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Résumé de l'article

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Assessing the Cost Efficiency of Commercial Banks in Nepal: An Empirical Analysis

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This paper examines the cost efficiency and its determinants for Nepalese commercial banks by using semi-parametric methodology. We first estimate the efficiency and growth of productivity using Data Envelopment Analysis and then identify firm-specific attributes that potentially explain cost efficiencies. The first-stage results indicate a considerable level of cost inefficiency, which is largely caused by technical inefficiency. Additionally, there exists a low level of external (particularly regulatory) influence on the input mix, as indicated by a very low level of allocative inefficiency. The growth in productivity is low and even negative, mostly resulting from a lack of technological progress. The second-stage results indicate that state-owned banks are less cost-efficient than private banks (domestic and foreign), and size has a consistently inverse impact on cost efficiency. Banks with higher financial capital, larger loan ratios, and higher profits tend to be more cost efficient; however, banks with higher credit risk tend to be less cost efficient. Our findings have implications for policymakers, regulators, and bank managers as a better understanding of the level and sources of bank efficiency helps reduce inefficiencies, formulate regulations to enhance the overall efficiency of the banking system, and develop policies to promote competition and financial stability.

Keywords: Banks, cost efficiency, data envelopment analysis, factor productivity, Nepal

Introduction

Over the last few decades, there have been significant changes in the banking industry, both in terms of the nature and structure of the industry. Specifically, the deregulation of financial institutions that began in the 1980s in the US and the UK, and more recently in other economies, has led to financial innovation, increased competition, and globalization (Allen and Santomero, 1998; Vives, 2001; Matthews and Thompson, 2005; Chava et al. 2013; Cornaggia et al. 2015). These changes in deregulation, financial innovation, and globalization have brought about structural changes in banking activities, particularly in three areas: the type of lending (banks' assets), type of borrowing (banks' liabilities), and additional activities in which banks engage (Kohn, 1994). Today, banks go beyond traditional banking activities and increasingly engage in lending without putting loans on their balance sheets (through securitization of their assets/loans), shifting their activities from interest-based to fee-based (guarantees, lines of credit, and other off-balance sheet activities) and diversifying their business into other non-banking activities (security services, insurance, underwriting, etc.). Banks often provide the full spectrum of financial services.

Furthermore, increased competition has resulted in intensive restructuring, consolidation, mergers, and acquisitions (Vives, 2001; Wellalage and Fernandez, 2019). In this regard, banks are more concerned about controlling and analyzing their costs and revenues, considering the risks taken to generate returns (Girardone et al., 2004). Banks should be efficient in allocating resources to minimize costs and maximize profits. However, the question arises as to whether these changes have resulted in gains in bank efficiency and productivity. There are extensive theoretical and empirical studies addressing these issues (Berger and Hannan, 1993; Berger and Humphrey, 1997; Berger and Mester, 1997; Allen and Santomero, 1998; Ahtiala, 2005; Casu and Girardone, 2006; Bikker and Haaf, 2002; Perera et al., 2006; Altunbas et al., 2007; Duygun et al, 2013; Delis et al. 2017; Zho et al. 2021). The focus has been on estimating cost efficiency and its determinants in a particular economy and across economies. Despite a great deal of empirical work in other economies, there is a lack of similar studies in Nepal.

Nepalese banking industry has undergone significant changes over the past few decades. The Nepal Rastra Bank (NRB) as a central bank, undertook major changes in policy measures, e.g. deregulation of interest rate in 1989, moving from direct to indirect methods of monetary control, emphasizing on open market operations as the main policy tool, abolishing the provision of statutory liquidity ratio in 1993, permitting market-determined exchange rate of the Nepalese currency against convertible currencies and full convertibility of the Nepalese currency in the current account (Bhattarai, 2005), following flexible licensing policy during 2000s, and strengthening and aligning legal framework to international standard in 2004. These changes resulted into entry of foreign-joint venture banks and domestic private banks into the market; widened the scope of activities undertaken by banks; added more pressure on competitiveness of individual banks; and fostered financial innovation and technology. Now, Nepal is now a member of the WTO, and the Nepalese market is open to foreign banks. The emerging concept of universal banking and the growing importance of the capital market have added dynamism to the Nepalese banking industry. Gajurel and Pradhan (2011, 2012) indicate that the Nepalese banking industry has a low level of market concentration and has increased market competition over the years. Nepalese banks are increasingly concerned about controlling and analyzing their costs and revenues and the optimal allocation of resources that minimize costs and maximize profits. Therefore, this study addresses the following issues:

- How efficient are the commercial banks in Nepal? What is the level of technical efficiency? What is the level of allocative efficiency? Are the banks cost efficient?
- What is the level of productivity growth?
- What are the determinants of cost efficiency in banks in Nepal?

Understanding banking efficiency is very important for bank managers and policymakers alike, as banks act as conduits for overall financial development in an economy (Berger and Mester, 1997; Levine 2002). From a manager's perspective, knowing their level of efficiency can help them allocate resources optimally and reduce costs. From the central bank's perspective, understanding banking efficiency allows regulators to develop regulations to enhance the banking sector's overall efficiency. From a policymaker or macro perspective, having better knowledge about the efficiency of the banking sector influences the cost of financial intermediation and overall financial stability (Mayo, 2014). Therefore, knowing the level of banking efficiency and its determinants is important for policymakers, regulators, and managers in Nepal. Therefore, this paper contributes to the existing literature by empirically estimating banking efficiency using DEA techniques for Nepalese commercial banks and identifying the determinants of efficiency for the period of 2001-2009. More specifically, this paper aims to achieve the following objectives:

- To identify the level of banking efficiency, particularly technical efficiency, allocative efficiency, scale efficiency, and cost efficiency.
- To identify productivity growth over time.
- To investigate the determinants of cost efficiency and their significance.

To the best of our knowledge, this is first study on banking efficiency in Nepal.

The rest of the paper is organized as follows. Section 2 provides a theoretical framework and reviews the major literature on banking efficiency. Section 3 describes the empirical method, whereas Section 4 presents empirical results and discussion. Finally, Section 5 concludes the paper.

Review of Literature

The Theoretical Framework

Banking System

A financial system refers to the flow of funds from one economic unit to another. There are two mechanisms for this flow: a direct financial system, in which deficit units directly borrow from surplus units through the capital market, and an indirect financial system, in which there is the presence of a third party, known as a financial intermediary, between surplus and deficit units. The utility functions of borrowers and lenders are different, and the bank as an intermediary attempt to optimize the utility function of both parties through size transformation, maturity transformation, and risk transformation in such a way that the bank will generate profit optimally (Matthews and Thompson, 2005). In this regard, the banking system can be viewed from two perspectives (Berger and Humphrey, 1997); in a broader sense, there are two approaches to the banking system: the production approach and the intermediation approach. In the production approach, the bank is considered as a firm delivering services to its clients in the form of transactions by employing two underlying inputs - labor and capital. As suggested by Mlima and Hjalmrsson (2002), a schematic diagram of banking system with potential input and output variables is shown in Figure 1.

Mlima and Hjalmrsson (2002) survey some of the recent studies and outline potential input and output variables. Figure 2 shows the schematic diagram of input and output variables under intermediation approach. [*See* Mlima and Hjalmarsson (2002) for methodological issues on production and intermediation approach]. This study uses an intermediation approach.

Figure 1: Banking system under production approach

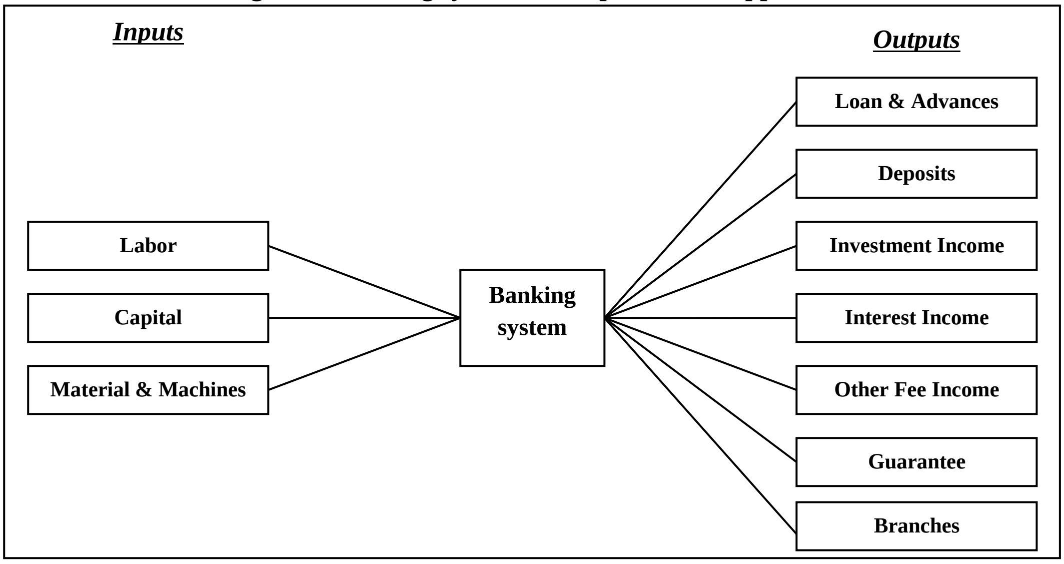
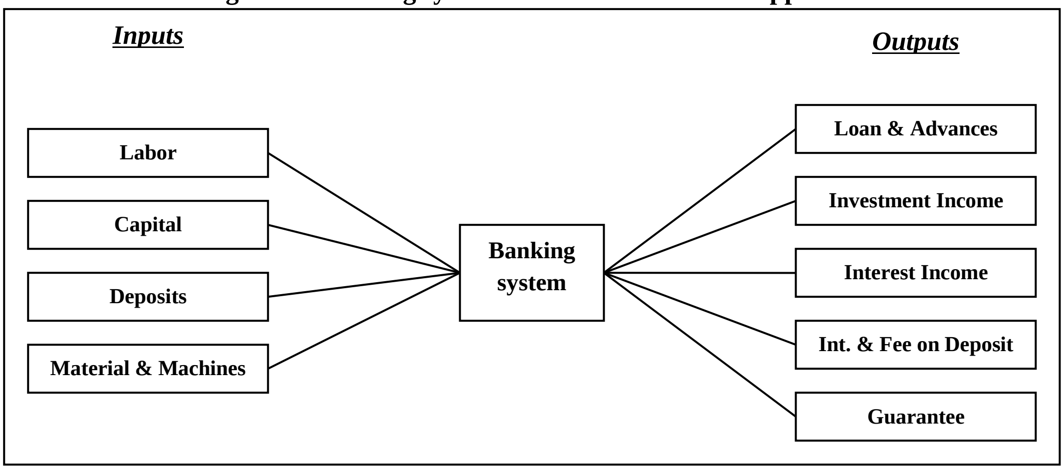


