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CORPORATE GOVERNANCE, OWNERSHIP AND PROFIT PRODUCTIVITY CHANGE: EVIDENCE FROM UNIVERSAL BANKS IN GHANA

BY

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DECLARATION

I do hereby declare that this thesis is the result of my own research and has not been presented by anyone for any academic award in this or any other university. All references used in the work have been fully acknowledged.

I bear sole responsibility for any shortcomings.

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CERTIFICATION

I hereby certify that this thesis was supervised in accordance with procedures laid down by the University of Ghana.

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PROF. KOFI ACHAMPONG OSEI (SUPERVISOR) DATE

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DEDICATION

This work is dedicated to my beloved parents, Mr. Martin Kojo Gogovie and Ms. Charlotte Bortiorkor Miller, and my siblings for their encouragement and support throughout the period of my studies.

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LIST OF ABBREVIATIONS

ACRONYM	MEANING
ACCESS	Access Bank Ghana Limited
ADB	Agricultural Development Bank
ANOVA	Analysis of Variance
ATM	Automated Teller Machines
BARODA	Bank of Baroda
BBG	Barclays Bank of Ghana Limited
BCC	Banker, Charnes and Cooper
BOA	Bank of Africa
BOD	Board of Directors
BOG	Bank of Ghana
BSIC	Banque Sahelo-Saharienne
CAL	Cal Bank Ghana Limited
CCR	Charnes, Cooper and Rhodes
CEO	Chief Executive Officier
CG	Corporate governance
CRS	Constant Returns to Scale
DEA	Data Envelopment Analysis
DMUs	Decision Making Units
EBG	Ecobank Ghana Limited
EC	Efficiency change
ENERGY	Energy Bank
FABL	First Atlantic Bank Limited
FBG	Fidelity Bank Ghana Limited
FEAR	Frontier Efficiency Analysis with R
FINSAP	Financial Sector Adjustment Program
GCB	GCB Bank Limited
GDP	Gross Domestic Product

GSE	Ghana Stock Exchange
GSS	Ghana Statistical Service
GTB	Guaranty Trust Bank
HFC	HFC Bank
IBG	Intercontinental Bank Ghana Limited
ICB	International Commercial Bank
IMF	International Monetary Fund
IOD	Institute of Directors
LPI	Luenberger Productivity Indicator
METRO	Metropolitan and Allied Bank
NIB	National Investment Bank
NYSE	New York Stock Exchange
PBL	Prudential Bank Limited
PEF	Private Enterprise Foundation
ROYAL	The Royal Bank
SBM	Slack-based measure
SCB	Standard Chartered Bank
SEC	Securities and Exchange Commission
SFA	Stochastic Frontier Analysis
SG-SSB	Societe Generale Ghana Limited
STANBIC	Stanbic Bank
SZAL	Simar-Zelenyuk-Adapted Li
TC	Technological change
TTB	The Trust Bank
UBA	United Bank of Africa
UK	United Kingdom
UMB	Universal Merchant Bank
UNIBANK	Unibank Ghana Limited
US	United States
UT	UT Bank

VRS	Variable Returns to Scale
ZENITH	Zenith Bank

ABSTRACT

Corporate governance generally look at the financial, market and efficiency performance of banks, however this study attempts to focus on bank productivity and corporate governance. The current study identifies the effect of corporate governance on bank productivity change of foreign-owned and domestic banks. The study adopts the nonparametric DEA-based Luenberger productivity indicator by Chamber, Chung and Fare (1996) to estimate bank productivity of twenty nine universal banks in Ghana from 2000 to 2014. Furthermore, the Spearman's correlation analysis is employed to identify the source of bank productivity. The SZAL test is used to compare the distribution of bank productivity of foreign-owned and domestic banks. Finally, panel regression models are employed in determining how governance affects dynamic productivity of banks.

The results indicate that, productivity change of banks in Ghana, which averaged 1.37 percent over the study period was driven significantly by profit technological change. However, the competing bank ownership theories and hypotheses are not supported because the differences of productivity, technological and efficiency changes not significant. Corporate governance has significant effect on bank productivity for both foreign-owned and domestic banks in Ghana in the observed period. Whereas board size and executive compensation significantly have negative effects on bank productivity after controlling for bank size, leverage, profitability and sales growth. Therefore, the study lends support for the agency theory and the resource dependence theory.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The banking industry plays a very essential part in the development of economies across the globe (Beck & Levine, 2004; Demirgüç-Kunt, 2004; Demirgüç-Kunt & Levine, 1996; Fethi & Pasiouras, 2010; Klein & Olivei, 2008; Levine, 1997, 1999, 2005; Levine & Zervos, 1998; Paradi & Zhu, 2013). In Ghana, the banking sector is seen to make very significant contributions to overall GDP. For example, statistics has it that in 2014 and 2014, the Ghanaian banking sector contributed 6.5% and 8.4% respectively to Ghana's overall GDP (GSS, 2015), and also expanded by 20.7% in 2014, being the largest growth recorded within the service sector (PWC, 2015). Given the sector's importance, a number of studies have assessed the performance of banks in terms of efficiency and dynamic productivity (Amidu & Wolfe, 2013; Casu, Ferrari, & Zhao, 2013; Fethi & Pasiouras, 2010; Jaffry, Ghulam, & Cox, 2013; Liu, Lu, & Lu, 2016; Paradi & Zhu, 2013).

In order to perform their roles well as intermediaries, compete globally in a competitive environment and mollify any risk exposure, banks require effective corporate governance (CG) mechanisms to reduce their principal-agent problems (Arun & Turner, 2004; Mullineux, 2006). CG implies the means by which organizations are controlled and directed (Gariba, Amidu, & Coffie, 2018). CG mechanisms are also important because they are seen to impact performance of financial institutions (Aebi, Sabato, & Schmid, 2012; Basuony, Mohamed, & Al-Baidhani, 2014; Caprio, Laeven, & Levine, 2007; De Andres & Vallelado, 2008; Levine, 2004; Macey & O'hara, 2003; Min & Bowman, 2015; Wanyama & Olweny, 2013), help reduce their principal-agent problem and information asymmetry (Arun & Turner, 2004; Mullineux, 2006).

Also many banking efficiency and productivity studies ignore the profit-oriented dimension of performance by dwelling on only technical and cost productivity which are encapsulated in profit productivity (Grifell-Tatjé, 2011; Maniadakis & Thanassoulis, 2004). Yet, profit-oriented productivity incorporates both technical and allocative elements as well as cost and revenue mix productivities of profit-maximizing organizations. Besides, there appears to be no study that has associated bank CG with bank productivity change.

The aim of this study is to propose a dynamic profit-oriented productivity similar to that of Juo, Fu, Yu, and Lin (2015) but different in estimation. Next, the proposed index is decomposed into profit efficiency change and profit technological change. Then, the index is empirically employed to assess the dynamic profit productivity of banks in Ghana and the drivers of change, then it determines the statistical difference of the profit-oriented dynamic productivity of different ownership types of banks in Ghana. Finally, the study identifies and quantifies key CG mechanisms that can affect banks' profit-oriented dynamic productivity and empirically employs the innovative bootstrapped truncated regression model of Simar and Wilson (Simar & Wilson, 2011; 2007) to determine the nexus between CG and dynamic profit productivity of banks in Ghana whilst controlling for other environmental variables.

1.2 Problem Statement

There are several studies that have linked corporate governance (CG) to bank performance. Still, we identify some gaps in the recent bank productivity literature. First, studies that examined the CG-performance nexus used financial and accounting ratios which are easy to compute and interpret. But ratios may be contradictory and indistinguishable, are partial measures of performance, and these may not incorporate multiple inputs and outputs, appear to indirectly assume constant returns to scale which is not valid in real settings, may not be able

to identify role models or efficient targets for inefficient firms and may not be able to decompose performance into several sources (Feroz, Kim, & Raab, 2003; Giokas, 2008; Paradi & Zhu, 2013; Sherman & Gold, 1985; Smith, 1990). Thus, financial ratios should be complemented with frontier efficiency and productivity analysis, which is scanty in the general bank performance analysis literature.

Second, although some studies assessed the impact of CG on bank efficiency (Bokpin, 2013; Gorton & Schmid, 1999; Isik & Hassan, 2003a; Jiang, Yao, & Zhang, 2009; Kader, Adams, Hardwick, & Kwon, 2014; Kambhampati, 2006; Pi & Timme, 1993; Zelenyuk & Zheka, 2006; Zheka, 2005), they did not explore the impact of corporate governance on dynamic productivity which incorporates performance trends and patterns. Ghanaian bank efficiency studies examined how Bank of Ghana's policy directives such as the minimum capital requirement affect efficiency (Akoena, Aboagye, Antwi-Asare, & Gockel, 2009) whilst others examined the impact of size, capitalization, expansion, loan losses and corporate social responsibility on efficiency (Adjei-Frimpong, Gan, & Hu, 2014; Isshaq & Bokpin, 2012; Ohene-Asare & Asmild, 2011; Ohene-Asare & Asmild, 2012; Saka, Aboagye, & Gemegah, 2012) and the effects of bank competition on efficiency (Adjei-Frimpong, Gan, & Hu, 2013; Korsah, Nyarko, & Tagoe, 2001; Ohene-Asare & Alhassan, 2013, 2015). None examined CG-bank profit productivity nexus.

Third, most studies employed Stochastic Frontier Analysis (SFA) to link efficiency to corporate governance which has limitations (Bokpin, 2013; Gorton & Schmid, 1999; Isik & Hassan, 2003a; Jiang et al., 2009; Kader et al., 2014; Kambhampati, 2006; Pi & Timme, 1993; Zelenyuk & Zheka, 2006; Zheka, 2005). Despite its ability to handle noise and inefficiency resulting in economic interpretation, SFA is unable to better handle multiple inputs of banks (like capital,

purchased funds and labour) and multiple outputs (like investments and loans) simultaneously (Fried, Lovell, & Schmidt, 2008; Murillo-Zamorano, 2004; Murillo-Zamorano & Vega-Cervera, 2001; Odeck, 2007; Zhu, 2015). Also, SFA, unlike DEA, requires that restrictive functions (for production, cost, revenue or profit) be specified and yet fails to impose some axiomatic properties such as convexity, concavity, free disposability and monotonicity on the production function (Dong, Hamilton, & Tippett, 2014; Lampe & Hilgers, 2015; Oh & Shin, 2015; Van Meensel, Lauwers, Van Huylenbroeck, & Van Passel, 2010).

Fourth, several dynamic productivity studies using Malmquist productivity change index are based on technical productivity which just accounts for quantities of inputs and outputs without considering their prices (Arjomandi, Valadkhani, & Harvie, 2011; Chang, Hu, Chou, & Sun, 2012; Chowdhury, Zelenyuk, Laporte, & Wodchis, 2014; Coelli, Prasada Rao, O'Donnell, & Battese, 2005; Essid, Ouellette, & Vigeant, 2014; Mahlberg, Luptacik, & Sahoo, 2011; Odeck, 2000; Sathye, 2002). There are a few studies that followed Maniadakis and Thanassoulis (2004) to estimate dynamic cost productivity (Baležentis, 2012; Balezentis, Krisciukaitiene, & Balezentis, 2013; Thanassoulis, Shiraz, & Maniadakis, 2015; Tohidi, Razavyan, & Tohidnia, 2012; Tzu-Chun, Kai-Ping, & Yung-Lieh, 2012). Except for two studies (Juo, Fu, et al., 2015; Juo, Fu, Yu, & Lin, 2016), none have considered the profit maximizing goal of the firm in a dynamic manner.

Fifth, few studies test the returns to scale (RTS) property in DEA (Simar & Wilson, 2002). DEA efficiency and productivity studies make RTS axioms without proper empirical analysis (Battese, Rao, & O'Donnell, 2004; Bonin, Hasan, & Wachtel, 2005; Juo, Lin, & Chen, 2015; Parteka & Wolszczak-Derlacz, 2013; Scotti & Volta, 2015), although other studies have applied the Simar and Wilson (2002) nonparametric test of returns to scale in non-banking

industries (de Borger, Kerstens, & Staat, 2008; Gómez-Calvet, Conesa, Gómez-Calvet, & Tortosa-Ausina, 2014; Mahlberg & Url, 2010; Moradi-Motlagh & Babacan, 2015; Simar & Wilson, 2015; Sueyoshi & Goto, 2012; Tortosa-Ausina, Armero, Conesa, & Grifell-Tatjé, 2010). To the author's best of knowledge, there appears to be no such test of RTS in bank dynamic profit productivity analysis.

1.3 Research Objectives

The general goal is to assess the causal linkage between corporate governance and the estimated profit-oriented productivity change of banks in Ghana. The following are the specific objectives.

1. To test the returns to scale (RTS) property in the Ghanaian banking industry.
2. To estimate the profit-oriented Luenberger productivity indicator (LPI) of banks in Ghana.
3. To investigate the drivers of profit-oriented productivity change of banks in Ghana.
4. To determine the statistical difference of the profit-oriented dynamic productivity of different ownership type of banks in Ghana.
5. To assess the effects of corporate governance on the profit productivity change of banks in Ghana.

1.4 Research Questions

The study seeks to answer the questions below:

1. What type of scale elasticity characterizes the Ghanaian banking industry?
2. Can a profit-oriented LPI be estimated and decomposed?

