an increase in the perceived intensity of competition will compel them to set the price closer to their marginal cost at a faster speed, therefore reducing the persistence of the overcharge. Specifically, we regress the natural logarithm of the overcharge on performing loans (i.e. the ratio of price over marginal cost) on its lagged value, and on the interaction of the lagged value with the policy-shift dummy R, controlling for industry and country-level variables using time dummies. The estimated parameter on the interaction term between the lagged overcharge and the policy-shift dummy is expected to give information on the difference in the intensity of competition between the periods of 1992-1997 and 1998-2004. Equation (7) is estimated by pooled OLS. The results are showed in Table 4.

<Insert Table 4 here>

The estimated coefficient on the one period lag of the overcharge on performing loans for the period 1992-1997 is α and for the period 1998-2004 is $\alpha + \gamma_p$. Both α (at 1% level) and γ_p (at 7% level) are statistically significant. The statistically significantly negative γ_p, the coefficient of the interaction between R and the lag of the overcharge of loans, indicates faster adjustment speed after 1997 and therefore suggests that competitive market forces become stronger in the latter stages of the reform. Our estimated persistence parameters are quite high (0.87 for 1992-1997, and 0.76 for the period of 1998-2004) compared with those obtained in other studies. For example Goddard *et al.*, (2004a) estimate a persistence of profitability parameter of 0.439 in a study on banks in the six larges European countries. This difference is to be expected given the conventional perception that the banking sector in developed countries is more competitive than in developing countries. Furthermore by looking specifically at the convergence of price towards marginal cost, we set a higher benchmark on the convergence process, which could also contribute to the higher persistence parameter we obtain.

To summarise, our results show increased competition in the lending market in the latter stages of the reform. This indicates that competition is a dynamic process that needs time to build pace onto the market place. Furthermore, the concurrence of stronger competition with the introduction of tighter prudential norms shows that the latter may not necessarily hinder competition.

The indication of stronger market forces after 1997 is also consistent with our finding of pure cost technology progress from 1996 onwards, a sign of the link between competition, cost minimisation and technological innovation.

6. Conclusions

Using a balanced panel dataset covering continuously operating public sector, domestic private and foreign banks throughout the period 1992-2004, we examined the impact of a deregulation – prudential re-regulation framework on the characteristics of the cost structure

and on the ownership-cost efficiency relationship of Indian commercial banks. Furthermore, we investigated the impact of such framework on the dynamics of competition in the lending market. Our results indicate that Indian commercial banks have been changing both their input mix and output composition to accommodate the changes in the regulatory environment. Pure cost technology worsens at the initial stages of the reform, possibly due to the rigid cost structure inherited from the pre-reform period, but improves after 1996 as market participants adjust to the new regulatory environment and take advantage of the new opportunities. Except for the once for all upward shift of the cost frontier after 1997, there is no significant structural break in the efficient cost function associated with the change of policy focus, a signal that the best practices among Indian commercial banks accomplished the majority of the adjustments to their production process before the change in policy measures. Our results also suggest that the ownership-cost efficiency relationship is affected by the reforms.

The analysis of the dynamics of competition in the lending market suggests stronger competitive market forces in 1998-2004, despite tighter prudential norms. These results are consistent with the appearance of pure cost technology progress during the same period. Therefore, prudential re-regulation may not necessarily come at the cost of competition.

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Table 1: Summary of the Indian banking industry (1992 – 2004)

	Public		Domestic private		Foreign		Total Banking Sector			
	N. of banks	Mkt Share	N. of banks	Mkt Share	N. of banks	Mkt Share	N.of banks	HH	CR5	σ^2
1992	28	0.885	25	0.042	24	0.072	77	0.102	0.516	0.00116
1995	27	0.861	32	0.064	27	0.073	86	0.079	0.463	0.00078
1998	27	0.743	34	0.140	42	0.116	103	0.072	0.446	0.00060
2000	27	0.712	32	0.177	42	0.110	101	0.072	0.445	0.00061
2004	27	0.745	30	0.185	33	0.069	90	0.064	0.415	0.00059

Note: Market Share, Herfindahl-Hirschman Index (HH) and Five-firm Concentration Ratio (CR5) are calculated relative to total assets. σ^2 measures the market shares' variance about the mean, i.e 1/n.