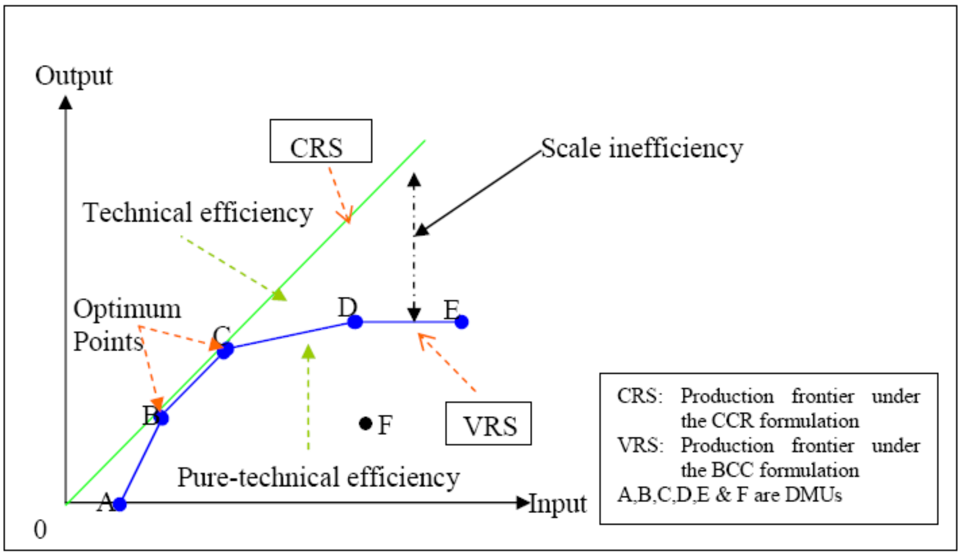
Figure 2: Banking system under intermediation approach



Measuring Banking Efficiency

Regarding efficiency, efficiency analysis refers to the comparison between the outputs and inputs used in the process of producing a product or service. It describes how well a banking system generates the maximum desired output for given inputs within the available technology. Efficiency can be measured with respect to the maximization of output, the minimization of cost, or the maximization of profits. Efficiency is generally divided into two components (Coelli et al. 2005). A bank is regarded as technically efficient if it can obtain maximum outputs from given inputs or minimize the inputs used in the production of given outputs. Bank managers aim to avoid waste. A bank is considered technically efficient if and only if it is impossible to produce more of any output without producing less of some other output or using more of some input. On the contrary, allocative efficiency is related to the optimal combination of inputs and outputs at a given price. It measures a firm's success in choosing a cost-minimizing combination of inputs. The objective of producers might entail the production of given outputs at minimum costs, utilization of given inputs to maximize revenue, or allocation of inputs and outputs to maximize profit. Therefore, cost efficiency is the product of technical and allocative efficiency.

Figure 3: Envelopment surface under CCR and BCC formulation



[Source: Seelanath (2007, p. 54)]

Furthermore, technical efficiency can be decomposed into pure technical and scale efficiency. Pure technical efficiency is measured relative to a variable return to scale (VRS) production frontier, that is, a frontier characterized by increasing, constant, and/or decreasing returns to scale. Firms operating on the VRS frontier are considered to be fully efficient in a purely technical sense. If the firm operates with increasing or decreasing returns to scale, it can improve its efficiency by moving to a constant return-to-scale frontier, that is, by becoming scale efficient.

Figure 3 graphically illustrates the shape of the envelopment surfaces for a single input and single output case under the CCR (Charner et al., 1978) and BCC (Banker et al., 1984) models. Points A, B, C, D, E, and F represent the observed performance of the six decision-making units (DMUs). The CCR model develops a production frontier based on the assumption that all firms operate at an optimum scale. The line extending from the origin through Points B and C is the production frontier identified by the CCR model. In contrast, the BCC model ignores this assumption and introduces a convexity condition to the basic CCR model, which allows the benchmarking of inefficient DMUs with similar-sized DMUs (Coelli et al., 2005). The curve that connects points A, B, C, D, and E represents the BCC production frontier.

As stated above, the CCR model does not consider the relative size of DMUs when estimating efficiency. It assumes that an increase in output is always proportional to an increase in inputs and that the scale of production is not considered. Conversely, the BCC model emphasizes the scale of operation when estimating efficiency. As a result, the efficiency estimated using the BCC model represents pure technical efficiency, while estimates using the CCR model represent technical efficiency. The difference between the estimated CCR and BCC efficiency scores is referred to as scale efficiency.

Economic Theories on Banking Efficiency and Hypotheses Development

There are various contextual economic theories that explain cross-sectional variations in banking efficiency (Berger and Humphrey, 1997; Berger and Mester, 1997; Allen and Santomero, 1998; Vives, 2001; Ahtiala, 2005; Altunbas et al., 2007). These differences in efficiency levels can be caused by a variety of factors, including the size and complexity of the bank, the level of market competition, the regulatory environment, and the ownership structure. In the following paragraphs, we will briefly summarize the economics behind cross-sectional variations and formulate hypotheses to test in this paper.

Agency theory argues that a bank's ownership structure can affect its efficiency. Private banks, driven by profit motives, try to maximize their profits by reducing their inefficiencies. Government-owned banks, on the other hand, largely obtain their mandate from the government and may focus on achieving policy objectives rather than minimizing costs or maximizing profits. After the initiation of the financial sector liberalization policy in Nepal, many private sector banks began operating. Based on the agency theory, we propose the following hypothesis:

H1: Private banks are more cost efficient than State-owned banks.

Furthermore, the global advantage hypothesis states that foreign banks may benefit from competitive advantages in comparison to domestic banks because they may have access to more advanced technology and resources and fewer agency problems. This advantage makes foreign-owned banks more efficient than domestic banks (Berger et al., 2000). In contrast, the home field advantage hypothesis suggests that foreign banks perform worse than domestic banks because domestically owned banks may have better access to credit information and competencies, which leads to lower costs for providing the same financial services or higher revenues than foreign banks (Berger et al., 2000). Consequently, this hypothesis assumes that domestic banks are more efficient than foreign banks. However, the appropriateness of a particular hypothesis depends on the economy's institutional structure. Berger et al. (2000) suggest that the global advantage hypothesis is more prevalent in developing economies, whereas the home-field advantage hypothesis is more prevalent in developed economies. As Nepal is a developing economy, we postulate the following hypothesis:

H2: Foreign banks are more efficient than domestically owned banks.

Regarding bank size, larger banks may benefit from economies of scale and banks with multiple services (e.g., universal banks) may benefit from economies of scope, leading to higher efficiency, particularly in cost efficiency. Clark (1986) suggests that small banks limit their output of loans and earn less profit. Consequently, they may reject loans that could increase a firm's value (Clark, 1986). However, according to the theory of asymmetric information, smaller firms are more likely to be credit-rationed because of higher information opacity and firm-specific risk (Mester et al., 1998). Therefore, small banks may be more profit-efficient than large banks (Berger and Mester, 1997; Neuberger et al., 2008). Taking the scale economy perspective, we hypothesize the following:

H3: Large banks are more cost efficient then small banks.

The cross-sectional variations in banking efficiency can further depend on the nature of the products and services offered by banks. Traditionally, banks have largely focused on the loan-product market. However, banks are currently providing universal banking services such as investment banking and insurance (Vives, 2001; Vennet, 2002; Wellalage and Fernandez, 2019). From the economies of scale and specialization perspective, by focusing on the loan products market, the key domain of banks' specialties and expertise, banks can achieve both cost and profit efficiency. However, proponents of universal banking argue that it provides a more disciplined approach to corporate management, including corporate restructuring, and allows room for scope economies (Vennet, 2002). Saunders (1994) argues that universal banking would enhance banking efficiency. As banks in Nepal are largely focused on conventional banking activities, we hypothesize that:

H4: Loan products are more cost-efficient than other earning assets.