3. What are the main drivers of dynamic profit productivity in the Ghanaian banking industry?
4. Is there a significant difference in the distribution of profit-oriented productivity change indicator between foreign and local banks in Ghana?
5. Does corporate governance significantly affect dynamic profit productivity and its components?

1.5 Research contributions

The study mainly purports to investigate how corporate governance affects the profit oriented productivity change of banks in Ghana to explore the major driving force of profit productivity change for these banks in order to influence policy and managerial decisions. The results of this study, therefore, is useful for policy, practice and academic literature. In terms of policy, the empirical assessment of the profit-oriented dynamic productivity of the Ghanaian banking industry can better inform the regulators of the industry (that is, the Bank of Ghana, BOG) on the financial health of the banks in terms of the change in various measures of their productive efficiency. By this, the BOG can be better informed regarding the trends and patterns of bank profit productivity change as well as the drivers of the change, towards implementing growth oriented banking policies and regulations. As a contribution to managerial practice, bank managements are able to determine which banking products or activities contribute more to their productivity growth. Also, management can ascertain whether their enhancement of corporate governance mechanisms is important to their profit productivity growth so as to make important managerial decisions to invest into these mechanisms and other environmental conditions, or whether they should focus on some mechanisms or de-invest resources from others.

This study makes some four-fold contribution to literature. First, this study contributes to bank efficiency and productivity studies by applying to the Ghanaian banking industry, the DEA-based profit-oriented Luenberger productivity indicator which considers both input and output prices in productivity assessments. Second, the study adds to the literature on bank productivity by firsthand using the second-stage bootstrapped truncated regression to explore the productivity-corporate governance nexus. Third, it is the first to investigate the impact of corporate governance on banks' productivity. Fourth, the study constitutes one of the few that test for the returns to scale property for various banks before their productivity assessment.

1.6 Limitations of the Study

Despite the various contributions of the study, it has some drawbacks regarding methodology, data and time. Despite the expected positive outcomes of this study, there are some constraints. To start with, this analysis uses DEA which is a nonparametric mathematical programming method. As it is distribution-free, it may be statistically constrained due to the presence of outliers and sampling variations that can bias the results. This limitation can be dealt with via bootstrapping. But, the algorithm for bootstrapping profit productivity is difficult to model. In any case, bootstrapping approximates the true frontier and is not a panacea to the sampling variation problem in DEA. However, a bootstrapped truncated regression is used to handle the serial correlation of productivity indices and second-stage regression variables. The other challenge, is the difficulty in undertaking the second-stage bootstrapped truncated regression since there is a further issue of the productivity scores being above unity. Also, the study used universal banks in Ghana as the DMUs. However, other banking institutions such as rural banks and microfinance institutions engage in banking activities. These other banking institutions were not included in this study because of the unavailability of data on them, coupled with different regulations and operating structure that faces them.

1.7 Thesis Structure

The study is categorized into five chapters, each with sections and potential subsections. The first chapter focuses on the background of the study, problem statement, objectives, questions, research contributions, and the scope within which the study is confined. Chapter two reviews the relevant literature on efficiency and productivity studies in banking in order to provide evidence to support the purpose of the research and seek answers to research questions. It also gives a brief discussion of the industry, the regulations, and the structure of the firms within the industry. In chapter three, the methodology of the research is discussed, detailing main nonparametric DEA and extensions of it. Chapter four entails data presentation, analyses of results, conducting of tests, and making graphical illustrations. The final chapter discuses, summarizes, concludes, makes recommendations and proposes directions for further research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides discussions of the main theories and empirical applications in the literature concerning corporate governance, productivity and efficiency in the banking sector. The chapter is structured into three main sections of theoretical review, empirical review and conceptual framework. The theoretical review discusses the theoretical justification for the study whereas the empirical review surveys the current state of research relating to bank performance and corporate governance since there is none productivity. The conceptual framework combines the theoretical and empirical reviews into one which drives the study.

2.2 Theoretical review

This section presents the theoretical underpinnings of the study. First, it explains three theories upon which the concept of corporate governance is based. Second, it explains the theories upon which performance differences of foreign and local banks can be based. Lastly, it explains the theory of productivity of firms.

2.2.1 Agency theory

The agency theory offers a substantial theoretical foundation on the contribution of Board of Directors towards ensuring performance of corporate bodies in the literature of corporate governance (Bhagat & Bolton, 2008). Jensen and Meckling (1976) indicate that with relationship of agency, there exists divorce of corporate ownership from corporate control, and this separation brings a conflict of interest between the managers and the shareholders. Though separating organizational control from ownership require management to undertake corporate

activities in the interest of owners (Kiel & Nicholson, 2003), conflicts rather arise where the owner of the corporate entity recognizes that management do undertake managerial decisions which are not in the utmost interests of the principal .

According to Blair (1995), the agency theory is based on the basic economic principle that firms exists to maximize their owners' wealth. The agency theory is applied where business units function under the conditions of incomplete information and uncertainty. These conditions generate two problems of agency relationships, which are adverse selection and moral hazard. The problem of adverse selection is said to have been occurred when a principal cannot determine whether an agent represents accurately his or her ability to do the work for which he or she is paid to do (Lülfesmann, 2002). According to Gifford (1999), moral hazard is a situation where a principal is uncertain if an agent has generate an optimum level of efforts required to meet the interest of the principal.

The theory of agency provides that the availability of corporate information to managers gives them an advantage over the owners of the firms. The information asymmetry created by separating management from ownership of firms generates a situation where managers may be more personally interested in maximizing their wealth than in the wealth of the owners of the firms (Fama, 1980; Fama & Jensen, 1983a, 1983b). According to Fama and Jensen (1983b), the corporate BOD is seen as the most important control mechanism in any company's internal governance. The theory supports that for the BOD to be able to act as an effective monitoring mechanisms, their effectiveness should be linked to characteristics of the board which include board size, board diversity and the key board committee structures, amongst others. These are very key to the effectiveness of CG mechanisms.

2.2.2 Stewardship theory

The stewardship theory does not regard managers as agents but rather as caretakers safeguarding the interest of shareholders. Accordingly, Davis, Schoorman, and Donaldson (1997, p. 27), indicate that "a steward protects and maximizes shareholders wealth through firm performance because by so doing the steward's utility function are maximized". The stewardship theory encourages the alignment of managers' goals with those of the organization or shareholders' interests in order to enhance performance. The protection of the interest of shareholders by managers, and the regard of managers as stewards has been the position of corporate regulations. For instance, the company law is underpinned by the requirement that directors stand in a fiduciary relationship with shareholders and should therefore discharge their roles towards the best interest of shareholders (Companies Acts, 1963).

2.2.3 Resource dependence theory

This theory highlights the roles of the BOD in relation to the dependence of a firm on directors' resources. The BOD has the potential to helping in acquiring and sustaining crucial resources needed for the survival of an organization (Pfeffer & Salancik, 1978). The theory helps provide some elaborations on how board size and its composition help to link an organization to certain crucial resources for its efficiency.

In many respects, when a board comprises members with external influences, the board undertakes a boundary-spanning function that "minimizes uncertainty of business operations, decreases operational dependencies, leads to information exchanges, represents the organization to external stakeholders, and enhances overall performance" (Provan, Beyer, & Kruytbosch, 1980, p. 211).

2.2.4 Ownership theories

There have contentions in literature as to whether foreign firms perform better than their domestic counterparts or vice versa. Some arguments go in favour of domestic firms while others go for the foreign. To understand these contentions, the ownersip-performance debate has been extended by a couple of theories and hypotheses.

Firstly, studies contended that the better multinational performance has been explained within the contexts of eclectic theory, portfolio diversification theory and global advantage hypothesis. Dunning's (1977) eclectic theory, Markowitz's (1952) portfolio diversification theory and global advantage hypothesis argue that multinational operations of a bank bring some gains to the firm's operation in the form of enhanced scale efficiency, better policies and reduced business risks.

The eclectic paradigm was first introduced by Dunning (1973, 1979, and 1980) based on earlier studies by Rostas (1948) and Frankel (1955) regarding higher productivity of the US manufacturing firms as compared to UK firms. From Dunning's (1977) eclectic theory, a banking firm will operate outside its national boundary if it has firm-specific advantages such as better technology, innovative product, trademark, enhanced service quality, superior managerial expertise and better distribution channels over the native banks. Therefore, international firms take advantage of imperfections including factor immobility, unreliable information, and monopoly rents in the external market to internationalise their operations. According to this view, firms invest abroad in order to exploit certain intangible firm-specific assets imperfect markets. In the banking industry, the customer base are factors which are immobile and this requires firms which want to exploit such resources to go multinational. The size and scale of foreign banks enable them to face lower average costs, and lower business

risk, leading to improved profitability, compared to purely domestic banks, all things being equal (Tecles & Tabak, 2010). Therefore, geographically diversified banks are expected to be more efficient and profit productive than domestic firms.

The portfolio diversification theory also argues that multinational firms are able to reduce systematic (non-diversifiable) risks when they operate on a multinational level (Markowitz, 1952). Because economies in different countries are in different business cycles at different times, firms that operate in these different countries are more likely to reduce fluctuations in their yearly earnings and revenue, thereby reducing business risks associated with their business activities than those who operate at the domestic levels only (Markowitz, 1952). Therefore, multinationality enables systematic risks of any economy to be reduced by holding international portfolio of assets in different countries (Escobar & Vredenburg, 2011). Clarke, Cull, Peria, and Sánchez (2003) argued that multinational operation of banks, therefore leads to greater stability of operation and lower business risk than domestic expansion of same.

The global advantage hypothesis supports the view that domestic firms underperform their foreign counterparts since the latter may have better policies or superior managerial skills, and therefore can operate at a minimal cost (Sufian, 2011b). This hypothesis takes two forms: the limited form and the general. The limited form stipulates that only banks from some specific foreign countries outperform local banks. The general form, in contrast to the limited, stipulates that regardless of the nation to which they belong, foreign firms perform better than the domestic firms.

Contrary to theories that posit foreign firms as been more efficient or profitable than local firms, the home field advantage hypothesis indicate local firms as being rather more profitable

or efficient than the foreign firms (Sturm & Williams, 2008; Sufian, 2011b). The home field advantage hypothesis attributes have an efficiency advantage to domestic firms over foreign firms because foreign firms incur more costs which domestic firms do not incur (Berger, Deyoung, Genay, & Udell, 2000). Examples of costs are the cost of staff turnover in overseas postings, the cost of monitoring from a distance, and the cost of barriers to entry including language differences, cultural differences, barriers of the market structure and barriers in the regulatory environment (Sturm & Williams, 2004). Equally, it is argued that local firms likely know the market better than foreign ones, and should therefore be able to operate more efficiently.

2.3 Empirical review and hypothesis development

2.3.1 Productivity assessment of the banking industry

Frontier efficiency indicate a firm's ability to utilize its limited resources to augment output or to contract inputs while maintaining the output level (Daraio & Simar, 2007). Productivity change is efficiency measured over time whilst accounting for technological changes. The concept of efficiency and productivity is linked to the prominent studies of Debreu (1951), Koopmans (1951), Malmquist (1953), and Farrell (1957). The evaluation of efficiency and/or productivity of decision making units (DMUs) is achieved by constructing a production, cost or profit frontier using a parametric SFA (Aigner, Lovell, & Schmidt, 1977; Meeusen & Vandenbroeck, 1977) or nonparametric DEA or free disposal hull, FDH (Banker, Charnes, & Cooper, 1984; Charnes, Cooper, & Rhodes, 1978; Deprins, Simar, & Tulkens, 1984). DEA has received extensive research attention as a method for assessing the efficiency and productivity of banks (Färe, Grosskopf, & Roos, 1998; Fethi & Pasiouras, 2010; Liu et al., 2016; Liu, Lu, Lu, & Lin, 2013a, 2013b). Most especially, the Malmquist Productivity Index (MPI) has become a popular approach for evaluating productivity change. The studies that applied the

Data Envelopment Analysis and the MPI has been summarized in Fethi and Pasiouras (2010); Liu et al. (2013a), Liu et al. (2013b), and Liu et al. (2016).

Despite the popularity gained by the MPI as a performance assessment tool, a large number of these frontier dynamic productivity studies in the banking industry focus on technical productivity, with samples drawn from Europe. Drake (2001), for example, assessed productivity change of nine banks in the United Kingdom (UK) between the period 1984 and 1995 and found that, UK banks exhibited a modest positive productivity growth. Similarly, Fiordelisi and Molyneux (2010) and Murillo-Melchor et al., (2010) in the assessment of productivity change for European banks from 1995 to 2002 and from 1995 to 2001 respectively, found out that productivity growth in the European banking system was due to improvement in production technology. These results possess some biases since these studies failed to consider cost of the inputs and price of outputs or allocative efficiency, an important determinant of total factor productivity change.

Rezitis (2008) and Halkos and Tzeremes (2013) focused on a sample of six and 45 Grecian banks over the period from 1982 to 1997 and from 2007 to 2011 respectively to estimate the operational efficiency gain or loss and concluded that the Greek banking industry experienced productivity gains due to regulatory reforms including such mergers and acquisitions. In addition, Halkos and Tzeremes (2013) found that the financial crisis of 2007/2008 in the Greek banking industry lead to loss on their productivity gains. The question these findings still leaves unanswered, has to do with the completeness of the productivity change assessment carried out. This is because their use of just the standard productivity change index of Fare et al. (1992, 1994) did not consider the cost inputs and the price of outputs. The current study has addressed the issue of considering cost of input and price of outputs in productivity assessment of banks.