Data source: Reserve Bank of India, author's calculation

Table 2: Descriptive Statistics of selected banking indicators

	1992	1995	1998	2002	2004
(1) Implicit deposit rate [a]	0.065	0.056	0.076	0.074	0.048
(2) Implicit credit rate [b]	0.155	0.11	0.136	0.108	0.095
(3) Loanable fund price [c]	0.080	0.063	0.081	0.075	0.052
Spread A = (2)-(1)	0.093	0.053	0.06	0.034	0.047
Spread B = (2)-(3)	0.075	0.047	0.055	0.033	0.043
Total loans/total earning assets [d]	0.603	0.588	0.578	0.541	0.510
Government security/total investment [e]	0.629	0.664	0.664	0.726	0.793
SRL [f]	0.339	0.349	0.323	0.373	0.416
Fee-based income/ total income [g]	0.134	0.138	0.154	0.196	0.237

Notes: [a] implicit deposit rate = interest paid on deposits/ total deposits

[b] implicit credit rate = interest income received on loans/total loans.

[c] loanable fund price = total interest rate payment/total deposits and money market borrowing.

[d] total earning assets = total loans and total investment.

[e] total investment = government securities, other approved securities, shares, debentures and bonds, subsidiaries and joint ventures and other investment outside India.

[f] SRL = Statutory Liquidity Ratio.

[g] total income = fee-based income and total interest income.

Table 3: ML estimates of the translog cost frontier [equations (3) and (4)]

Variables	Parameter	Estimate	Standard error
Cost Function			
intercept	β_0	11.256	0.022**
Lny1	α_1	0.539	0.027**
Lny2	α_2	0.442	0.026**
Lny3	α_3	0.002	0.013
Lnw1	β_1	0.886	0.035**
Lny1*lny1	α_{11}	0.070	0.012**
Lny1*lny2	α_{12}	-0.078	0.017**
Lny1*lny3	α_{13}	0.022	0.005**
Lny2*lny2	α_{22}	0.108	0.020**
Lny2*lny3	α_{23}	-0.025	0.004**
Lny3*lny3	α_{33}	-0.002	0.002
Lnw1*lnw1	β_{11}	-0.047	0.025*
Lnw1*lny1	δ_{11}	-0.074	0.017**
Lnw1*lny2	δ_{12}	0.074	0.017**
Lnw1*lny3	δ_{13}	-0.016	0.012
T	θ	0.074	0.008**
T*T	λ	-0.018	0.001**
Lny1*T	θ_1	-0.012	0.003**
Lny2*T	θ_2	0.016	0.003**
Lny3*T	θ_3	-0.003	0.001**
Lnw1*T	ζ_1	-0.035	0.004**
R	α_r	0.069	0.027**
Inefficiency model			
Intercept	δ_0	-0.937	0.299**
Df	δ_1	-0.779	0.410*
Dp	δ_2	1.172	0.296**
TDf	δ_3	0.256	0.094**
TDp	δ_4	-0.313	0.110**
T	δ_5	0.095	0.086
R	δ_6	-1.406	0.486**
RT	δ_7	0.213	0.095**
RDf	δ_8	1.658	0.470**
RDp	δ_9	-0.398	0.312
RTDf	δ_{10}	-0.311	0.095**
RTDp	δ_{11}	0.265	0.107**
T*T	δ_{12}	-0.008	0.004**
σ^2		0.037	0.003
γ		0.785	0.036**
Log likelihood function	578.22		

Note: $\sigma^2 = \sigma_u^{\ 2} + \sigma_v^{\ 2}$ $\gamma = \sigma_u^{\ 2} / \sigma^2$. *, **, significant at 10% and 5% respectively.

Table 4: Competition Dynamics in the Lending Market [equation (7)]

α	.8709*** (.0455)
γ_p	-.0921* (.0510)
λ_{1993}	-0.007 (.0313)
λ_{1994}	.0441** (.0217)
λ_{1995}	-.0130 (.0214)
λ_{1996}	.1059*** (.0149)
λ_{1997}	.1175*** (.0179)
λ_{1998}	-.0606*** (.0223)
λ_{1999}	.0108 (.0144)
λ_{2000}	.0263* (.0138)
λ_{2001}	.0665*** (.0202)
λ_{2002}	.0724*** (.0164)
λ_{2003}	.1089*** (.0229)
λ_{2004}	.0751*** (.0277)
Adjusted R-squared	0.84
Root MSE	0.15
Pro>F(14, 64)	0.00

Note: the figures in bracket are standard errors that are asymptotically robust to both heteroskedasticity and serial correlation. *, **, ***, indicates significance at 10%, 5% and 1% levels respectively.