According to industrial economics literature, the structure of an industry plays a crucial role in the relationship between banking profitability and efficiency (Berger and Hannan, 1993; Wong et. al, 2007). The structure-performance hypothesis posits that banks operating in concentrated markets can achieve higher profits by engaging in collusive behavior and raising prices for their products and services (Bain, 1951). However, high concentration can also inhibit competition and improve performance (Berger and Hannan, 1993). On the contrary, the relative market power hypothesis argues that banks with larger market shares and diverse product offerings can leverage their market power to achieve superior profits (Berger and Hannan, 1993). In addition, profitable banks can invest in technology and cost-saving measures to improve cost efficiency. By aligning the incentives of managers and employees, profitable banks can also achieve better productivity and efficiency (Meulbroek, 2001). Gajurel and Pradhan (2012) observe monopolistic market competition in the Nepalese banking industry, and Gajurel and Pradhan (2011) suggest that higher market concentration is linked to greater profitability in this industry. Therefore, it is hypothesized that:

H5: Profitable banks are more cost efficient than their non-profitable counterparts.

In addition to ownership structure and size, important factors affecting banking efficiency are the capital and risk structure of banks. A bank needs to increase the capital (equity) commensurably with the amount of risk taken because a bank is a highly levered firm and the equity capital provides caution against the risk (Berger et al. 1995). While there is no explicit economic theory that explains the relationship between bank capital and efficiency, Berger and Humphrey (1992) indicate that banks approaching failure also tend to have low levels of cost efficiency. From a regulatory perspective, regulators may allow efficient banks for more leverage. The general understanding is that the more levered banks engage in more riskier assets (loan or investment) that increases the efficiency (particularly, cost efficiency) at least in short run (Altunbas et al., 2007). Therefore, our hypothesis regarding the relationship between bank capital and efficiency is as follows:

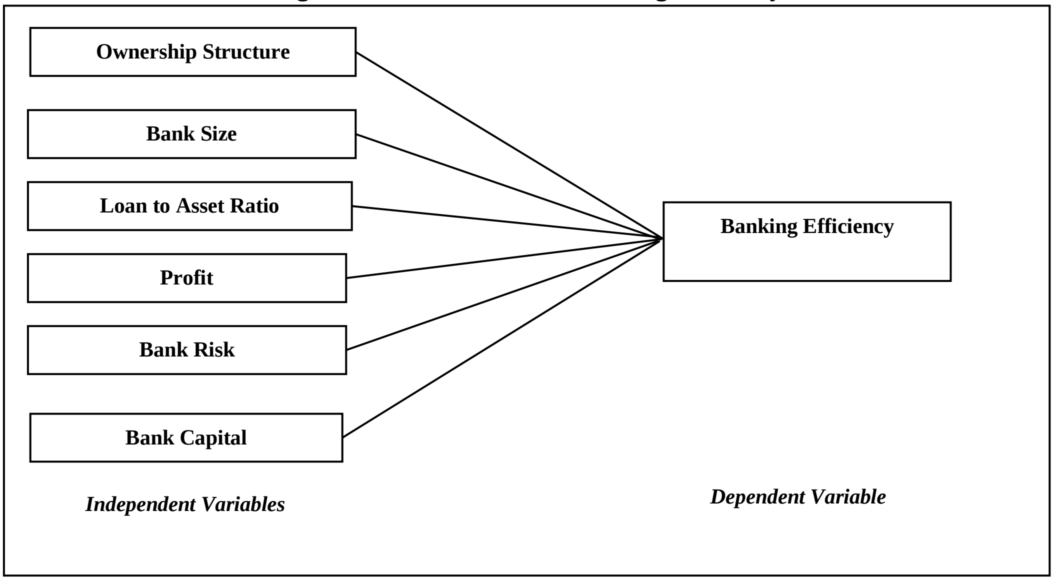
H6: There is an inverse relationship between bank capital (equity) and efficiency.

Berger and DeYoung (1997) provide several explanations for the relationship between non-performing loans (NPLs) and cost efficiency. The ‘bad luck’ hypothesis states that when loans become past due, the bank incurs additional managerial efforts and expenses to deal with these loans, making banks with higher NPLs less cost-efficient. The "bad management" hypothesis suggests that a low level of cost efficiency signals poor bank management; such subpar managers do not sufficiently monitor and control their operating expenses and loan management practices, resulting in higher NPLs. From a "moral hazard" perspective, banks with relatively low capital may respond to moral hazard incentives by increasing the riskiness of their loan portfolios, leading to higher NPLs (Berger and DeYoung, 1997). Altunbas et al. (2007) argue that banks that are not very efficient at assessing, and monitoring loans are unlikely to be very efficient in achieving a high level of operating (cost) efficiency. we develop the following hypothesis:

H7: Banks with higher non-performing loans (risker banks) are less cost efficient.

In sum, these economic theories state that bank efficiency is a function of bank size, ownership structure, capital, risk structure, market structure, and macroeconomic developments, and Figure 4 depicts this relationship. In the theoretical framework above, we discuss the theoretical foundations for measuring economic efficiency and the factors influencing economic efficiency. We now provide a review of empirical studies that examine the level of efficiency of banks and their determinants across different countries.

Figure 4: Determinants of banking efficiency



Review of Empirical Studies

In this section, studies focusing more on the level of banking efficiency and its correlates are briefly reviewed, along with some international survey studies, and presented in chronological order. See Aiello and Bonanno (2016; 2018) for an extensive review of the banking efficiency literature and meta-analysis. Table 1 summarizes some major studies, along with their methodology and major findings.

Ferrier and Lovell (1990) used both econometric and linear programming techniques to estimate the efficiencies of 575 US banks in 1984. The authors used three inputs (total number of employees, occupancy costs, expenditure on furniture and equipment, and expenditure on materials) and five outputs (number of demand deposit accounts, number of time deposit accounts, number of real estate loans, number of installment loans, and number of commercial loans). Their results show an average technical inefficiency of 16 percent. They report relatively high technical inefficiencies and modest allocative inefficiencies. Moreover, their findings indicate that the majority of banks experienced increasing returns to scale and the smallest banks were the most efficient banks.

Yue (1992) examined the efficiency of 60 commercial banks in Missouri, US, for the period 1984 through 1990 by applying DEA approach. The author used four inputs (interest expenses, non-interest expenses, transaction deposits, and non-transaction deposits) and three outputs (interest income, non-interest income, and total loans) and found that the average efficiency score was approximately 0.92, and pure technical inefficiency was the major source of technical inefficiency (rather than scale inefficiency).

Fukuyama (1993) examined the efficiency of 143 Japanese banks in 1990. Employing three inputs (labor, capital, and funds from customers) and two outputs (revenue from loans and revenue from other business activities), the author observed pure technical efficiency averaging around 0.86 and scale efficiency around 0.98. Similar to Yue's (1992) findings, the major source of overall technical inefficiency was pure technical inefficiency. Scale inefficiency was found to be mainly due to increasing returns to scale. The author also observed that banks with different organizational statuses perform differently with respect to all efficiency measures (overall, scale, pure tech.). Scale efficiency is positively and weakly associated with bank size.

Elyasiani and Mehdian (1995) evaluated the efficiency performance of 150 small and 150 large US banks to examine the relationship between size and productive efficiency both before and after deregulation using the DEA approach. They employed four inputs (large certificates, time and saving deposits, demand deposits, capital, and labor) and four outputs (investment, real estate loans, commercial and industrial loans, and other loans). One special feature of this study is the employment of separate production frontiers for each group and a common frontier to test whether the two groups face identical frontiers. The results indicate that they do not share identical frontiers, and the results based on group-specific frontiers indicate that while small banks were more efficient than large banks in 1979 (the period prior to deregulation), they performed equally efficiently in 1986 (the post-deregulation period). Another finding of the study is that, although the mean efficiency measures for both groups declined between 1979 and 1986, the decline was substantial for small banks. The dispersion of efficiency increased substantially for small banks in the same period. These findings indicate that small and large banks have directly affected environmental changes.

Table 1: Review of Empirical Studies on Banking Efficiency

Study	*Country*	*Method*	*Major findings*
Ferrier and Lovell (1990)	USA	SFA	Average technical efficiency is 84 percent and smallest banks were the most efficient banks.
Yue (1992)	USA	DEA	Average technical efficiency is 92 percent.
Fukumaya (1993)	Japan	DEA	Average technical efficiency is about 84 percent; positive relationship between size and efficiency.
Elyasiani and Mehdian (1995)	USA	DEA	Before deregulation the small banks were more efficient than large banks but after deregulation, they are equally efficient, however over the period the pace of efficiency was declining.
Favero and Papi (1995)	Italy	DEA	Average technical efficiency is about 88 percent, and the results are robust to changes in input and output variables. Size is positively related to efficiency.
Yeh (1996)	Taiwan	DEA	Average efficiency is about 85 percent. More efficient banks have higher capital adequacy and profitability and lower liquidity.
Berger and Mester (1997)	USA	SFA	Average cost efficiency is about 87 percent. small banks are most efficient; banks with higher lona-to-total asset ratios