Mukherjee, Ray, and Miller (2001) also investigated the productivity change of the US banking industry during the initial post-deregulation period (from 1984 to 1990), using a sample of 201 commercial banks. The result demonstrated that on average the industry experienced a 3% productivity progress. However, the initial implementation period of 1984-1985, saw a productivity decline of 7%. Given the argument of Maniadakis and Thanassoulis (2004) that allocative efficiency assessment could further improve the productivity growth, the conclusion of this study may be biased as it failed to account for the input and output prices.

The study of Matthews and Zhang (2010) concerning the Chinese banking industry a showed a complete deviation from the other studies. The authors found out that, on average productivity has been constant in the Chinese banking industry from 1997 to 2007. Their results showed that the policy of opening up the industry to foreign competition was yet to accrue any benefit at the time of the study. However, in relation to bank ownership, City Commercial Banks (CCBs) experience a productivity progress, indicating possible benefits of the liberalization of the banking industry.

Though the productivity studies on African countries are few, Moffat, Valadkhani, and Harvie (2009) studied 10 banks in Botswana during the post-reform era from 2001 to 2006,. The empirical results of the study indicate a loss or little productivity gain attributed to technological regress due to the failure of the banks in Botswana to adopt new technology such as telephone and internet banking. Furthermore, the sector was not employing cost effective technologies due to the lack of competition. Similarly, Kamau (2011) studied the intermediation productivity and efficiency of the banking industry of Kenya during the post-liberation era. The study employed the DEA and MPI to study the performance of 40 banks

from 1997 to 2009 and found that banks were not fully efficient as a result of lack of technological improvement and lack of economies of scale. Also, Maredza and Ikhide (2013) examined the total factor productivity of the biggest four banks in South Africa from 2000 to 2010 by using the Hicks–Moorsteen index, and concluded that the global financial crisis impacted productivity of banks, apart from the effects of size, non-interest income activities, non-performing loans, and operational efficiency that significantly impacted productivity of South Africa's banking industry.

In Ghana, Ohene-Asare and Asmild (2011) assessed technical efficiency of banks in Ghana from 2006 to 2008 whilst examining the effects of Corporate Social Responsibility (CSR) on bank efficiency using both first-stage DEA and second-stage OLS regression. This study, and any other Ghanaian study, failed to empirically test the returns to scale (RTS) technology of Ghana's banking industry. Also, the authors assumed variable returns to scale (VRS) based on the deviation in the values of asset base of the largest and smallest banks, and applied the Friedman test to determine whether there were significant differences between efficiency scores. However, the Friedman test like most other nonparametric statistical tests only test for differences of means or medians of scores of efficiency, and not the differences of the entire distribution of efficiency scores, which is more suitable (Epure, Kerstens, & Prior, 2011).

Also, Isshaq and Bokpin (2012) assessed the effects of expansion profit and banks' cost efficiency in Ghana by use of SFA. Results showed that profit efficiency is unrelated to distance, size, or cost and profitability ratios. Also, albeit cost efficiency was positively associated with distance, it was not influenced by size or cost and profit ratios. Although different authors arrived at different conclusion as to the consistency between efficiency scores estimated using SFA and DEA, (Ferrier & Lovell, 1990; Resti, 1997; Weill, 2004), the SFA

requires the specification of particular restrictive functional form of the production, cost, revenue or profit frontier (Bogetoft & Otto, 2011). SFA also requires a single input-multiple output or a single output-multiple inputs. However, this is unrealistic as banks employ multiple inputs to produce multiple outputs (Odeck, 2007). Equally, Bokpin (2013) assessed the profit and cost efficiencies of Ghana's banking industry by use of SFA, whilst determining the impact of corporate governance and ownership structure on these measures of efficiency. His study indicate that though foreign-owned banks in Ghana had higher score of cost efficiency than their local-owned counterparts, they did not essentially perform better in terms of profit efficiency.

Alhassan (2015) recently conducted a premiere bank productivity study in Ghana by employing the Malmquist Productivity Index (MPI) with its three-factor decomposition into scale efficiency change, technological change and pure efficiency change. It was concluded that market concentration led to productivity decline, income diversification led to productivity progress and a significant relationship existed between risk and leverage and productivity differences among banks in Ghana. But Alhassan (2015) failed to consider profit or cost productivity by ignoring the cost of inputs and prices of output, and thus considers only technical aspects of productivity. The study also failed to test for scale elasticity, and assumptions on CCR and BCC models would overestimate the efficiency scores resulting in misleading conclusions (Chen, 2003). This study addresses all these problems.

2.3.2 Profit-oriented productivity assessment of banks

Most productivity studies focused on technical, cost or revenue productivity changes at the expense of profit-oriented productivity change. There seems available only two studies that address profit-oriented productivity of banks (Juo, Fu, et al., 2015; Juo et al., 2016). For

example, the study of Juo, Fu, et al. (2015) which focused on 31 banks in Taiwan, indicate that profit-oriented productivity growth was enhanced by a 29.08 percent change in profit technology, whereas same was hampered by a 27.91 percent decline in profit efficiency. The decline in profit efficiency change principally results from allocative inefficiencies of the banks. The results indicate that with respect to ownership, public banks improved their profit productivity more than private banks, and as a probable effect of the global financial crisis, profit productivity fell significantly during the 2008-2009 period. Juo et al. (2016) used similar methodology to access profit productivity on same banks but adopted a slack-based measure (SBM) approach. Despite the consideration of prices and quantities of both outputs and inputs in these studies, they failed to determine the exogenous factors that drive the profit-oriented productivity growth of banks.

2.3.3 Sources of productivity in banking

Few studies empirically examined the source or driver of bank productivity. Grifell-Tatjé and Lovell (1997) studied the productivity of Spain's banking industry from 1986 to 1992 by applying the MPI. The study indicated that technological change drives the most changes productivity. Also, Casu, Girardone, and Molyneux (2004) studied productivity of the banking industry of five European economies from 1994 to 2000 using both parametric and nonparametric estimation methods, and found technological progress as the main driver of productivity progress for both methods of estimation used. Similarly, Chang et al. (2012) found that the productivity growth of Chinese banks from 2002 to 2009 was riven by technological change. More so, Krishnasamy, Ridzwa, and Perumal (2004) attributed productivity growth of Malaysian banks to the benefit of technological change as a result of their strategic alliances of most of the banks from other countries. Further empirical analysis by Moffat et al. (2009) in Botswana during the post-reform era from 2001 to 2006 indicate productivity loss was

attributed to technological regress due to the failure of the banks in Botswana to adopt new technology such as telephone and internet banking. Kamau (2011) confirms that productivity regress of banks in Kenya was as a result of lack of technological improvement. On the contrary, Wheelock and Wilson (1999) found that the productivity change of banks in US from 1984 to 1993 was attributed to efficiency change. The finding of Wheelock and Wilson (1999) was confirmed by Alhassan (2015) using data from the banking industry of Ghana. Alhassan (2015) found that the productivity of banks in Ghana was driven by efficiency change, where banks were catching up with those on the efficient frontier. Despite the evidence provided by these studies, their measure of productivity did not consider the cost of inputs and the price outputs in estimating productivity. The present study adds to literature in that it considers cost of inputs and price outputs to derive the source of productivity of banks in Ghana. Following from the findings of Casu et al. (2004), Chang et al. (2012), Krishnasamy et al. (2004) and Moffat et al. (2009), this study posit that:

H_1: Profit oriented productivity of banks in Ghana is driven by technological change

2.3.4 Productivity difference of local and foreign banks

Arguments on difference of performance of foreign and domestic banks have been grounded in banking literature (Berger et al., 2000; Berger, Klapper, Peria, & Zaidi, 2008; Bonin et al., 2005). Though it had been demonstrated by previous studies that the type of bank ownership is significant in explaining performance of banks, the studies of Molyneux and Forbes (1995) and Elyasiani and Mehdian (1992) indicate that the type of ownership of banks is unimportant in examining performance difference of banks. According to Berger, Hasan, and Zhou (2009), most foreign-owned banks prove greater but less volatile loan quality and growth, possibly mirroring a more broadened fund base. Bokpin (2013) indicates that the operational and organizational diversity amongst foreign-owned and local-owned banks suggests that

dissimilarities exists in structures of cost and scale, and degree economies for foreign and domestic banks. Berger et al. (2000) posit that foreign banks operate under different technologies from local banks; where in many cases, foreign-owned banks are just as efficient as local banks regarding their group-specific production frontier. As indicated by Sufian (2011a), foreign owned banks in developing nations have a tendency to perform superior to their local counterparts. This has been the assertion of the type of ownership of banks and how efficiency varies across groups, with the perspective generally held in Ghana that foreign banks are more efficient than the local banks (Bokpin, 2013; Saka et al., 2012).

According to Berger et al. (2000), despite the fact that the structure of cost of the groups of banks are distinctive, the economy of scale and scope measures for the foreign and local banks, in respect to their group cost frontier, are not critical. Jiang, Yao, and Feng (2013) and Weill (2003) are of the view that foreign-owned banks are more efficient and less volatile than domestic-owned banks because of their enhanced mechanisms of corporate governance, structures of operational, and most likely because they are more diversified. Also, foreign banks have moderately lower non-performing loan, with their profitability enhanced when contrasted with local banks (Tecles & Tabak, 2010). Also, Fujii, Managi, and Matousek (2014) indicate that foreign-owned banks had greater input efficiency levels than local banks, primarily because of their predominant scale efficiency, despite the fact that it did not lead to better profitability. Similarly, Bokpin (2013) indicate higher cost efficiency for foreign-owned banks than local-owned banks, but found that foreign banks are not necessarily more profit efficient than local banks. On the contrary, Berger et al. (2000) indicate that local banks are more cost and profit efficient than banks which are foreign-owned. On the other hand, Havrylchyk (2006) and Lozano-Vivas, Pastor, and Pastor (2002) found that foreign banks have just about the same average efficiency as local banks. The argument is still inconclusive

because empirical findings tend to contradict the propositions of the eclectic and portfolio diversification theories in some cases. Following the propositions of the eclectic and portfolio diversification theories, and the global advantage hypothesis, this study postulates that:

H_2: Foreign banks have significantly higher profit oriented productivity indicator than local banks in Ghana

2.3.5 Board size and profit productivity

The BOD of any organization serves as the highest decision making and governance body and it exercises utmost duty necessary for efficient performance of the company (Black & Kim, 2012; De Andres & Vallelado, 2008). With the responsibilities placed on the BOD, its composition plays an important role in the governance structure of any organization. Board size is indicated to have a significant effect on the corporate governance quality, and represents an important determinant of corporate performance. Therefore, studies have made attempts to define an appropriate size of the board of directors required for effective functioning of an organization. For example, Chrisostomos (2008) suggest that boards whose membership is greater than seven may be ineffective. These researchers suggest that large board sizes result in ineffective communication, inadequate coordination, poor decision making, and are subject manipulation by CEOs. This outcome of large board sizes is therefore, numerous conflicts and interactions between/among board members (Yoshikawa & Phan, 2003).

A number empirical studies on the size of the board reveal relationship to firm performance. Some of these results are inconclusive with mixed results, with some not able to establish any nexus between board size and performance. With respect to efficiency as a specific performance measure, some researchers have indicated that size of board impacts the

efficiencies of banks positively (Bokpin, 2013; Hsu & Petchsakulwong, 2010; Olson, 2000). Whereas Tian and Twite (2011) indicate a positive significant impact of size of board on total factor productivity of non-financial firms, Chiang and Lin (2007) revealed an inverse impact in the manufacturing sector. Despite the usefulness of these findings, none have considered the effect of board size on profit-oriented productivity change. Consequent to the propositions of the resource dependence theory and the findings of most studies, it is expected that:

H_3: Board size has a significant positive impact on profit oriented productivity of banks in Ghana.

2.3.7 Board diversity and profit productivity

Most prior literature concentrate on the gender perspective of diversity, which has resulted in highlighting the importance of having more women on the board (Nguyen, Locke, & Reddy, 2015). For example, Carter, D'Souza, Simkins, and Simpson (2010, p. 402) argue that "the gender composition of the board can affect the quality of the monitoring role that is played by the board". They suggest that women possess critical symbolic values, both within and outside the company, which can influence the company's high performance (Adams & Ferreira, 2009; Carter et al., 2010; Gallego-Álvarez, García-Sánchez, & Rodríguez-Dominguez, 2010; Nguyen et al., 2015).