			have higher profit efficiency; and risk is negatively related to cost/profit efficiency
Rime and Stiroh (2003)	Swiss	SFA	Average cost efficiency is 60 percent and profit efficiency is 50 percent. there exist scale economies for the small to mid-sized banks and little gain from scope economies.
Espitia-Escuer and Garcia-Cebrian (2004)	EU	SFA	Highest efficiency in the region is 97 percent for Holland and lowest efficiency is 53 percent for Spain. Number of habitants per branch is negatively related to efficiency score.
Bonin, Hasan and Wachtel (2005	Transition (Europe)	SFA	Average cost efficiency is 78 percent and average profit efficiency is 69 percent. Foreign banks are most efficient than domestic banks. Efficiency decreases nonlinearly with bank size. Privatization by itself is not sufficient to enhance the efficiency.
Mostafa (2007)	Gulf (GCC) countries	DEA	Average efficiency is 73 percent. Banking industry in developing countries is less efficient or less competitive than that of developed countries.
Hassan and Sanchez (2007)	Latin America	DEA	Highest cost efficiency in the region is 66 percent for Ecuador and lowest efficiency is 42 percent for Venezuela. Risk is inversely but equity is positively related to efficiency. No relationship between profitability and efficiency indicates lower market competition in the countries.
Perera *et al.* (2007)	South Asia	SFA	Highest efficiency in the region is 92 percent for India and lowest efficiency is 87 percent for Sri Lanka. Size, equity and profitability are positively related to cost efficiency. Listed bank outperform non-listed banks.
Chen (2009)	Africa	SFA	Average efficiency in the countries in the region lies between 70 to 80 percent. There is the importance of policy that aims to enhance institutional structures.
Casu and Girardone (2010)	Europe	DEA	Provide evidence of convergency of efficiency level towards EU average but no overall improvement of efficiency levels towards best practice.
Mlambo and Ncube (2011)	South Africa	DEA	Average level of cost efficiency is around 42% but an upward trend over the sample period.
Mohanty et al. (2016)	GCC countries	SFA	While the cost and profit efficiencies vary by countries, the average level of cost and profit efficiencies are similar for Islamic banks and conventional banks.
Banya and Biekpe (2018)	Frontier African countries	DEA	Average level of technical efficiency for 10 frontier African banking market is about 60%; Risk structure, bank capital and asset structure have significant influence on banking efficiency.

Berger and Mester (1997) examined several possible sources, including differences in the efficiency concept, measurement methods, number of banks, market, and regulatory characteristics, with a large sample size of about 6000 US commercial banks for the period of 1990-1995. The authors suggested that the concept of alternative profit efficiency can control many unmeasured differences in output quality. The mean cost efficiency was about 87 percent, and the choices of measurement technique, functional form, and other variables made very little difference in terms of average industry efficiency and the ranking of individual firms. Regarding the efficiency correlates, among others, they observed that small banks are most efficient; banks with higher loan-to-total asset ratios have higher profit efficiency, and risk is negatively related to cost/profit efficiency. Berger and Mester's (1997) study has given empirical foundations for many subsequent studies.

The study by Favero and Papi (1995) investigated the efficiency of 174 Italian banks in 1991, employing two alternative approaches to the specification of inputs and outputs: the intermediation approach and the asset approach. The intermediation approach differs from the asset approach in that current accounts and savings deposits are defined as outputs. The average efficiency under the intermediation approach was found to be 0.878 in the case of constant return to scale (CRTS) and 0.909 in the case of variable return to scale (VRTS), and under the asset approach, 0.794 and 0.839, respectively. They reported that their results were robust to changes in the specifications of inputs and outputs. Another feature of the study was the examination of determinants of efficiency using regression analysis. Efficiency in the case of VRTS was related positively to productive specialization, proxied as the ratio of profit from banking services to the total intermediation margin, positively to size, and to a lesser extent, to location (lower efficiency of banks in Southern Italy).

Yeh (1996) applied DEA in conjunction with financial ratio analysis to investigate the efficiency of six commercial banks in Taiwan over the period from 1981 to 1989. The author used three inputs (interest expenses, non-interest expenses, and total deposits) and three outputs (interest income, non-interest income, and total loans). The average efficiency was about 85 percent. The findings of the study indicate that banks with high DEA scores have higher ratios in capital adequacy, asset utilization, and profitability and lower ratios in financial leverage and liquidity.

Rime and Stiroh (2003) examined the cost and profit efficiency, along with economies of scale and scope, of Swiss universal banks considering the consolidation process in the Swiss banking industry for the period of four years (1996 to 1999) with a sample of 289 banks. The authors defined the broader set of outputs, including off-balance sheet activities, brokerage and portfolio management activities, and trading activities, to capture the effect of universal banking. By applying the parametric approach with a translog specification, they found about 40 percent cost inefficiency (60 percent cost efficiency) and about 50 percent profit inefficiency (50 percent profit efficiency). In addition, they observed that measuring the efficiency using the traditional banking products as output variables understate the relative efficiency of universal banks. Similarly, the efficiency estimates by category of Swiss bank contrast with the widespread idea that regional and cantonal banks are less efficient because the median efficiency score, both in profit and cost function, of regional and cantonal banks are higher than that of big banks. The finding indicates that there exist scale economies for the small to mid-sized banks but little scale economies for the very largest banks and little obvious gain for larger universal banks from the broader product mix (scope economies).

Using the Cobb-Douglas production function framework, Espitia-Escuer and Garcia-Cebrian (2004) studied the efficiency of the European banking system from 1988 to 1999. The authors used the number of employees, number of branches, capital, and deposits as input variables, and loans as the output variable. Using a stochastic frontier approach (maximum likelihood method), they found that the banking sector improved its efficiency during the period under analysis. The lowest starting point corresponded to the banking systems of Spain (0.414), Portugal (0.426), the UK (0.503), and Denmark (0.570), which were substantially contrasting with France (0.919) and Holland (0.970), countries showing the highest efficiency values of the sample, and which maintained these values until the end of the period. However, the most substantial improvement over the period was observed precisely in the countries with the worst initial results: there was an improvement in efficiency of the national bank sectors of over 30 percent in these countries, with Spain and Portugal achieving figures of over 50 percent. In addition, the authors tested the different efficiency scores for different countries and found that the number of inhabitants per branch was negatively related to the efficiency score, and the results of time, density of population, unemployment, and GDP were inconclusive. These findings indicate that the level of service offered bears favorably on the levels of efficiency achieved, hence reducing or closing of branches would depress the overall sector efficiency.

The study by Bonin et al. (2005) analyzed the effects of ownership, especially by a strategic foreign owner, on bank efficiency for eleven transition countries in an unbalanced panel data consisting of 225 banks and 856 observations covering the period 1996 through 2000. The authors used total deposits, total loans, total liquid assets, and other investments as output variables and the price of capital and price of funds as input variables. The stochastic frontier approach was used to find the profit and cost efficiency, taking account of both the time and country effects directly. They found average cost efficiency to be 77.7 percent and average profit efficiency to be 69.4 percent. Furthermore, a second-stage regression model was used to study the effect of ownership on efficiency and profitability, and they found that, relative to domestic private banks, banks with majority foreign ownership but without a strategic foreign owner are more efficient by cost and profit measures, while strategic foreign ownership improves only cost efficiency. The authors further observed that foreign-owned banks are more cost-efficient than other banks, and they also provide better service, if they have a strategic foreign owner, whereas government-owned banks are less efficient in providing services. The efficiency appeared to decrease nonlinearly with bank size, which is a puzzling result. The study signified that privatization by itself is not sufficient to increase bank efficiency as government-owned banks are not appreciably less efficient than domestic private banks.

In a study of the top 50 Golf Cooperation Council banks in 2005, Mostafa (2007) examined the efficiency by using the data envelopment analysis method. The author used assets and equity as input variables and net profit, return on assets (ROA), and return on equity (ROE) as output variables. The efficiency scores revealed from the study ranged from 13 percent to 100 percent, with an average score of 73 percent. The study also observed that the extent of inefficiencies prevalent with respect to asset mismanagement in GCC banks indicated significant improvements. The findings indicated that the banking industry in developing countries is less efficient or less competitive than that of developed countries.

Hassan and Sanchez (2007) investigated the dynamics and determinants of Latin America by employing semi-parametric methodology for the period of 1996-2003. The average cost efficiency in the region is 66 percent for Ecuador, which is the highest, and 42 percent for Venezuela, which is the lowest. The level of profit and revenue efficiency was observed to be lower than that of cost efficiency. The authors found a negative relationship between risk and efficiency, and a positive relationship between equity, but did not find a relation between profitability and efficiency, indicating lower market competition in the sample countries.

The study of Perera et al. (2007) aimed to assess the cost efficiency in South Asian banking and the effect of bank size, ownership, and exchange listing on cost efficiency. The study covers four countries from the region, namely, Bangladesh, India, Pakistan, and Sri Lanka over the sample period of 1997 to 2004. By using a single-stage frontier approach, the authors observed that Indian banks were more cost-efficient, followed by Bangladeshi banks, and Sri Lankan banks were the least cost-efficient in the region. The average cost efficiency for India was 0.9245 and for Sri Lanka was 0.8737. The authors further find that larger banks are more cost-efficient, and listed banks outperform non-listed banks, and private banks are more cost-efficient than government banks. They also observe that a higher level of bank equity and profit is associated with a higher level of cost efficiency. The authors concluded that there was no evidence of the Asian financial crises of 1997-1999 in the South Asian banking industry.

Chen (2009) studied the cost efficiency of banks in ten Sub-Saharan African middle-income countries for the period of 2000 to 2007. The author uses the stochastic frontier approach to estimate efficiency. The average efficiency of countries in the sample ranges from 70 percent to 80 percent, with Mauritius having the highest cost efficiency and Angola having the lowest cost efficiency in the region. Regarding the efficiency determinants, there is a negative relation between risk and cost efficiency and a positive relation between loan-to-total asset and cost efficiency. From a macroeconomic perspective, a higher income level brings higher cost efficiency, and a higher level of financial depth contributes to higher cost efficiency. The author concluded that a higher level of competition, political stability, and better governance are positively associated with the efficiency of the banking industry.

Casu and Girardone (2010) examined the integration and efficiency convergence in the EU banking markets for the period of 1997-2003 and found that the average overall efficiency score was 76.5% for the whole sample period. They also found a convergence trend of the average efficiency score over time, but such convergence did not translate into a gain in efficiency in the region.

The study of Mlambo and Ncube (2011) examines competition and efficiency in the banking sector of South Africa for the sample period of 1999-2008 using DEA technique. The authors found that the average level of cost efficiency was 41.2% and observed an upward trend in average efficiency over the sample period.

Mohanty et al. (2016) examined cost and profit efficiencies of banks in six GCC countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates) using SFA technique and showed that the cost and profit efficiencies of banks vary widely across the six Gulf countries over the sample period, but the cost and profit efficiencies of Islamic banks are similar to that of conventional banks. The authors concluded that the country-specific variables had a significant impact on cost and profit efficiencies of banks operating in GCC countries.

Although a lot of work has been carried out to evaluate the efficiency of commercial banks throughout the globe, there is a lack of literature on the efficiency of the Nepalese banking sector. There is a dire need to carry out a study to evaluate the efficiency of the Nepalese banking industry. This study, therefore, examines the level of efficiency and its correlates. Furthermore, this study explores the growth of productivity in Nepalese commercial banks and shows some prospects for enhancing the health of the financial system.

Data and Methodology

Data

This study considers only the commercial banks in operation for the sample period of nine years from 2001 to 2009. Therefore, there are a minimum of 15 banks (for 2001) and a maximum of 25 banks (for 2009) each year during the sample period. The KIST bank was promoted as a commercial bank in 2009, and hence it is not included in the study. The nine-year sample period is regarded as sufficient to capture the characteristics of the Nepalese banking industry. The choice of the sample period is also confined by the availability of data at the time.

This study is mainly based on accounting (secondary) data of commercial banks for the period of 2001-2009. The required data were extracted from the annual reports and financial statements of the banks available in the Securities Board (SEBO) database and the Nepal Rastra Bank (NRB) database. While collecting data, there was no availability of audited financial statements for all the banks for 2009. Therefore, the data for 2009 is based on unaudited financial statements of banks available on the NRB database. Since banks are highly regulated and regularly monitored by the central bank, it is reasonable to believe that the variations in audited and unaudited financial statements wouldn't be significant.

Methodology

Data Envelopment Analysis[1]

Data Envelopment Analysis (DEA) is a linear programming technique that creates a piecewise-linear convex isoquant over the data points, with the objective of measuring relative efficiency among similar firms (usually referred to as Decision Making Units, DMUs, in the DEA literature) that use the same technology to produce similar outputs with similar inputs. The DEA frontier is constructed from a set of efficient firms, for which no additional output can be produced from a given level of inputs and/or the input resources cannot be minimized for a given level of outputs. Thus, the level of efficiency of an individual bank depends on how other banks under consideration are performing, particularly the bank(s) with the best practice or bank(s) that fall within the frontier. A bank is considered efficient if it falls on the frontier and inefficient if it falls below it. The distance between the frontier and the performance of a bank below it is known as inefficiency. As a result, the efficiency scores of DMUs are bounded between zero and one, with fully efficient banks having an efficiency score of one (Coelli et al., 2005).

Several alternative models have been introduced in the DEA literature to determine which DMU establishes the best efficiency frontier; for details, see Cooper et al. (2007). Here, both the CCR (Charnes, Cooper, and Rhodes, 1978) and the BCC (Banker, Charnes, and Cooper, 1984) input-oriented models are adopted. The CCR model assumes constant returns to scale, while the BCC model assumes variable returns to scale. Cost efficiency measures the potential reductions in cost that can be achieved if a bank is both technically and allocatively efficient (Elyasiani and Mehdian, 1995). A bank is considered technically efficient (TE) if it operates on the efficient frontier and allocatively efficient (AE) if it chooses the correct mix of inputs given the input prices. Therefore, cost efficiency (CE) is the product of technical efficiency and allocative efficiency.

To compute the cost efficiency for a particular bank (j), first find the minimum cost of producing outputs (O) for a given set of input prices (w). Assume that there are n banks that use I different inputs to produce O different outputs. The minimum cost is calculated using the following linear programming problem:

[1] An alternative to Data Envelopment Analysis (non-parametric) technique is the Stochastic Frontier Analysis (parametric) technique. We chose DEA techniques in this paper due to limited sample size (often SFA ask for bigger sample size due to large number of parameters to be estimated), and DEA also enables us to address our research question on productivity growth.

$$
\begin{aligned}
&Min_{I_i} \quad \sum_{i=1}^{m} w_i I_i, \\
&s.t. \quad \sum_{j=1}^{n} \lambda_j O_{rj} \geq O_{rjo,} \\
&\qquad \sum_{j=1}^{n} \lambda_j I_{ij} \leq I_{ijo,} \\
&\qquad \sum_{j=1}^{n} \lambda_j = 1, \\
&\qquad \lambda_j \geq 0.
\end{aligned}
\qquad \ldots (1)
$$

where for bank *j*, λ_j and w_j are the intensity variables and input prices, respectively. O_{rj} is the r_{th} output variable of the bank; I_{ij} is the i_{th} input variable of the bank; O_{rjo} is its observed output vector; and I_{ijo} is its observed input vector. Cost efficiency for bank *j* is measured by the ratio of minimum cost to actual cost incurred by the bank.

To calculate technical efficiency (TE) for bank *j*, the following linear programming problem is solved:

$$
\begin{aligned}
&Min \quad \Theta, \\
&s.t. \quad \sum_{j=1}^{n} \lambda_j O_{rj} \geq O_{rjo,} \\
&\qquad \sum_{j=1}^{n} \lambda_j I_{ij} \leq \Theta . I_{ijo,} \\
&\qquad \lambda_j \geq 0.
\end{aligned}
\qquad \ldots (2)
$$

Technical efficiency (TE) can be decomposed into pure-technical efficiency (PTE) and scale efficiency (SE). Pure-technical inefficiency results from using more inputs than necessary (input waste), while scale-inefficiency occurs if the bank does not operate at a constant return to scale.

To retrieve the aforementioned efficiency results, particularly variable returns to scale based BCC model, one more constraint should be added:

$$\sum_{j=1}^{n} \lambda_j = 1 \qquad \ldots (3)$$

In line with the literature (Berger and Humphery, 1997; Berger and Mester, 1997; Delis and Papanikolaou, 2009; Hassan and Sanchez, 2007; Kumar and Gulati, 2008), this study adopts the intermediation approach and uses three input variables, namely labor, deposit funds, and capital, and two output variables, namely loan and investment. The variables and their measures are shown in Table 2. DEA has the advantage of not requiring a specific functional form for the production frontier, and it simplifies the measurement of total factor productivity growth. Due to these benefits, as well as the smaller sample size, the DEA methodology was chosen for estimating efficiency measures (Canhoto and Dermine, 2003). To estimate different efficiency measures, the DEAP 2.1 computer program developed by Coelli (1996) was utilized.

Table 2: Inputs, Outputs, Input Prices, and Their Proxies

Variables	Proxy Measures
Input variables	
Deposit Funds	Total deposits consisting of current deposit, saving deposit and fixed deposit as reported in balance sheet of the bank
Labor	Total employee expenses as reported in bank's annual report
Capital	Fixed assets including other operating assets as reported in bank's annual report
Output variables	
Loan and Advances	Total loan and advances as reported in balance sheet of the bank
Investments	Total investment made in financial assets (govt. securities, corporate securities, and foreign securities) as reported in balance sheet of the bank
Input prices	
Cost of Deposit Funds	Total interest expenses divided by total deposit funds
Labor Cost	Total staff expenses divided by total assets
Capital Cost	Other operating expenses divided by total assets

Malmquist Productivity Index

Malmquist Productivity Index (MPI) is the product of two elements: the change in technical efficiency change (ΔTE), or how closer a bank can get to the efficient frontier (catching up), and technological change (ΔTC), or how much the benchmark production frontier shifts at each bank's observed input mix (innovations or shocks). A Malmquist index that is greater than 1 implies that total factor productivity progress has occurred, while an index less than 1 means that total factor productivity has instead retarded.

The Malmquist productivity index (MPI) can be computed based on the distance function (d) between two period's efficiency frontiers as:

$$M(I_{t+1}O_{t+1}, I_tO_t) = \left[\frac{d_{t+1}(I_{t+1}, O_{t+1})}{d_t(I_t, O_t)}\right] \times \left[\frac{d_t(I_{t+1}O_{t+1})}{d(IO)} \times \frac{d(IO)}{d_{t+1}(I_tO_t)}\right]^{1/2} \quad \ldots (4)$$

This represents the productivity of production point (I_{t+1},O_{t+1}) relative to the production unit (I_t,O_t). The subscript t and t+1 represent the production technology in period t and t+1. On right hand side of equation (4), first component measures the efficiency change whereas second component measure technical chance.

The technical change can further be decomposed into pure efficiency change and scale change where technical change is now computed under variable return to scale and so forth to pure technical change and scale change. For detailed explanation methodological consideration about MPI, *see* Coelli *et al.* (2005).

Econometric Method

The cost efficiency of a bank depends on the size, ownership structure, business specialty (market penetration), financial (equity) capital, risk structure (credit risk), and profitability of the bank. Therefore, we specify the following econometric model:

$$CE_{i,t} = \alpha + \beta_1 OWN_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 LOAN_{i,t} + \beta_4 ROA_{i,t} + \beta_5 NPL_{i,t} + \beta_6 EQTY_{i,t} + \varepsilon_{i,t} \quad \ldots (5)$$

where CE is the cost efficiency score, OWN is the dummy (to capture ownership effect) which takes value of 0 for the State-owned and 1 for private banks; SIZE is the natural logarithm of total assets measured in real term by using GDP deflator; LOAN is the ratio of total loan to total assets; ROA is the ratio of net income after tax divided by total assets; NPL is the ratio of non-performing loan to total loan; and EQTY is the ratio of shareholders' equity (net worth) to total assets. ε is the residual term and normally distributed. The subscripts *i* and *t* refer to bank and year respectively.