Studies suggest that earnings of companies were significantly higher for firms with senior female executives, and the involvement of women on boards lead to greater profitability and shareholders' value (Kang, Cheng, & Gray, 2007; van der Walt & Ingley, 2003). By resource dependency theory's propositions, greater transparency can be achieved by organizations by having enough female representatives on the board which may subsequently translate into

competitive advantage of the firm (Carter et al., 2010; Nguyen et al., 2015). It is suggested that female directors contribute to the competitive advantage of a firm firstly because they are more independent since they do not partake of the "old boys network", and secondly because they tend to understand consumer needs and behaviour better (Adams & Ferreira, 2009, p. 296). Previous studies justified a more gender diversified board (Adams & Ferreira, 2009; Carter et al., 2010; Erhardt, Werbel, & Shrader, 2003; Kang et al., 2007; Nguyen et al., 2015; Rosa, Carter, & Hamilton, 1996; van der Walt & Ingley, 2003). However, Nguyen et al. (2015) indicate that the relationship between board diversity and corporate performance is quite more complicated than findings of previous literature. The findings in literature on the impact of board gender diversity are therefore inconclusive, and these studies further explore its link with profit-oriented productivity of banks. Consistent with the resource dependence and agency theories, the study postulates that:

H_4: Board diversity is positively related to profit oriented productivity of banks in Ghana

2.3.7 Equity based compensation and profit productivity

Consistent with the agency theory, Jensen and Meckling (1976) argue that corporate managers are economic agents who are self-interested individuals, and are risk-averse. The implication is that management will desire their compensation to be designed in such a way so as to minimize personal risk. Accordingly, at any level of managerial remuneration, managers would have less preference for equity-based compensation over fixed cash compensation (Hirshleifer & Suh, 1992; Mehran, 1995; Ofek & Yermack, 2000). Since equity-based compensation is tied to a company's returns of shares and it is beyond the control of managers to some degree, it is reinforced since the value of the managerial human capital varies with the value of the firm.

With the aim to minimize their risk of equity compensation, corporate managers are likely to undertake decisions to lessen the risk of the firm, thereby adversely affect shareholders' wealth (Amihud & Lev, 1981; Jensen & Meckling, 1976).

Since shareholders are rather risk-neutral, it is established that they will foresee the attempt of corporate managers to avoid risks which can adversely affect corporate performance. Though there exist numerous means by which conflict over risk can minimized, literature posit that tying managerial compensation to corporate value influences managers to take decisions that maximizes value of the firm (Grossman & Hart, 1983b; Harris & Raviv, 1979; Holmström, 1999). It is also suggested that one specific means of tying executive compensation to corporate value is to make a larger proportion of managerial compensation share-based, by means of share-based payment and executive share options (Jensen & Murphy, 1990). Previous literature have indicated that incentive-compensation plans influence managers to take greater risks (Hirshleifer & Suh, 1992). Because of these factors, holding the level of compensation constant, shareholders would desire a greater form of equity-based compensation as part of compensation packages of managers, despite the fact that it may be sub-optimal to tie all components of the managerial compensation to the price of a corporate shares.

The study of Mehran (1995) found significant positive impacts of executive compensation and share compensation on corporate value, measured by Tobin's Q. this had been confirmed by recent studies that equally found a direct impact of share compensation on performance of firms (Chen & Jermias, 2014; Ntim, Lindop, Osei, & Thomas, 2015). No study has yet explored the effect of executive compensation and share options on productivity of banks. Following the predictions of the agency theory, this study hypothize that:

H_5: Share based payment as a means of equity settled compensation positively affects bank productivity in Ghana.

2.4 Conceptual framework

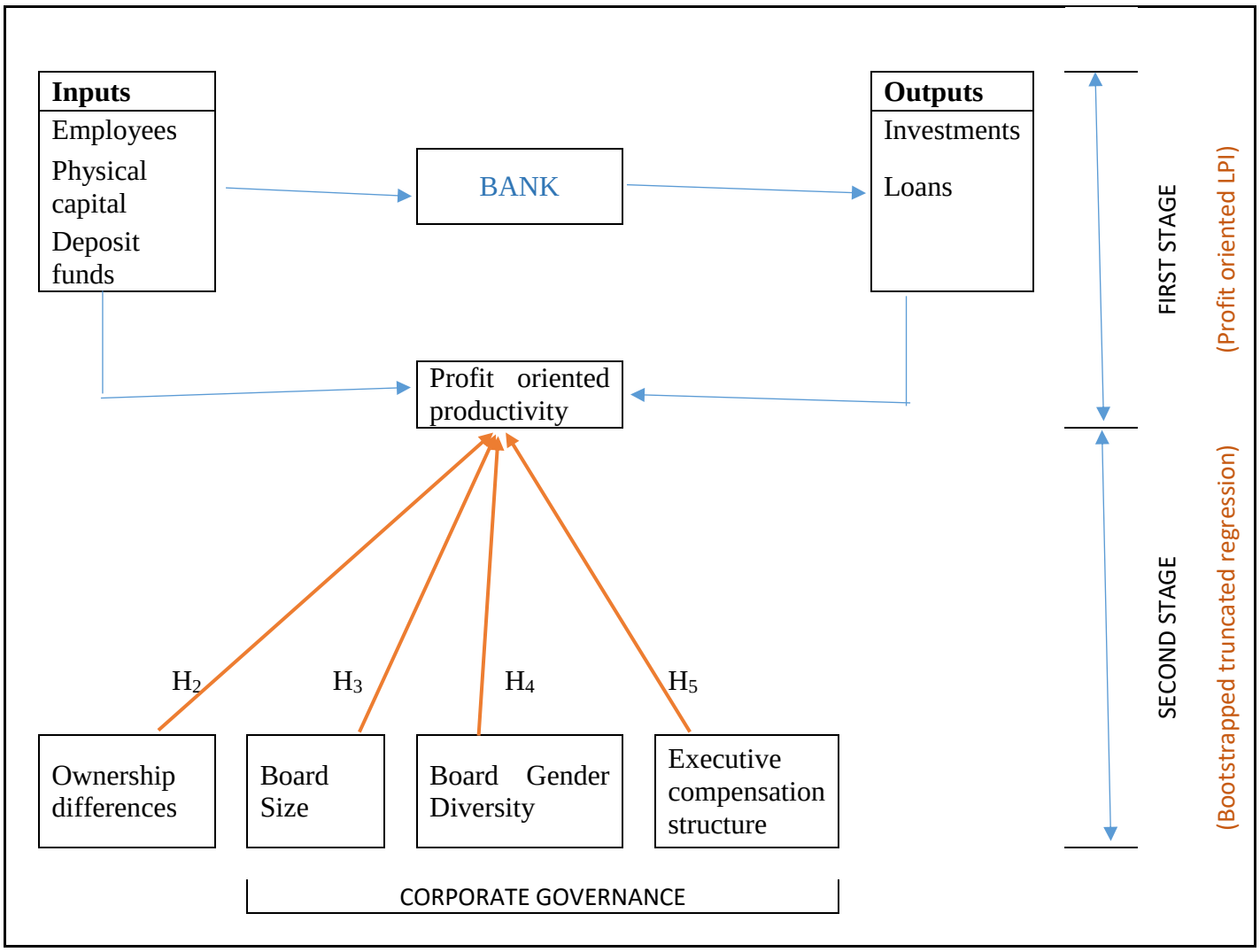

Figure 2. 1 Conceptual framework of the study

(Source: Author's Construct (2019))

The conceptual framework shows that banks use inputs such as physical capital (measured by net book value of property, plants equipment) and labour to intermediate between surplus spending units and deficit spending units. These banks have their different ownership groups for which a given group may be more profit productive. Also, the level of bank profit productivity is indicated to have been impacted by corporate governance constructs of board size, board diversity, and executive compensation structure.

2.5 Corporate governance in Ghana

Unlike jurisdictions of the UK and US, Ghana does not have a single comprehensive CG framework. Unlike with financial reporting rules, there is no single overarching set of principles for corporate governance for companies in Ghana.

For example, the Companies Code contains some corporate governance provision that all companies are required to comply with. These include provisions on the number, appointment, duties, remuneration and removal of directors; shareholder meetings; rights of shareholders; and the appointment, duties, powers, remuneration and removal of auditors. Other corporate governance rules such as the mix between executive and non-executive directors and the existence of board committees are not covered by the Code. Provisions on these other corporate governance best practices can however be found in other laws. For example, the Securities and Stock Exchange Rules in addition to the Companies Code, require listed companies to comply with corporate governance principles set out in the Securities Industry Law (1993), the Securities Industries (Amendment) Act 2000, the SEC Regulations (2003) and the GSE Listing Regulations. A principal element of this provision is the existence and composition of an audit committee for every listed firms. Within this framework, a listed firm is required to have an audit committee whose chairman should be a non-executive director. Equally, financial

expertise critical for members of the audit committee are outlined in the regulation.

Lastly, voluntary corporate governance codes exist in Ghana, which include the Ghana Manual on Corporate Governance issued by the Private Enterprises Foundation (PEF) and the Institute of Directors (IOD); and the SEC Guidelines on Best Corporate Governance Practices. The SEC guidelines are principally based on OECD principles. These voluntary codes however have little recognition in Ghana and are mostly not adhered to. The lack of adherence to these voluntary corporate governance codes is hardly surprising given that even statutory laws in Ghana generally suffer from weaknesses in compliance (World Bank, 2005).

As noted by the World Bank (2005), several key aspects of good corporate governance practices are observable in Ghana – protection of basic shareholder rights, basic AGM rules, equitable treatment of shareholders in the law, and timely disclosures in the annual reports. There is however a lack of a coherent and comprehensive regulatory framework for corporate governance practices. This has resulted in the following significant weaknesses in corporate governance practices in Ghana – no rules on board independence, poor enforcement, lack of certain key disclosures, inconsistencies in the provisions relating to mergers in the Companies Code and the SEC regulations, single tier boards and limited audit committee effectiveness and expertise (World Bank, 2005). Consequently, as with the regulatory framework for financial reporting, there is a need for comprehensive corporate governance rules in Ghana for to address the weak level of corporate governance. The ability of the regulators to enforce compliance must also be enhanced to ensure a more effective adherence to the existing provisions of corporate governance.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The conduct of a research is seen in terms of the research philosophy subscribed to, the research approach adopted to achieving the research objectives, and the strategy to used. This chapter of the study expounds the research design adopted, the source of data and variables used and the research methodology adopted to achieve the objectives of the study.

3.2 Research design

The research design encompasses the set of research philosophy, approach and strategy adopted to execute the research. The research design is decomposed below.

3.2.1 Research philosophy

This involves the belief about the way in which data about a phenomenon is gathered, analyzed and used (Mark, Philip, & Adrian, 2009) . The term epistemology (what is known to be true) comprises the various philosophies of approaches to research (Zikmund, Babin, Carr, & Griffin, 2012). According to Saunders, Saunders, Lewis, and Thornhill (2011), there are two main acceptable research philosophies which describe how knowledge is developed and judged, namely positivism and interpretivism. This study adopts the positivist research paradigm because knowledge of corporate governance and bank productivity is not subjective, but rather requires objectivity from the researcher.

3.2.2 Research approach

The research approach links a given research philosophy to an appropriate research method, which bridges philosophical notions to practical and applicable research strategies (Byrne,

2001). As the inductive approach is regarded an interpretivist one, the deductive is attached to positivist approach. The deductive approach is adopted for this study because it leads to testing of the hypotheses with specific data. In connection with the positivism philosophy, data for the research (normally from secondary sources) remain objective so as to enable comparisons to be made.

3.2.3 Research strategy

The strategy of a research is a general plan of how to go about answering the research question (Saunders, 2009). With regards to the fundamental differences and the discussion in the literature review, it is apparent that this research follows the quantitative strategy. The quantitative strategy obtained an unbalanced panel data on banks in Ghana over a fourteen year period. An unbalanced data is used (rather balanced panel) because of unavailability of some observations of the same unit in every time period (year), though it can lead to noise being introduced by unit heterogeneity (Baltagi & Griffin, 1983).

3.3 Population, sampling and source of data

The population of the study comprises all universal banks operating in Ghana for the period from 2000 to 2014. This period is selected on the basis that most of the data on corporate governance variables to be used in the study are able to be obtained for such period. The population consisted of 29 banks as at 31 December, 2014, of which 13 were locally-owned, and 15 were foreign-owned. All banks that constitute the population were sampled for the study. Universal banks were chosen primarily due to the availability and reliability of data, and also for the fact that universal banks have received a lot of attention in the last few years. Throughout the study period, 31 banks had their profit oriented Luenberger Productivity Indicator estimated but two were not included in the second stage analysis because their annual

reports were not available. The motivation for using all banks is to be able to derive results capable of explaining corporate governance and productivity of the banking industry of Ghana.

The panel data was, however, unbalanced. The basic reason for using the unbalanced panel data is because the entry and exit of some banks created missing data for periods the banks were not in existence. The study used secondary data covering various inputs and outputs, and corporate governance variables of universal banks in Ghana, which was extracted from their respective annual reports and with the financial data cross-validated with similar figures from the Bank of Ghana.