Empirical Results and Discussion

DEA Efficiency Estimates

The efficiency measures of the Nepalese banking industry estimated through Data Envelopment Analysis are presented in Table 3. The annual statistics are the result of the annual frontier, i.e., estimated separately for each year or separate frontier for each year. The average cost efficiency for the year 2001 is 87.7 percent, indicating that if the average bank were to reach the cost efficiency level of its most efficient counterpart in that year, it could experience a cost saving of 12.3 percent (i.e., 1 - 0.877). The annual cost efficiency score is more than 85 percent, except in 2002 and 2008. The sample period average cost efficiency is about 84 percent, which means there is about 16 percent cost inefficiency in Nepalese commercial banks.

When segregating cost efficiency into technical efficiency and allocative efficiency, the average technical efficiency for the year 2001 is 92.5 percent. This means that if the average bank in the sample were to achieve the technical efficiency level of its most efficient counterpart, it could realize about 7.5 percent savings in its inputs. In other words, the average inputs wastage (technical inefficiency) is about 7.5 percent. There is an upward trend over the sample period, and the level of technical efficiency for the overall sample period is about 91.5 percent. Similarly, the average allocative efficiency for the banks over the sample period is 91.2 percent. This means the average banks can reduce their costs by 5.6 percent if they choose the optimal mix of inputs for the given level of outputs. These results indicate that cost efficiency could be improved by enhancing both technical efficiency (input productivity), particularly technical inefficiency constitutes more for overall economic (cost) inefficiency.

Table 3: Annual Estimates of Different Efficiency Measures

Efficiency Measures\Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**Average of Annuals**
Cost Efficiency	0.877	0.743	0.852	0.877	0.886	0.862	0.866	0.727	0.878	0.836
	0.924	*0.728*	*0.896*	*0.924*	*0.924*	*0.926*	*0.917*	*0.737*	*0.881*	*0.874*
	(0.178)	(0.199)	(0.170)	(0.178)	(0.132)	(0.140)	(0.144)	(0.141)	(0.094)	(0.157)
Allocative Efficiency	0.944	0.791	0.893	0.944	0.980	0.974	0.979	0.816	0.939	0.912
	0.961	*0.771*	*0.934*	*0.961*	*0.985*	*0.992*	*0.997*	*0.815*	*0.939*	*0.952*
	(0.072)	(0.152)	(0.113)	(0.072)	(0.024)	(0.032)	(0.027)	(0.087)	(0.040)	(0.105)
Technical Efficiency	0.925	0.931	0.953	0.925	0.904	0.886	0.885	0.886	0.934	0.915
	0.982	*1.000*	*1.000*	*0.982*	*0.948*	*0.955*	*0.953*	*0.901*	*0.955*	*0.967*
	(0.157)	(0.140)	(0.140)	(0.157)	(0.134)	(0.146)	(0.145)	(0.119)	(0.085)	(0.129)
Pure Technical Efficiency	0.972	0.974	0.995	0.972	0.967	0.964	0.952	0.956	0.976	0.970
	1.000	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*
	(0.082)	(0.069)	(0.014)	(0.082)	(0.050)	(0.087)	(0.117)	(0.098)	(0.039)	(0.074)
Scale Efficiency	0.944	0.957	0.957	0.944	0.933	0.921	0.933	0.930	0.958	0.943
	0.985	*1.000*	*1.000*	*0.985*	*0.991*	*0.966*	*0.990*	*0.942*	*0.989*	*0.992*
	(0.118)	(0.129)	(0.140)	(0.118)	(0.122)	(0.131)	(0.116)	(0.097)	(0.083)	(0.112)
No. of bank observations	15	16	17	17	18	18	20	25	25	171
No. of banks in frontier	5	2	4	5	3	3	4	2	4	

Table 4
Different Efficiency Measures Assuming a Common (Single) Frontier

Efficiency Measures\Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2001-2009**
Cost Efficiency	0.578	0.623	0.644	0.618	0.643	0.597	0.618	0.664	0.653	0.633
	0.594	*0.644*	*0.640*	*0.632*	*0.640*	*0.601*	*0.644*	*0.667*	*0.659*	*0.642*
	(0.111)	(0.164)	(0.159)	(0.141)	(0.142)	(0.175)	(0.108)	(0.134)	(0.083)	(0.130)
Allocative Efficiency	0.856	0.900	0.901	0.876	0.879	0.841	0.860	0.870	0.848	0.873
	0.858	*0.908*	*0.889*	*0.862*	*0.857*	*0.848*	*0.831*	*0.833*	*0.817*	*0.862*
	(0.092)	(0.083)	(0.077)	(0.079)	(0.084)	(0.203)	(0.096)	(0.085)	(0.089)	(0.086)
Technical Efficiency	0.685	0.698	0.718	0.714	0.741	0.686	0.735	0.772	0.781	0.734
	0.706	*0.731*	*0.739*	*0.746*	*0.750*	*0.747*	*0.768*	*0.814*	*0.804*	*0.760*
	(0.148)	(0.178)	(0.165)	(0.172)	(0.173)	(0.207)	(0.181)	(0.170)	(0.133)	(0.164)
Pure Technical Efficiency	0.788	0.795	0.831	0.835	0.892	0.821	0.882	0.904	0.927	0.864
	0.766	*0.842*	*0.845*	*0.870*	*0.939*	*0.916*	*0.954*	*0.954*	*0.947*	*0.898*
	(0.145)	(0.177)	(0.147)	(0.164)	(0.129)	(0.219)	(0.162)	(0.116)	(0.082)	(0.144)
Scale Efficiency	0.869	0.875	0.861	0.851	0.827	0.790	0.834	0.851	0.843	0.847
	0.928	*0.907*	*0.879*	*0.862*	*0.861*	*0.843*	*0.884*	*0.898*	*0.886*	*0.879*
	(0.129)	(0.123)	(0.124)	(0.116)	(0.146)	(0.195)	(0.139)	(0.143)	(0.128)	(0.129)

Note: The median score is given below the mean score in italics and standard deviation is given below median score in parenthesis.

Moreover, the decomposition of technical efficiency into pure technical efficiency and scale efficiency shows that the level of pure technical inefficiency is only about 3 percent, whereas scale inefficiency is about 5.7 percent. This suggests that bank executives are using bank resources efficiently, but they are choosing the wrong mix of inputs and outputs, perhaps for reasons beyond their control (Hassan and Sanchez, 2007). All the efficiency measures for the sample periods show an upward trend.

Since these efficiency measures are relative measures and are calculated by referring to the best practice bank within the given year, year-by-year comparisons of these estimates lack consistency (Canhoto and Dermine, 2003). As an alternative, the annual data is pooled into one sample, assuming a common benchmark technology to estimate the efficiency measures. Now the annual efficiency measures are comparable (Canhoto and Dermine, 2003). The efficiency estimates from the common frontier are reported in Table 4. Under the common frontier, the average cost efficiency of the Nepalese banking industry is about 63.3 percent, indicating about 36.7 percent input waste considering their prices. The median statistic supports this. The level of technical efficiency is about 73.4 percent, and the level of allocative efficiency is about 87.3 percent. These empirical results show that the economic efficiency of the Nepalese banking industry is lower than that reported in other countries in the region (Perera et al., 2007) and similar to other developing countries around the world (Mostafa, 2007; Hassan and Sanchez, 2007; Chen, 2009).

Looking at the annual efficiency measures, although cost efficiency decreased in 2004, 2006, and 2009, there is an upward trend over the sample period. The similar trend reveals for technical efficiency and allocative efficiency. However, this increase (decrease) in efficiency could be because banks are becoming more (less) efficient and/or because the benchmark technology is changing. Hence, factor productivity growth (Malmquist Productivity Index, MPI) is estimated and analyzed.

Ownership and Efficiency

The ownership structure of banks influences their economic behaviors, hence affecting the efficiency and financial performance of the banks (Altunbas et al., 2001). In this regard, different efficiency measures are summarized based on three ownership categories: state-owned banks, private (domestic) banks, and foreign-owned banks, and reported in Table 5. The bank with government equity participation is regarded as a state-owned bank, and the bank with foreign equity participation is regarded as a foreign-owned bank.

Under the average of annual frontiers, the average cost efficiency of state-owned banks is about 61 percent, in contrast to about 87 percent for private banks (both domestic and foreign-owned banks). The evidence suggests that state-owned banks are significantly less efficient than their counterparts; however, domestic private banks are equally efficient to foreign-owned (foreign joint-venture) banks. The efficiency estimates from the common frontier as well as efficiency estimates for other efficiency measures (e.g., technical efficiency, allocative efficiency, and scale efficiency) show the same pattern across the ownership and lead to similar conclusions. The less cost efficiency in state-owned banks may be a reflection of high government influence, a very large branch network and high operating cost, and conventional technologies. However, looking at the annual efficiency score (not presented here) of state-owned banks, they are gaining efficiency over the sample period, which might be a consequence of reformation programs in those banks.

Table 5: Summary Efficiency Measures based on Bank Ownership Structure

	Average of Annual Frontiers				Average of Common Frontier			
	All banks	State-owned banks	Domestic private banks	Foreign-owned banks	All banks	State-owned banks	Domestic private banks	Foreign-owned banks
Cost Efficiency	0.836	0.609	0.869	0.875	0.633	0.448	0.686	0.618
	0.874	*0.642*	*0.88*	*0.926*	*0.642*	*0.424*	*0.668*	*0.635*
	(0.157)	(0.19)	(0.105)	(0.135)	(0.130)	(0.162)	(0.105)	(0.065)
Allocative Efficiency	0.912	0.85	0.923	0.92	0.873	1.000	0.846	0.866
	0.952	*0.926*	*0.943*	*0.96*	*0.862*	*1.000*	*0.826*	*0.867*
	(0.105)	(0.167)	(0.082	(0.101)	(0.086)	(0.001)	(0.072)	(0.080)
Technical Efficiency	0.915	0.725	0.941	0.951	0.734	0.449	0.812	0.719
	0.967	*0.757*	*0.961*	*1.000*	*0.760*	*0.424*	*0.807*	*0.727*
	(0.129)	(0.197)	(0.072	(0.099)	(0.164)	(0.162)	(0.104)	(0.101)
Pure Tech. Efficiency	0.970	0.979	0.966	0.974	0.864	0.709	0.877	0.908
	1.000	*1.000*	*1.000*	*1.000*	*0.898*	*0.723*	*0.879*	*0.952*
	(0.074)	(0.074)	(0.061	(0.093)	(0.144)	(0.227)	(0.102)	(0.119)
Scale Efficiency	0.943	0.736	0.975	0.977	0.847	0.639	0.927	0.798
	0.992	*0.757*	*0.992*	*1.000*	*0.879*	*0.641*	*0.944*	*0.799*
	(0.112)	(0.181)	(0.043)	(0.041)	(0.129)	(0.105)	(0.063)	(0.096)
No. of observations	171	23	94	54	171	23	94	54

Note: The *median* score is given below the mean score in italics and *standard deviation* is given below median score in parenthesis.

The summary of various efficiency measures for all banks, along with three groups (state-owned banks, domestic private banks, and foreign-owned banks), is provided in Table 5. To test our hypothesis 2 (foreign banks are more efficient than domestically owned banks), we performed a t-test for domestic private banks and foreign banks, focusing on common frontier-based estimates for cost efficiency. The mean cost efficiency for domestic private banks is 68.6%, with a standard deviation of 10.5%, and for foreign banks is 64.8%, with a standard deviation of 6.5%. The t-statistic was 4.86. At a 95% level of confidence, the test concluded that domestic private banks are more cost-efficient than foreign banks, which is contrary to the hypothesis we had. Our finding supports the explanations provided by the *home advantage hypothesis* for the Nepalese banking industry.

Malmquist Productivity Index

Here, the Malmquist Productivity Index (MPI), also known as the total factor productivity (TFP) index, is used to calculate productivity changes/growth within the Data Envelopment Analysis framework as suggested by Coeili (1996). As the sample period of 2001-2009 contains unbalanced panel data, the MPI is computed for each two-year period to minimize sample observation loss.

The MPI measures two effects on changes in the frontier: the "frontier shift" effect, which measures technical progress between two periods, and the "catching up" effect, which measures how much sample banks are moving closer or farther away from their own period best practice frontier (Coeili, 1996; Canhoto and Dermine, 2003). The total factor productivity change is the product of these two components. Table 6 reports the MPI index and its components, including technical change, technical efficiency change, pure efficiency change, and scale efficiency change. A value of MPI or any of its components less than unity indicates deterioration in performance, whereas a value greater than unity indicates improvement or growth in productivity.

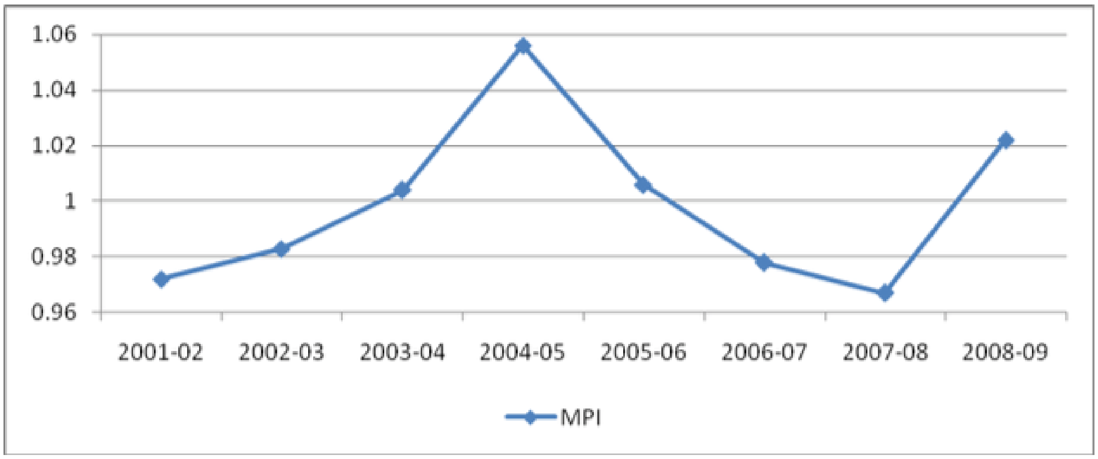
Table 6 shows that the average factor productivity growth rate of the Nepalese banking industry is -0.2 percent (i.e., 1-0.998) with a high of 5.6 percent in 2005 and a low of -3.3 percent in 2008, as indicated by the annual average MPI. Productivity gradually improved until 2006, from -2.8 percent in 2002 to 5.6 percent in 2005. Productivity then declined and even deteriorated during 2006-2008. However, in 2009, there was about a 2.2 percent increase in TFP. Figure 5 illustrates these changes.

Table 6: Malmaquist Productivity Index

Period	No. of banks in panel	Malmquist Index (MPI)	Efficiency Change (EFFCH)	Technical Change (TECHCH)	Pure Efficiency Change (PECH)	Scale Change (SECH)
2001-02	15	0.972	0.966	1.006	1.017	0.950
2002-03	16	0.983	1.021	0.963	1.028	0.993
2003-04	17	1.004	0.965	1.041	0.972	0.993
2004-05	17	1.056	0.995	1.061	1.005	0.990
2005-06	18	1.006	0.979	1.028	0.994	0.985
2006-07	18	0.978	0.996	0.982	1.005	0.991
2007-08	20	0.967	1.037	0.932	1.027	1.010
2008-09	25	1.022	1.060	0.964	1.027	1.032
Average		0.998	1.002	0.996	1.009	0.993

Decomposition of the TFP reveals that technical changes (TECHCH) have caused the deterioration of productivity. The year-to-year index of technical changes has decreased over the sample period, particularly after 2006. This outcome indicates a lack of technological innovation in Nepalese commercial banks in later years. The lowest value of EFFCH was observed in 2004, indicating certain changes in the input mix, resulting in a higher use of input variables to produce the given level of output. The mean value of EFFCH suggests that there is a very minimum or no "catching up" effect, and the average banks have not increased their relative cost efficiency over the sample period. Further decomposition of EFFCH into pure technical changes (PECH) and scale changes (SECH) shows that pure technical changes contribute more to changes in efficiency than scale efficiency. Therefore, on average, the source of efficiency lies in the input-output mix rather than the size of operation.

Figure 5: Evolution of Malmaquist Productivity Index



The above results indicate that the level of cost efficiency of Nepalese commercial banks is lower than that reported for banks in other countries in the South Asian region (Perera et al., 2007) and like other developing countries around the world (Mostafa, 2007; Hassan and Sanchez, 2007; Chen, 2009). Nepalese commercial banks can enhance their cost efficiency by reducing their technical inefficiency, and there is a low level of external (particularly regulatory) influences on input inefficiency mix, as indicated by a very low level of allocative inefficiency. Allocative inefficiency in banking economics is also known as regulatory inefficiency, where the allocation of resources is subject to regulatory compliances (Hassan and Sanchez, 2007). There is a deterioration in total factor productivity, and productivity growth is even negative, mostly resulting from the lack of technological progress. The banks can break down the stagnant phase of efficiency through technological innovation.

Determinants of Cost Efficiency

Interest in studying the determinants of banking efficiency in the Nepalese context has been stimulated by empirical works in the international sphere. Since the 1990s, a great deal of effort has been given to investigate how bank efficiency is empirically determined (Berger and Mester 1997; Altunbas et al., 2001; Akhigbe and McNulty, 2003; Perera et al., 2007). Bank efficiency can be expressed as a function of firm-specific variables as well as macroeconomic variables (Berger and Mester, 1997; Perera et al., 2007). From the firm-specific perspective, the literature suggests that factors such as size, ownership, risk structure, capital adequacy, profitability, and others are important determinants. From the macroeconomic perspective, factors such as the level of inflation, interest rates, gross domestic product, financial liberalization policy initiatives, and market structures influence the banks' activities and hence the level of banking efficiency. In this section, firm-specific factors influencing bank efficiency are studied using econometric models.

Here, the relationship between efficiency measures, particularly cost efficiency, and other bank-specific variables is studied using econometric methods. However, as argued by Berger and Humphrey (1997), the choice of explanatory variables in the efficiency analysis is fraught with difficulty and relies more on the interests of the study. Following Berger and Mester (1997), Perera et al. (2007), and Delis and Papanikolaou (2009), five key independent variables, namely size (total assets), business specialty (loan to total assets ratio), risk (non-performing loan to total loans), capital adequacy (equity ratio), and profitability (ROA), are chosen for the study. Cost efficiency is estimated from DEA methodology assuming a common frontier for the sample periods.