3.4 Frontier productivity analysis

Building on the estimation of relative efficiency of Decision Making Units (DMUs) by Farrell (1957), Data Envelopment Analysis (DEA) was introduced firstly by Charnes et al. (1978), with further extension by Banker et al. (1984). It is a non-parametric optimization-based linear programming method used in estimating the relative efficiency of similar DMUs which employ multiple inputs to produce multiple outputs (Ali & Seiford, 1993; Cook & Seiford, 2009; Cooper, Seiford, & Tone, 2006; Fried et al., 2008; Lewin & Seiford, 1997). The DMUs can be airlines, oil firms, insurance firms, football clubs, universities, hospitals, banks and manufacturing firms. The DEA methodology creates a production, cost, revenue or profit frontier termed as the “best practice frontier” from the observed DMUs. Those DMUs which form the “best practice frontier” are efficient since they are not dominated by any other DMU. From the created “best practice frontier” the inefficiency or efficiency scores of the DMUs enveloped by the “best practice frontier” are computed from the observed point to the border of the “best practice frontier”. Because of its ability toward optimization of resources, DEA

enables firm managers to recognize the best performing DMUs objectively so as to identify the section for improving performance in a firm's multidimensional operating activities. To gain better understanding of the development of frontier efficiency analysis and DEA, the reader is referred to Cooper, Seiford, and Zhu (2011), Daraio and Simar (2007), Coelli et al. (2005), and Førsund and Sarafoglou (2002). Concerning the application of DEA to the banking industry, see Berger (2007), Berger and Humphrey (1997), Tzeremes (2015), Staub, da Silva e Souza, and Tabak (2010), and Fethi and Pasiouras (2010).

Various advantages of DEA makes it the chosen methodology for the present study. Firstly, DEA can be able to incorporate multiple inputs and multiple outputs in analyzing efficiency of organizations (Charnes et al., 1978; Cook, Tone, & Zhu, 2014; Färe, Lovell, & Zieschang, 1983; Sueyoshi & Sekitani, 2009). For instance, banks employ various inputs like labour, purchased funds (deposits), and physical capital (property, plants and equipment) to generate various outputs such as loans and advances, and investments in money market and government securities. Therefore, the use of DEA provides a suitable estimation techniques in the multifaceted operating activities of banks. The DEA estimation methodology is also able to disintegrate efficiency into various sources such as technical, pure technical, cost, revenue, scale, allocative, mix, and profit efficiencies, for which key sources of inefficiencies of firms can be identified for improvement. Furthermore, DEA does not impose any form of restrictive function for the technology underlying production, cost or profit or make assumptions regarding the distribution of the observations, unlike in some parametric approaches such as the SFA (Dong et al., 2014; Lampe & Hilgers, 2015; Oh & Shin, 2015; Van Meensel et al., 2010). In other words, DEA gives room for the "data to speak for themselves" rather than restricting the data to a given structure, thereby avoiding errors related to specification (Cummins, Weiss, Xie, & Zi, 2010). Further, DEA is unit invariant (Lovell & Pastor, 1995)

which means that the various resource inputs and outputs in DEA need not have the same unit of measurement. For instance, although man-hours is the unit for measuring labour, square meters is the measure for space, currency unit measure operating expenses in a production firm, all these inputs can be used for estimating efficiency using DEA. More so, DEA is able to detect peers or reference sets any inefficient DMU which makes it imperative for policy making in strategic management.

All though DEA is useful for performance assessment, the techniques does not provide solution for all challenges that are faced by other tools used in assessing performance. Firstly, DEA estimates the relative efficiency of a unit in comparison with others, and not the absolute efficiency. Hence, the "best practice frontier" that a firm must attain to be judged as efficient is affected by the best-performing firm in the sample. This implies that including and excluding certain firms can have an effect on the estimated efficiency score (Sengupta, 2005; Simar, Vanhems, & Wilson, 2012; Simpson, 2007). Also, the DEA technique is deterministic which makes it prone to identification problems. This emanates from the fact that every form of deviation from the "best practice frontier" is seen as inefficiency though such a deviation may also be as result of statistical noise in the data. These problems have however been addressed through the use of bootstrapping algorithms which solve the challenges of sampling variations in the first stage and serial correlations in the second-stage efficiency analysis (Simar & Wilson, 2011; Simar & Wilson, 1998; Simar & Wilson, 1999, 2000, 2007). Again, DEA is an outlier methodology, making it subtle to stochastic noise resulting from missing explanatory variables or measurement errors thus biasing the estimated efficiency scores (Ohene-Asare & Asmild, 2012; Simar, 2003; Simar & Zelenyuk, 2011). Additionally, certain inputs or outputs, though, heterogeneous in nature are treated as being homogenous, which biases the efficiency estimates (Coelli, 1998; Coelli, Prasada Rao, & Battese, 1998; Coelli et al., 2005; Sickles,

2005). A typical illustration of this problem is where unskilled and skilled labor are not treated as different inputs, but are rather treated generally as labor input in assessing efficiency, though these inputs can generate better measure of efficiency when treated as two different labor inputs.

In order to formulate efficiency using the DEA technique, given there are n observable DMUs assess, with each DMU utilizing various quantities of m inputs to produce various quantities of s outputs, where a particular DMU_j uses x_{ij} quantities of input i to produce y_{rj} quantities of output r. The production possibility (technology) set, *T*, is defined as:

$$T = \{(x,y): \ x \quad can \quad produce \quad y\} \tag{1}$$

3.5 Formalising the Luenberger productivity indicator

The profit oriented Luenberger Productivity Index measures the dynamics in profit efficiency from one period to another. Profit efficiency estimated the closeness of a DMU to the "best-practice profit frontier". To formulate profit efficiency, suppose there are n observed banks $(j = 1,\ldots,n) \in \Re_+^n$ which employ a vector of x_i inputs $(i = 1,\ldots,m) \in \Re_+^m$ to derive y_r outputs $(r = 1,\ldots,s) \in \Re_+^s$ for which w_i cost is incurred $(i = 1,\ldots,m) \in \Re_+^m$ to obtain each input and p_r price $(r = 1,\ldots,s) \in \Re_+^s$ is received from each output, the optimum profit is expressed by a linear optimization model as:

$$\Pi^* = \max\ py - wx = \sum_{r=1}^{s} p_{ro}\, y_{ro} - \sum_{i=1}^{m} w_{io}\, x_{io}$$

s.t.

$$\sum_{j=1}^{n} \lambda_j\, y_{rj} \geq y_{ro}; r = 1,\ldots,s$$

$$\sum_{j=1}^{n} \lambda_j\, x_{ij} \leq x_{io}; i = 1,\ldots,m \qquad (2)$$

$$\sum_{j=1}^{n} \lambda_j = 1\,(vrs)$$

$$\lambda_j \geq 0;\ j = 1,\ldots,n$$

To derive profit efficiency of DMU$_o$ (PE$_o$), a proportion of actual profit, Π^o to the maximum profit, Π^* is found (See appendix A for derivation). The revenue/cost efficiency DMUo is ultimately given as:

$$PE_{RC} = \frac{\sum_{r=1}^{s} p_{ro}\, y_{ro} \Big/ \sum_{i=1}^{m} w_{io}\, x_{io}}{\sum_{r=1}^{s} p_{ro}\, y^*_{ro} \Big/ \sum_{i=1}^{m} w_{io}\, x^*_{io}} \qquad (3)$$

The profit efficiency derived using the revenue/cost ratio bounded between 0 and 1, and cannot be negative even when the maximum profit attains a positive value and the observed profit is negative (Cooper, Pastor, Aparicio, & Borras, 2011; Sahoo, Mehdiloozad, & Tone, 2014). Given input and output prices, the gap between an efficiency score and unity is the potential by which actual profit can be increased to attain the maximum profit attainable by a DMU.

Having formulated the profit efficiency, the profit oriented LPI is also derived (see appendix A). The profit oriented Luenberger Productivity Indicator is given by:

$$\pi L = \frac{1}{2}\left\{\left[\frac{p^t y^t / w^t x^t}{R^t(y^t)/C^t(x^t)} - \frac{p^t y^{t+1} / w^t x^{t+1}}{R^t(y^t)/C^t(x^t)}\right] + \left[\frac{p^{t+1} y^t / w^{t+1} x^t}{R^{t+1}(y^{t+1})/C^{t+1}(x^{t+1})} - \frac{p^{t+1} y^{t+1} / w^{t+1} x^{t+1}}{R^{t+1}(y^{t+1})/C^{t+1}(x^{t+1})}\right]\right\} \quad (4)$$

The above indicator is then decomposed into profit efficiency change and profit technological change as follows:

$$\pi L = \underbrace{\left[\frac{p^t y^t / w^t x^t}{R^t(y^t)/C^t(x^t)} - \frac{p^{t+1} y^{t+1} / w^{t+1} x^{t+1}}{R^{t+1}(y^t)/C^{t+1}(x^{t+1})}\right]}_{\text{Profit efficiency change } (\Delta \pi E)} + \underbrace{\frac{1}{2}\left\{\left[\frac{p^{t+1} y^t / w^{t+1} x^t}{R^{t+1}(y^{t+1})/C^{t+1}(x^{t+1})} - \frac{p^t y^t / w^t x^t}{R^t(y^t)/C^t(x^t)}\right] + \left[\frac{p^{t+1} y^t / w^{t+1} x^t}{R^{t+1}(y^{t+1})/C^{t+1}(x^{t+1})} - \frac{p^t y^{t+1} / w^t x^{t+1}}{R^t(y^t)/C^t(x^t)}\right]\right\}}_{\text{Profit technology change } (\Delta \pi T)} \quad (5)$$

3.6 An illustrative example of the Luenberger productivity indicator

To illustrate the LPI, let us consider a sample of six hypothetical banks that use deposits as an input (x_1) to derive loans and advances as an output (y_1) in time periods 1 and 2, with the cost of the input being w_1, and the price of the output given as p_1.

Table 3. 1 hypothetical Data

Bank	Period	x_1	y_1	w_1	p_1
A	1	4	3	0.06	0.2
B	1	4	4	0.05	0.25
C	1	5	4	0.07	0.22
D	1	2	2	0.06	0.26
E	1	5	3	0.05	0.27
F	1	6	5	0.04	0.23
A	2	2	5	0.07	0.21
B	2	4	5	0.07	0.23
C	2	4	6	0.05	0.22
D	2	3	4	0.06	0.25
E	2	3	5	0.04	0.25
F	2	1	3	0.05	0.24

Source: Author's construct (2019)

The observed input and output is shown in Figure 3.1 in an input-output possibility set space.

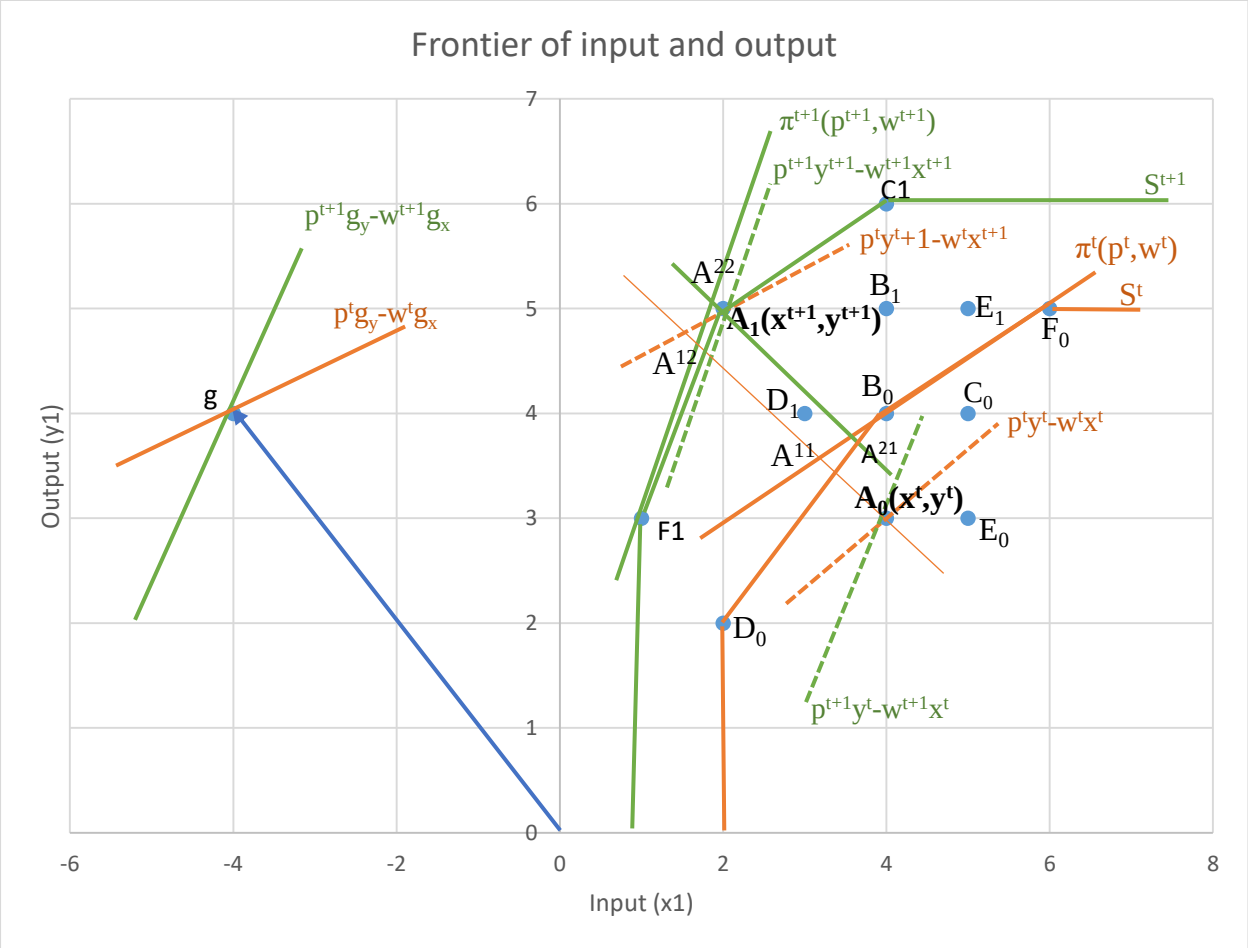

Figure 3. 1 Graphical illustration of the Luenberger productivity indicator

(Source: Author's Construct (2019))

From figure 3.1, A_0 and A_1 represent the observed input-output combinations of bank A in periods t and $t+1$ respectively, with S^t and S^{t+1} being respectively the production frontier in periods t and $t+1$, and π^t and π^{t+1} are respectively the profit frontiers of periods t and $t+1$. The common vector Og represents the direction vector to which A_0 and A_1 must be projected to the profit frontier in both time t with $t+1$ periods. The points A^{11} and A^{12} are respectively the profit efficiency frontiers in periods t with $t+1$ to which A_0 must be projected. Equally, points A^{21} and A^{22} represent the points on the profit frontiers in t with $t+1$ to which A_1 must be projected. By graphical illustration above, profit oriented Luenberger productivity score of bank A can be assessed from model (15) as:

$\pi L = 1/2 \times \left[\left(A_0 A^{11}/Og - A_1 A^{22}/Og\right) + \left(A_0 A^{12}/Og - A_1 A^{21}/Og\right)\right]$. The graphical decomposition into the profit efficiency change is $\Delta\pi E = \left(A_0 A^{11}/Og - A_1 A^{22}/Og\right)$. Also, the profit technological change is:

$$\Delta\pi T = 1/2 \times \left[\left(A_0 A^{11}/Og - A_0 A^{12}/Og\right) + \left(A_1 A^{22}/Og - A_1 A^{21}/Og\right)\right] = 1/2 \times \left(A_0 A^{11}/Og + A_1 A^{22}/Og\right).$$

It must be noted that though bank A is on the production frontier in period $t+1$, it is not on the profit frontier. Therefore, though it is technically efficient, it is not profit efficient. Also, bank A will be super profit efficient (with profit efficiency score higher than 1) relative to the profit frontier t because it lies outside that period's profit frontier.

Given the data in table 1 above, the profit oriented productivity of bank A can be numerically estimated as follows.

i. Compute the observed cost of bank A for each of the two years by multiplying the inputs with their prices, hence $C^1 = 0.06 \times 4 = 0.24$ and $C^2 = 0.07 \times 2 = 0.14$

ii. Calculate the observed revenue of bank A for each year by multiplying outputs with their prices, thus $R^1 = 0.2 \times 3 = 0.6$ and $R^2 = 0.21 \times 5 = 1.05$

iii. By the use of the linear programming models in (13) and (14), the minimum cost and maximum revenue for bank A in the first period are given as 0.205714 and 0.685714, respectively, whereas the second period generate 0.1325 and 1.05 for the minimum cost and the maximum revenue respectively.

iv. Therefore, the own period profit efficiency of bank A for the two periods can be computed using model (10) respectively as:

v. $PE^{11} = \frac{0.6/0.24}{1/0.2} = 0.5$ and $PE^{22} = \frac{1.05/0.14}{1.05/0.1325} = 0.9464$.

vi. By evaluation the cross-period cost and revenue of bank A in the second period, the observed cost and revenue obtained were 0.12 and 1 respectively. Given these, the cross-period efficiency of bank in the second year is found as:

$$PE^{21} = \frac{1/0.12}{1/0.2} = 1.6667 \text{ and } PE^{12} = \frac{1/0.12}{1.05/0.1325} = 0.15625.$$

vii. By applying model (15), the profit oriented Luenberger of bank A is given by:

$$\pi L = \frac{1}{2}\{[1.6667 - 0.5] + [0.9464 - 0.15625]\} = 0.9784.$$

viii. Following model (16), the profit efficiency change and the profit technological change can be computed respectively as $\Delta\pi E = 0.9464 - 0.5 = 0.4464$ and $\Delta\pi T = \frac{1}{2}\{[0.5 - 0.15625] + [1.6667 - 0.9464]\} = 0.5320$. It should be noted that the profit efficiency and profit technological changes sum up to the profit oriented Luenberger Productivity Indicator. And since the value of the profit oriented Luenberger productivity indicator and its two-component decomposition of bank A exceed 0, bank A is seen to progress on its profit productivity

Similar procedures are applicable in evaluating the other banks. By applying the linear programming models in (13) and (14) above, the observed and optimum costs and revenues of all banks (including bank A, which was evaluated) are shown in table 3.2 below:

Table 3. 2 Computed values of cost and revenue of hypothetical banks

Bank	Period	Observed cost (w_1x_1)	Observed profit (p_1y_1)	Minimum cost	Maximum revenue
A	1	0.24	0.6	0.2	1
B	1	0.2	1	0.2	1
C	1	0.35	0.88	0.2	1
D	1	0.12	0.52	0.12	0.52
E	1	0.25	0.81	0.2	1
F	1	0.24	1.15	0.24	1.15
A	2	0.14	1.05	0.1325	1.05
B	2	0.28	1.15	0.1575	1.15
C	2	0.2	1.32	0.2	1.32
D	2	0.18	1	0.12	1
E	2	0.2	1.25	0.1825	1.25
F	2	0.05	0.72	0.05	0.72

Source: Author's computation (2019)

Applying the revenue/cost ratio as given in model (10) to models (15) and (16) yields the following profit efficiency in the own-period and cross-period, the profit efficiency change, the profit technological change, and the profit oriented Luenberger productivity indicator for each of the hypothetical banks (including bank A) as follows:

Table 3. 3 Computed profit efficiency and productivity scores of hypothtical banks

Bank	PE^{11}	PE^{22}	PE^{21}	PE^{12}	$\Delta\pi E$	$\Delta\pi T$	πL
A	0.5	0.946429	1.666667	0.15625	0.446429	0.531994	0.978423
B	1	0.5625	1.25	0.357143	-0.4375	0.665179	0.227679
C	0.502857	1	1.25497	0.36	0.497143	0.198913	0.696056
D	1	0.666667	1.155556	0.289352	-0.33333	0.599769	0.266435
E	0.648	0.9125	1.199515	0.2875	0.2645	0.323758	0.588258
F	1	1	3.708333	0.566667	0	1.570833	1.570833

Source: Author's Construct (2019)

3.7 Test and choice of returns to scale

In estimating the profit oriented dynamic productivity of banks, there is the need to choose an appropriate return to scale (RTS). Numerous studies chose either the variable returns to scale (VRS) or constant returns to scale (CRS) without empirically testing which one suffices (Battese et al., 2004; Bonin et al., 2005; Juo, Lin, et al., 2015; Parteka & Wolszczak-Derlacz, 2013; Scotti & Volta, 2015). Though this test of return of scale had been applied in non-banking industries (de Borger et al., 2008; Gómez-Calvet et al., 2014; Mahlberg & Url, 2010; Moradi-Motlagh & Babacan, 2015; Simar & Wilson, 2015; Sueyoshi & Goto, 2012), this study provide empirical test of returns to scale in Ghana's banking industry.

This study applies the nonparametric test of returns to scale (RTS) of Simar and Wilson (2002) to test the technology under which banks in Ghana operate. The fundamental concept is to test "the null hypothesis that the technology exhibits globally constant returns to scale (CRS) against the alternative hypothesis that the technology exhibits globally variable returns to scale (VRS)" (Simar & Wilson, 2002, p. 119).

The test statistic is computed based on the mean of ratios or ratio of means of efficiency of all firms. The mean of ratios is computed as follows:

$$\widehat{S}_1 = n^{-1}\sum_{i=1}^{n}\left[\frac{D_n^{CRS}(x,y)}{D_n^{VRS}(x,y)}\right] \tag{6}$$

The ratio of means is computed as:

$$\widehat{S}_2 = \frac{\sum_{i=1}^{n} D_n^{CRS}(x,y)}{\sum_{i=1}^{n} D_n^{VRS}(x,y)} \tag{7}$$

The null hypothesis is rejected if $\hat{S}$ is significantly less than unity. The critical and p-values are used to perform a statistical check. Appropriate bootstrapping is applied by Simar and Wilson (2002) suitable critical values.

3.8 Inputs, outputs, input costs and output prices

Basically, two approaches (production approach and intermediary approach) are employed to determine the efficiencies of banks. The production approach considers deposits and loans as outputs using purchased funds with a number of accounts and transactions on them critical to the selection of inputs (Sealey & Lindley, 1977). The major difficulty with this approach is the inability of banks to give adequate information on transactions of the banks which is important in determining some inputs. Furthermore, this approach is limited in application though a number of studies used it estimate static efficiency (Athanassopoulos, 1997; Camanho & Dyson, 1999; Giokas, 2008; Vassiloglou & Giokas, 1990). In contrast, the intermediation approach as the name suggests, considers banks as offering financial intermediation. In mobilizing funds from surplus units and transform them into loans for the deficit units for

investments. This approach measures outputs and inputs in monetary terms to help access the economic viability of banks and it has been used widely by majority of studies on bank efficiency (Das & Ghosh, 2006; Drake, Hall, & Simper, 2009; Holod & Lewis, 2011; Matthews & Zhang, 2010).

This study follows the argument of Berger and Humphrey (1997) who explain that for bank efficiency estimation, the intermediation approach is more suitable compared to the production approach. An intermediate product is produced as an output by the bank or Decision Making Unit (DMU) using different inputs. Furthermore, the intermediation approach recognizes bank, which are deposit-taking institutions, as financial intermediaries between surplus and deficit spending units. Three input costs are used: the costs of labour, deposits (purchased funds), and physical capital (fixed assets). The cost of labour is computed as a ratio of personnel expenses to total assets. Respectively, costs of physical capital and deposits are given by non-labour operating expenses (operating costs net of personnel expenses) divided by fixed assets, and interest expenses divided by total deposits. Also, two output prices are used: the prices of loans and advances, and investments. The prices of loans and investments are respectively the ratios of interest incomes from loans and investment relative to their amounts. Table 3.4 gives detailed description of the inputs and outputs, with their respective costs and prices used in this study.

Table 3. 4 Description of inputs, outputs, input cost, and output prices

Variables	Definition	Description	Empirical Application
Outputs			Rezitis (2006);Tortosa-Ausina (2004); Fu & Heffernam (2007); Tortosa-Ausina et al, (2008); Delis et al. (2009), Ray & Das (2010); Bokpin (2013).
Y_1	Loans	Loans and advances	
Y_2	Investments	Investments in money market and government securities	
Input Levels			Grifell-Tatje & Lovell (1997); Isik and Hassan (2003); Carvallo & Kasmanb (2005); Tortosa-Ausina (2004); Rezitis (2006); Fu & Heffernam (2007); Tortosa-Ausina et al. (2008); Ray & Das (2010); Bokpin (2013).
X_1	Labour	Labour expenses	
X_2	Deposits	Deposits from customers	
X_3	Capital assets	Property, plant and equipment	
Input Costs			
W_1	Cost of Labour	$\frac{Personnel\ \exp enses}{Total\ assets}$	Carvallo & Kasmanb (2005); Tortosa-Ausina (2004); Fu & Heffernam (2007); Ray & Das (2010); Bokpin (2013); Juo et al. (2015, 2016)
W_2	Cost of loanable funds	$\frac{Interest\ \exp enses}{Depositss}$	
W_3	Cost of Physical Capital	$\frac{Non-labour\ \exp enses}{NBV\ of\ PPE}$	
Output Prices			
P1		$\frac{Interest\ income\ from\ loans}{Loans\ and\ advances}$	Juo et al. (2015, 2016); Fu & Heffernam (2007); Ray & Das (2010); Bokpin (2013).
P2		$\frac{Interest\ income\ from\ investments}{Investments}$	

Source: Author's construct

3.9 Second-stage regression analysis

The survey of Simar and Wilson (2007) indicate that they have problems with prior studies that applied Tobit regression models because of the DEA scores are truncated or censored (which are limited 1 as the highest score). Therefore, the studies were opposed as a result of their inability to explain the underlying DEA that allow uncontrollable covariates to influence a firm's efficiencies. Simar and Wilson (2007) contended that the efficiency scores from DEA in the first stage are serially related with (depend on) the inputs and outputs of the stage-one computation in a complex and obscure means. Also, it is further argued that the first-stage serial correlation mean that the random error term in a Tobit regression is equally associated with the second-stage variables, thus rendering Tobit regression estimates biased. Consequently, deductions from the parameters of the regression model becomes unreliable and misleading. Deploying the maximum likelihood in the regression analysis implies asymptotical vanishing of this correlation (resulting in more reliable estimates). That notwithstanding, the rate at which the error term converges is slow and may still yield invalid deductions. Accordingly, Xue and Harker (1999) and Hirschberg and Lloyd (2002) developed a single bootstrap algorithm to deal with serial correlation, with empirical application by Casu and Molyneux (2003). Be that as it may, Simar and Wilson (2007) indicated their bootstrap method as being "naive" bootstrap approach for resampling without considering the unique distribution of the scores estimated through nonparametric DEA methodology. Simar and Wilson (2007) along these lines of argument proposed the use of a bias-corrected efficiency estimate during the stage-two regression so as to augment the robustness of the regression coefficients and enhance the level of their estimated confidence interval. Simar and Wilson (Simar & Wilson, 2011; 2007) proposed an intelligent, well-defined model where truncated regression give consistent estimates instead of OLS or Tobit estimated. Their twofold bootstrap algorithm to deal with left-truncated bias-corrected DEA scores was given to permit valid deductions and

enhance statistical consistency of the regression estimates in the second-stage.