Table 7 presents the Pearson correlation coefficients for the variables (dependent and independent) used in econometric analysis. Some interesting observations from the table are that OWN, a dummy variable taking a value of 0 for state-owned banks and 1 otherwise, is highly correlated with the equity ratio and non-performing loan to total ratio. The equity ratio is also highly correlated with lnTA, a proxy for size, and non-performing loan to total ratio. The table provides meaningful insights to develop alternative equations to assess the impact of independent variables on dependent variable(s), considering multicollinearity issues.

Table 7: Correlation Matrix

	CE	OWN	SIZE	LOAN	EQTY	NPL	ROA
CE	1.00						
OWN	0.56	1.00					
SIZE	-0.54	-0.56	1.00				
LOAN	0.53	0.50	-0.50	1.00			
EQTY	0.84	0.66	-0.61	0.43	1.00		
NPL	-0.66	-0.61	0.37	-0.51	-0.71	1.00	
ROA	0.25	0.12	0.08	0.05	0.27	-0.37	1.00

Since this study employs panel data, there are two alternatives for estimating the parameter in Equation (5): one is to pool all the data and estimate parameters using the ordinary least squares method, and the other is to use panel data models (fixed effects model and/or random effects model). Here, considering the issue of multicollinearity, we provide three model specifications and estimate parameters using both estimation techniques - pooled ordinary least squares and random effects generalized least squares. The use of the random effects model is motivated by the fact that there are changes in cost efficiency (as described earlier in this section) over the sample period.

The regression results are reported in Table 8. The interesting observations on the results presented are that all the models are statistically significant; all the models have a moderate to high level of explanatory power; and all the individual coefficients are statistically significant at the normal level. The economic significance of those estimates is explained in the following paragraphs.

Regarding the impacts of state versus private (both domestic and foreign) ownership on cost efficiency, private ownership has a significant positive effect on cost efficiency. Some possible reasons for these results in the Nepalese case include that state-owned banks have government intervention in their functioning, which sometimes forgoes cost-effectiveness; managerial expertise and their responsibility and accountability, which are poor in state-owned banks. The evidence suggests privatization of state-owned banks to enhance the efficiency of those banks.

In accordance with the findings of Isik and Hassan (2002), Girardone et al. (2004), and Altunbas et al. (2007), cost efficiency is always inversely related to the size of the bank (lnTA), and the coefficients for size are consistent across different model specifications and different estimation techniques. The negative coefficient of size indicates that as bank size increases, the level of efficiency decreases. The results are the opposite of the general notion that as size increases, efficiency will be enhanced through scale and scope biases (Berger and Humphrey, 1997). This empirical evidence suggests that for the Nepalese commercial banks, an increase in the size of assets reduces the level of efficiency, which is also in contrast to the findings for other South Asian economies (Perera et al., 2007, Table 9, p. 54).

There may be several plausible reasons for this inverse relationship between efficiency and the size of banks in the case of Nepal. Small banks may have greater information access and fewer agency problems, so they tend to outperform large banks (Mester et al., 1998). The small banks are limited to certain market segments; hence their originating, servicing, and monitoring costs per rupee of loan might be lower than those of larger banks (Isik and Hassan, 2002), which may help increase the level of efficiency of small banks. Furthermore, most of the banks are highly concentrated in urban areas, particularly in the Kathmandu valley, and even more particularly in city centers. Larger banks, for their extension, open branches outside the Kathmandu valley, which tend to have very high costs per branch because business is limited in scale and scope in those suburban and rural areas. Smaller banks hesitate to extend their branches in those regions, which provides some operational advantages to smaller banks.

The results consistently show a positive and statistically significant relationship between the loan-to-total asset ratio across various model specifications and estimation methods. This variable is an indicator of the strategic focus of the bank, specifically their preference for loans versus other earning assets (Berger and Mester, 1997; Chen, 2009). This preference could suggest that the bank places a higher value on its loan product compared to other investments or earning assets, or it may reflect the greater market power that exists in loan markets versus non-loan markets (Berger and Mester, 1997). These findings are consistent with previous studies conducted by Berger and Mester (1997) and Chen (2009). In the case of Nepalese banks, loan products appear to be more cost-efficient than other earning assets.

Table 8: Regression Results on Determinants of Cost Efficiency

Model Specifications	Pooled OLS Estimates			Random Effects GLS Estimates		
	I	II	III	I	II	III
CON	1.397	1.593	0.498	1.325	1.460	0.460
	0.247	*0.205*	*0.021*	*0.230*	*0.193*	*0.030*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
OWN	0.087			0.081		
	0.027			*0.043*		
	(0.002)			(0.062)		
SIZE	-0.043	-0.044		-0.040	-0.040	
	0.010	*0.009*		*0.010*	*0.009*	
	(0.000)	(0.000)		(0.000)	(0.000)	
LOAN	0.216	0.134	0.181	0.226	0.193	0.263
	0.056	*0.054*	*0.036*	*0.063*	*0.061*	*0.046*
	(0.000)	(0.014)	(0.000)	(0.000)	(0.002)	(0.000)
ROA	0.808	0.403		0.510	0.305	
	0.192	*0.193*		*0.142*	*0.142*	
	(0.000)	(0.038)		(0.000)	(0.032)	
NPL		-0.358			-0.211	
		0.057			*0.051*	
		(0.000)			(0.000)	
EQTY			0.634			0.549
			0.036			*0.042*
			(0.000)			(0.000)
F-statistic	40.28	54.20	246.4	8.470	9.250	61.64
p-value (F-stat)	0.000	0.000	0.000	0.000	0.000	0.000
R-square	0.493	0.566	0.746	0.802	0.815	0.874
Adj. R-square	0.480	0.556	0.743	0.764	0.778	0.852

About the relationship between profitability and efficiency, the sign of coefficient of ROA is always positive and statistically significant. The result is consistent with the earlier findings of Isik and Hassan (2002) and Berger and Humpherey (1997). The results suggest that profitable banks are cost efficient which are as obvious because the banks which are better able to minimize their costs may have higher profits. Similarly, the bank executives in profitable banks have more incentive to perform more efficiently.

Regarding the effect of risk on efficiency, coefficient for the risk (non-performing loan to total loans), is always negatively related to bank efficiency, particularly to cost efficiency. This evidence suggests that the banks which have higher non-performing loans (bad loans) are less cost efficient. In other words, the loan portfolio with higher credit risk is associated with lower cost efficiency. As argued by Berger and Mester (1997) banks which are poor in operation might also be poor in risk management (loan management). This result is consistent with some earlier studies in international sphere (Delis and Papanikolaou, 2009). From the results, it can be suggested that the Nepalese banks can enhance their level of efficiency by effective evaluation of credit risk.

Regarding the coefficient for financial capital (equity), it is positively related to the bank efficiency. The results are consistent with Mester (1996) but inconsistent with Altunbas *et al.* (2007). The positive relationship between financial capital and efficiency implies that if a bank increases its equity capital/total assets ratio then its level of efficiency will increase because higher capital ratios may prevent moral hazard (Mester 1996). In addition, as the inefficiencies are usually inversely correlated with bank performance, inefficiencies result to increase in cost and/or decrease in profit and hence reduces the shareholders' equity (net worth).

Robustness Tests

The above empirical results are robust across different specifications even when parameters are estimated using Tobit Maximum Likelihood method (pooled and random effects). Furthermore, as suggested by industrial economic theories, there might be a bidirectional causality between profitability and efficiency. Hence, the Model specifications I and II are re-estimated using seemingly uncorrelated regression (SUR) method, where ROA is regressed with the same explanatory variables, including cost efficiency. The results are similar for both model specifications.

Concluding Remarks

The paper examines the cost efficiency and its correlates for the Nepalese Banking Industry between 2001 and 2009, using the semi-parametric methodology. First, Data Envelopment Analysis (non-parametric methodology) is used to estimate cost efficiency along with other efficiency measures. Second, the cost efficiency from the first stage is regressed by firm-specific factors.

The results from DEA indicate that the average annual level of cost efficiency is approximately 63%, ranging from about 58% in 2001 to 66% in 2008. This translates to an average of 37% inefficiencies. The sources of cost inefficiency are allocative and technical inefficiencies. The average level of allocative inefficiency is about 13%, and technical inefficiency is about 27%. Additionally, there is a deterioration in total factor productivity, and productivity growth is mostly negative due to a lack of technological progress. Econometric analysis shows that private (domestic and foreign) banks are more cost-efficient than state-owned banks, and size is inversely related to efficiency. Banks with higher financial capital (equity) tend to be more efficient, and banks emphasizing more on other earning assets. Banks with higher credit risk are less efficient, whereas profitable banks are more cost-efficient.

The results have significant implications for bank managers and policymakers alike. Bank managers can enhance their cost efficiency by reducing their technical inefficiency and optimizing input mixes. The banks can break down the stagnant phase of efficiency by technological innovation. Regulators may allow flexibility on input decisions, such as bank deposits and bank capital, to reduce the allocative inefficiency of the banks. To increase productivity and technological innovation in the industry, policymakers should focus on enhancing market competition and bringing technological know-how via making the market viable for international banks.

Banking efficiency is an evolving phenomenon, and future studies may collect more data and use both parametric and non-parametric approaches to estimate banking efficiency. The recent wave of merger deals among commercial banks and finance companies and implementation of Basel III accord require more empirical studies to capture the changes that may have brought banking efficiency in Nepal. This is left for future research.

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