Taking ρ_k to be the true unknown efficiency score of DMU *k* and Z_k to be s (row) vector of observation-specific contextual variables for DMU *k* (which is expected to be related to the DMU's efficiency score), the second-stage truncated regression model is specified as:

$$\rho_k = \alpha + Z_k\delta + \varepsilon_k, \qquad k = 1,...,K \tag{8}$$

where α is the intercept term, δ is the vector of parameters to be estimated, ε_k is the statistical or idiosyncratic noise. Equation (8) can be seen to be the first-order approximation of the unknown true relationship. Following the algorithm of Simar and Wilson (2007) double bootstrap procedure, it is assumed that the distribution of ε_k is restricted by the condition $\varepsilon_k \geq 1-\alpha-Z_k\delta$, given that both sides of model (8) are bounded by one and the distribution of ε_k is taken to be normally truncated with a mean of zero (prior truncation), unknown variance, and (left) truncation point given by the very restriction on ε_k. Besides, the true but unknown efficiency score, ρ_k, in model (8) is replaced by its bootstrapped-based, bias-corrected DEA estimate $\tilde{\rho}_k$ obtained in the first-stage analysis. Due to the argument of Simar and Wilson (2007) against Tobit regression estimation, the study follow their suggestion and used a truncated econometric regression model formally given by:

$$\tilde{\rho}_k \approx \alpha + Z_k\delta + \varepsilon_k, \qquad k = 1,...,K \tag{9}$$

where

$$\varepsilon_k \sim N(0,\sigma_\varepsilon^2), \text{ such that } \varepsilon_k \geq 1-\alpha-Z_k\delta, \quad k = 1,...,K \tag{10}$$

where the estimated regression parameter, $\hat{\delta}$, is derived by maximizing the corresponding likelihood function, relative to $(\delta,\sigma_\varepsilon^2)$. From (10), the algorithm of Simar and Wilson (2007)

on parametric bootstrap which considers data on the parametric structure and axioms on the distribution of the data, is used to derive bootstrapped confidence intervals of the estimates of parameters δ and σ_{ε}^{2}. Simar and Wilson (2007) suggested the use of a Monte Carlo simulation so as to ensures feasibility this procedure, to obtain unbiased and reliable estimates of the parameters of the truncated regression. To obtain a more comprehensive understanding of the bootstrapping algorithm, the reader can refer to Simar and Wilson (Simar & Wilson, 2011; 2007).

Alongside other models like the Random effects and systems GMM, this study used a second-stage bootstrapped truncated regression to solve the problems encounter by using the Tobit and OLS regression as proposed by Simar and Wilson (2007). The bootstrapped truncated regression have been applied by previous studies that investigated the impact of exogenous variables of efficiency (Alhassan & Biekpe, 2015; Chortareas, Girardone, & Ventouri, 2012; Hsu & Petchsakulwong, 2010). In this study, corporate governance variable are considered to be exogenous variables which have effects on Luenberger productivity indicator (LPI). The empirical model is given by:

$$LPI_j^{t,t+1} = \alpha + \delta_1 BSIZE_{jt} + \delta_2 BDIV_{jt} + \delta_3 EXC_{jt} + \delta_4 SIZE_{jt} + \delta_5 LEV_{jt} + \delta_6 SG_{jt} + \varepsilon_{jt} \quad (11)$$

The second stage variables are described in table 3.5 below:

Table 3. 5 Second-stage variables Description

Variables	Description	Measurement	Application (Empirical)
CG variables			
BSIZE	Board size	Number of board of directors	Bokpin (2013); Isik and Hassan (2003a); Zelenyuk and Zheka (2006); Yeh, Wang, and Chai (2010)
BDIV	Board gender diversity	Proportion of female directors on the Board	Gallego-Álvarez et al. (2010); Adams and Ferreira (2009);
EXC	Executive share compensation	Proportion of share payments relative to the total emolument of directors	Core, Holthausen, and Larcker (1999); Mehran (1995); Murphy (1985); Tosi and Gomez-Mejia (1989)
Control variables			
LEV	Leverage	Proportion of total liabilities to total assets	Margaritis and Psillaki (2010); Berger and Bonaccorsi di Patti (2006);
SIZE	Bank size	Natural log of total assets	Gallego-Álvarez et al. (2010); Adams and Ferreira (2009)
SG	Sales growth	Percentage change in net interest income	Albertazzi and Gambacorta (2009); Berger et al. (2000); Hughes, Lang, Mester, Moon, and Pagano (2003)

Source: Author's construct (2019)

3.10 Data analysis instruments

The analysis was performed using the non-parametric linear programming software MaxDEA Pro version 6.5 (Cheng & Qian, 2014), and FEAR (Wilson, 2008), Benchmarking (Bogetoft & Otto, 2011), truncReg (Croissant, Zeileis, & Croissant, 2009), in R and Stata 14. The MaxDEA software is preferred to the others because it is easier to enter data and run commands for the computation of the efficiency scores. It is can also contain unlimited number of DMUs coupled with its capacity to handle both radial and non-radial (SBM) productivity scores, all the returns

to scale and all the orientations (Cheng & Qian, 2014). The Frontier Efficiency Analysis in R (FEAR) is a library package in the R software which, according to Wilson (2008), can be used in making statistical inference and hypothesis testing with DEA and other nonparametric efficiency estimators.

CHAPTER FOUR

PRESENTATION OF DATA AND DISCUSSION OF RESULTS

4.1 Introduction

The chapter begins with the descriptive statistics of the Ghanaian banking industry's input and output variables as well as the explanatory variables employed in the second-stage analysis. Also, correlation analyses were undertaken for both first stage and second stage variables. Furthermore the results of the data analysis are presented in manner consistent with the objectives of the study. Also the results are discussed to provide support for both empirical and theoretical arguments in literature.

4.2 Descriptive analysis

The primary reason for this study is to investigate the effect of corporate governance on the profit productivity change of banks in Ghana. To achieve this purpose, data for this study was sourced from successive annual reports of 29 banks that have been compiled for the years 2000 to 2014. For the purpose of this study, inputs and outputs were selected in accordance with literature. Since the specification of inputs and outputs for productivity analysis in banking literature had received considerable controversies, it is necessary for the variables used for the productivity analysis to be described. The study used three inputs with their costs and two outputs with their prices. The input variables consist of total deposits ($X1$) as a proxy for loanable funds, personnel expenses ($X2$) as a proxy for labour input and net book value fixed assets (property, plant and equipment) ($X3$) as a proxy for physical capital input. The output variables are represented by total loans and advances ($Y1$) and investments ($Y2$). The respective costs of the three inputs are: cost of deposit (W1), the ratio of interest expense to deposit; cost of labour (W2), the ratio of staff cost to total assets; and the cost of physical capital (W3), the ratio of non-labour operating cost to fixed assets. The respective prices of the two outputs, P1 and P2 are the ratios

of interest income derived on each output to the output. Table 4.1 gives the pooled summary statistics of the variables used at both first and second stages of the analysis.

Table 4. 1 Descriptive statistics of data

	Variable	Mean	Std. Dev.	Min	Max
Inputs	Labour (x1)	516,425,507.83	32071376.3	532,192.10	22,033,073,000.00
	Deposits (x2)	20,687,182.62	1492812968	49,094.00	259,868,000.00
	Capital Assets (x3)	16,249,010.50	22825326.3	59,111.00	185,976,000.00
Outputs	Loans (y1)	282,635,171.56	444202609	154,708.00	4,751,640,055.00
	Investments (y2)	153,500,077.85	260417697	61,000.00	1,864,261,000.00
Input Costs	Labour cost (w1)	0.0825	0.0100	0.0008	0.4022
	Cost of loanable funds (w2)	0.0327	0.0500	0.0007	0.0968
	Phys. capital cost (w3)	1.7371	1.9100	0.1513	21.3191
Output Costs	Price of loan (p1)	0.191	0.0700	0.0164	0.5197
	Investment income (p2)	0.1784	0.0900	0.002	0.6841
Other	*LPI*	0.0137	0.3626	-3.4767	2.9042
	TC	0.0204	0.3693	-2.554	2.6218
	EC	-0.0066	0.2613	-0.9227	0.8063
	BSIZE	9	2	4	15

	BDIV	0.1217	0.102	0	0.4286
Explanatory Variables	*EXC*	0.1012	0.085	0	1
	LEV	0.8478	0.1177	0.0283	0.9969
	SIZE	616,750,798.98	1.4365	884,009.00	5,669,630,000.00
	SG	0.7483	67.109	-0.9916	27.7464

Results from Table 4.1 indicate that the average of GH₵ 1.74 as the cost of physical capital (measured by fixed assets) is the highest cost, making physical capital the most expensive factor of production in Ghana's banking industry. Empirically, previous studies indicate that high cost of capital inputs is typical of developing countries (De Mello Jr, 1997; Hasan & Marton, 2003). The average costs of deposits and labour are relatively low. The results also suggest that the interest spread of banks in Ghana is quite wide. This is illustrated by the difference of price of loan or investments which stood at 19.1 percent and 17.84 percent respectively and cost of deposits of 3.27 percent. The net interest margin show that the price of outputs are at least twice more than the cost of deposits. Also, the average profit oriented LPI over the years is 1.37 percent. This value indicate that on the average, the banks have progressed on their profit maximizing objective over the period. However, this improvement is principally driven by the industry's technological change rather than improvement in managerial inefficiency of banks, since efficiency change on the average recorded declines by 0.66 percent.

Over the period, the mean board size was nine members, ranging between four (4) and fifteen (15). And 12.17 percent of the board, on average, comprises female. There were some boards without a female gender representation, whereas some boards had a maximum of 42.86% of

the board being female. With respect to executive compensation, only 10.12 percent of share option for executives were observed over the period. Leverage of the banks averaged 84.78 over the period, with a minimum of 2.83 percent and a maximum of 99.69 percent. Bank size, measured in terms of total assets averaged GH₵ 616,750,798.98 over the study period, ranging from 884,009 to 5,669,630,000. The wide range of size of banks indicate show that the sampled banks vary in sizes. Therefore, deploying the Variable Returns to Scale (VRS) model suggested by Banker et al. (1984) to estimate the profit oriented Luenberger productivity indicator is justified.

4.3 Isotonicity test

Since the study used a non-parametric analysis, there is the need for the test of isotonicity property. In a nonparametric frontier analysis, the test of correlation between inputs and outputs is required as a precondition for robust analysis. This requires that all inputs show a positive relationship with outputs . Table 4.2 presents a test correlation matrix for all outputs and inputs employed in this study.

Table 4. 2 Correlation among inputs and outputs

	X1	*X2*	*X3*	*Y1*	*Y2*
DEPOSITS (X1)	1				
STAFF COSTS (X2)	0.4633***	1			
FIXED ASSETS (X3)	0.3242***	0.6857***	1		
LOANS AND ADVANCES (Y1)	0.3738***	0.6975***	0.6337***	1	
INVESTMENTS (Y2)	0.4306***	0.8291***	0.5507***	0.5455***	1

*** indicates significant at 1% significant level

All three inputs (labour, deposits and fixed assets) show significantly positive associations with both outputs (loans and investments). This confirms that the isotonicity property of DEA is not

violated. It states that an output should not decrease with an increase in an input (Daouia & Simar, 2005; Dyson et al., 2001; Wanke, Barros, & Faria, 2015) Wanke, Barros, & Faria, 2015). This confirms the selected inputs and outputs are relevant for the study.

4.4 Test of Returns to Scale

In order to achieve the first objective, the Returns to scale (RTS) property of the Ghanaian Banking industry was tested using the nonparametric test of returns to scale (RTS) of Simar and Wilson (2002). For the purpose of this study, the mean of ratios is used, with 2,000 bootstrapped samples, and a 5 percent significance level. The empirical test produced the following result:

Table 4. 3 Results of empirical test of returns to scale of Ghana's banking sector

Year	s-value	s-critical	p-value	Decision on H_0	Returns to scale
2000	0.9195055	0.9202471	0.0495	Reject H_0	VRS
2001	0.9587406	0.939844	0.1805	Do not reject H_0	CRS
2002	0.9512583	0.8980199	0.3865	Do not reject H_0	CRS
2003	0.9183516	0.8949388	0.112	Do not reject H_0	CRS
2004	0.9524086	0.9098646	0.2545	Do not reject H_0	CRS
2005	0.9018712	0.9051876	0.0425	Reject H_0	VRS
2006	0.8078192	0.8079616	0.05	Reject H_0	VRS
2007	0.9329024	0.8776891	0.3095	Do not reject H_0	CRS
2008	0.908305	0.919608	0.019	Reject H_0	VRS
2009	0.8180007	0.55643	0.6165	Do not reject H_0	CRS
2010	0.9274806	0.9318485	0.04	Reject H_0	VRS

2011	0.8330232	0.8594129	0.0145	Reject H0	VRS
2012	0.8370571	0.8411381	0.0415	Reject H_0	VRS
2013	0.8901313	0.889433	0.0535	Do not reject H_0	CRS
2014	0.8564609	0.7601789	0.2845	Do not reject H_0	CRS
Pooled	0.8880097	0.9030015	0.0235	Reject H_0	VRS

Source: Author's computation (2019)

The empirical test indicate that apart from the years 2000, 2005, 2006, 2008, 2010, 2011 and 2012, the remaining years indicate a CRS for the banking industry of Ghana. However, the pooled data exhibited a VRS. Therefore, the variable returns to scale is applied in evaluating the profit oriented productivity of banks in Ghana.

4.5 Productivity change of banks in Ghana

First, the profit productivity change and the sources were examined, in fulfillment of the second and third objectives. Starting with the dynamic profit productivity, results of the profit Luenberger Indices are presented in tables 4.4 and 4.5. Profit productivity levels of each individual bank as well as the industry provide very vital information about the nature of profit performance of banks in Ghana over time.

Table 4. 4 Productivity change of banks (2000 to 2007)

BANK	00/01	01/02	02/03	03/04	04/05	05/06	06/07

1	ACCESS							
2	ADB	-0.2842	-0.3145	0.3796	-0.1835	0.1524	-0.0481	-0.2906
3	AMAL	0.0000	0.0087	0.0048	0.0000	-0.0988	-0.3426	0.1040
4	BARODA							
5	BBG	-1.7325	1.1214	0.0838	-0.1184	0.2610	-0.0178	-0.1131
6	BSIC							
7	CAL	0.2505	0.0901	0.2690	-0.0571	-0.5369	0.2198	-0.2206
8	ECOBANK	0.0257	0.0651	0.2004	-0.2347	0.3971	0.1718	0.0438
9	ENERGY							
10	FAMB	0.0000	0.1110	0.3914	0.0755	0.0000	-0.0009	-0.0023
11	FBL							0.0000
12	FCPB							
13	GCB	0.1438	0.0000	0.0000	0.0000	-0.1502	0.0000	0.0000
14	GTB							-0.3518
15	HFC				-0.2882	-0.1233	0.1223	-0.0171
16	IBG							-0.1318
17	ICB	0.0255	0.0000	-0.1910	0.0794	0.0712	-0.1163	0.0341
18	MBG	0.0385	-0.0691	0.3776	-0.0587	0.1605	0.2255	-0.0240
19	NIB	0.0016	-0.0840	0.3916	-0.0569	-0.4916	-0.4244	0.1328
20	PBL	0.0822	0.2262	0.0005	0.0806	0.1680	-0.0018	-0.0011
21	ROYAL							
22	SCB	0.0000	-0.1996	0.1903	0.1524	0.1547	0.0000	0.0000
23	SG-SSB	-0.4252	0.1889	0.1326	0.1204	0.0572	-0.3594	-0.0291
24	STANBIC	0.0112	-0.3089	0.2645	-0.4629	0.4050	-0.4714	0.0396
25	TTB	-0.6535	0.0208	0.3261	0.0656	0.0983	0.1972	0.0000
26	UBA						-0.4396	0.0980
27	UNIBANK		-0.1026	0.0905	0.0000	-1.9475	-0.1431	-0.1349
28	UT BANK							
29	ZENITH							-0.0769

Table 4. 5 Productivity change of banks (2008 to 2014)

	BANK	07/08	08/09	09/10	10/11	11/12	12/13	13/14

1	ACCESS			-0.3083	0.0018	-0.2690	0.1715	0.2711
2	ADB	0.1488	-0.0319	0.5206	-0.3484	0.3254	-0.1827	0.0539
3	AMAL	-0.0682	0.4822	-0.0235	0.2744	0.2143	-0.0695	-0.0471
4	BARODA			1.7227	0.1834	0.0204	0.3294	-1.2248
5	BBG	-0.1019	0.0985	0.0000	-0.1627	0.1893	0.0118	-0.6500
6	BSIC		-3.4767	0.5760	0.0932	0.0520	0.6692	-0.0775
7	CAL	0.0973	0.1339	0.0724	-0.0031	0.3473	0.0571	-0.0822
8	ECOBANK	-0.1856	0.4032	0.0000	0.0521	0.3301	0.2089	-0.0883
9	ENERGY					-0.1683	0.1834	-1.3724
10	FAMB	0.0774	-0.3391	-0.0937	-0.8357	0.0808	0.0686	0.0210
11	FBL	-0.1386	0.0936	0.2983	0.0901	0.0613	0.1645	0.3540
12	FCPB							0.1206
13	GCB	-0.0471	-0.0182	0.0000	-0.0133	0.2470	-0.0079	-0.1029
14	GTB	0.0848	-0.7877	0.5955	-0.0577	0.4521	0.0523	2.9042
15	HFC	0.0018	-0.1177	0.2560	-0.2008	0.3287	0.1741	0.0765
16	IBG	0.2235	-0.0028	0.0675				
17	ICB	-0.4485	1.1006	-0.2920	-0.5600	-0.0817	0.0374	-0.1318
18	MBG	0.0506	-1.1263	-0.2735	-0.1245	0.0420	0.0816	
19	NIB	0.1366	0.0178	0.0946	0.2701	-0.1258	0.2917	-0.3713
20	PBL	-0.0509	0.1146	-0.1081	-0.1621	0.2408	0.0057	0.1075
21	ROYAL							0.0335
22	SCB	-0.0832	-0.1549	-0.0057	-0.0890	-0.3436	0.4192	-0.2781
23	SG-SSB	0.0000	-0.2300	0.3249	-0.5859	0.2031	0.3983	0.7463
24	STANBIC	-0.0392	0.1191	0.1070	-0.2808	-0.0487	0.0630	-0.4680
25	TTB	0.1717	-0.0586	0.5221				
26	UBA	-0.1628	0.1596	0.3567	0.1667	0.4242	-0.0060	0.0439
27	UNIBANK	-0.3371	0.0175	0.1541	0.1287	0.4378	0.1231	0.0000
28	UT BANK			0.4839	0.0000	0.2107	0.0494	0.1135
29	ZENITH	-0.1382	0.0703	0.4926	-0.1282	0.1655	0.6802	0.2321

To understand the sources of profit productivity in the industry, the profit Luenberger indices of the various banks are decomposed and the results are presented in table 4.6.

Table 4. 6 Drivers of profit productivity

Year	**LPI**	**TC**	**EC**

00/01	-0.14709	-0.11891	-0.02817
01/02	0.01011	-0.0019	0.012007
02/03	0.171603	0.059025	0.112578
03/04	-0.04366	-0.00981	-0.03385
04/05	-0.10516	-0.16953	0.06437
05/06	-0.07939	-0.02293	-0.05645
06/07	-0.03758	-0.04169	0.004107
07/08	-0.03417	-0.02984	-0.00433
08/09	-0.0665	0.275863	-0.34236
09/10	0.213086	-0.0779	0.290983
10/11	-0.09548	0.016	-0.11148
11/12	0.133435	0.145923	-0.01249
12/13	0.158969	0.196055	-0.03709
13/14	0.007064	-0.04593	0.052998
Average	0.006089	0.012459	-0.00637

From table 4.6, we realize that the profit-oriented productivity change show a progress of 0.61 percent on average over the period with technological change also improving by an average of 1.25 percent over the same period whereas efficiency change decline by 0.64 percent average over the period. However, the trend had not been smooth over the study period. There were fluctuations in the level of the productivity scores over the years. The trend is illustrated in Figure 4.1 below.

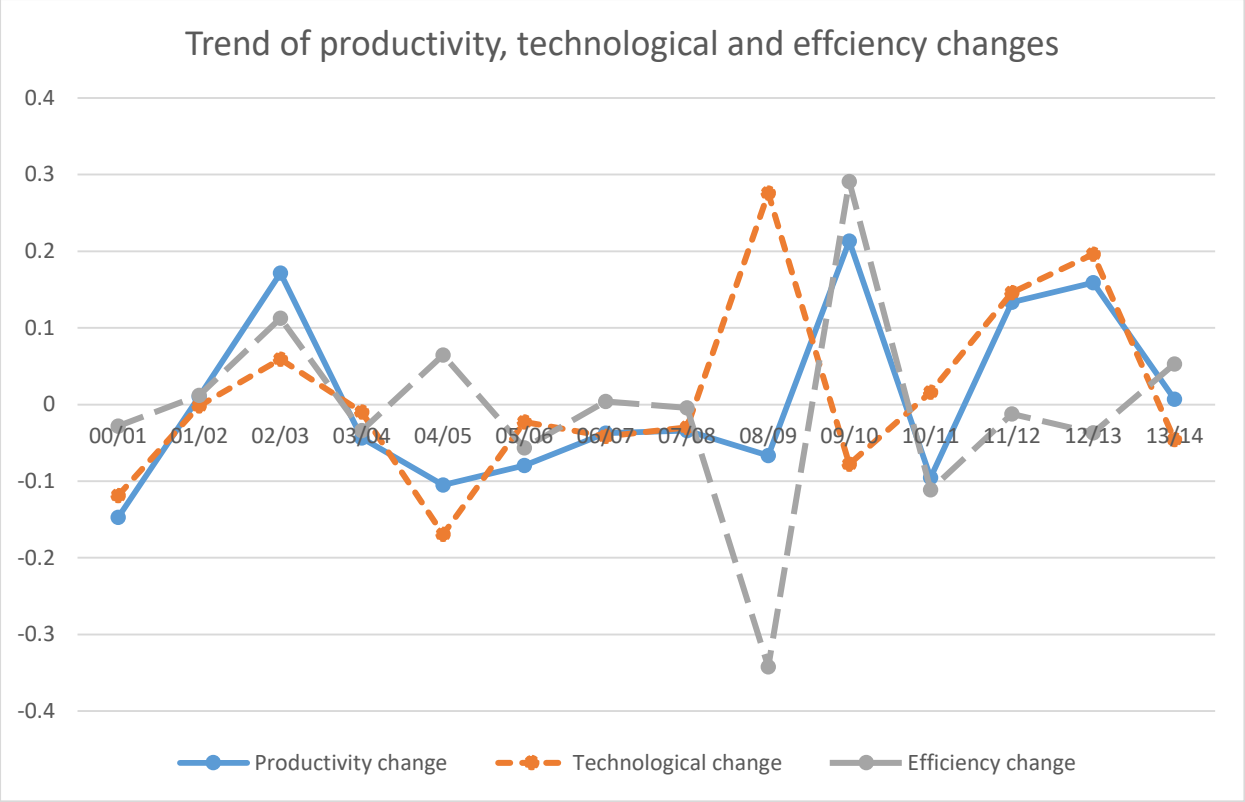

Figure 4. 1 Trend of profit productivity change of Ghana's banking industry

Source: Author's construct (2019)

From figure 4.1, we could tell that there were initial improvements over the productivity index by 2003, with improvements in both technological and efficiency changes over the same period, after which it retrogressed up to 2009. During these periods when there were regress of productivity, technological regressed was witnessed, with fluctuations in efficiency change. The regress on profit-oriented productivity change over these year intervals may be an indication of unfavorable exogenous factors driving the banking industry. In 2008, efficiency change fell to its lowest whereas technological change reached its highest. These suggest the adverse effect of the 2008 global financial crisis on the profit oriented productivity of Ghana's banking sector (Gulati & Kumar, 2016; Halkos & Tzeremes, 2013; Juo, Fu, et al., 2015; Maredza & Ikhide, 2013; Moradi-Motlagh & Babacan, 2015), which quickly saw technologically innovated banking products at its peak. However, the industry recovered in

2009, by recording progress on efficiency and productivity, but with regress on technology. By 2010, the productivity indicator and efficiency change fell again whiles technological change saw progress. The efficiency change then rose persistently from 2012 to 2014, recovered from its regress, and showed progress by 2014. However, technological change increased to a point 2013 and had decreased from thence to a regress in 2014. Similarly, productivity increased to a point in 2013, and then stagnated in 2014.The data relating to the entire decomposition profit-oriented productivity change of all banks is shown in the appendix.

4.6 Source of bank productivity change in Ghana

The third objective this study addresses is to identify the sources of the profit-oriented productivity change of banks in Ghana. This can help in identifying factor contribution to progress or regress of the productivity change, so that appropriate measures can be taken to enhance progress or to minimize regress. The results is demonstrated in Table 4.7 below.

Table 4. 7 Spearman's correlation coefficients of LPI decompositions

	LPI	*TC*	*EC*
LPI	1		
TC	0.8314***	1	
EC	0.3390***	0.2408***	1

*** indicates significant at 1% significant level

From Table 4.7, technological change highly correlates with the profit-oriented LPI, and the correlation coefficient is significant at 1 percent significant level. However, efficiency change has a significantly weak correlation with the profit oriented LPI. It can therefore be said that the main driver of profit oriented productivity change of Ghana's banking industry is the technological changes, rather than improvements in managerial efficiency. Therefore,

consistent with the first, hypothesis of the study, bank productivity in Ghana is driven by technological change. This finding is contrary to finding of Alhassan (2015) (who indicate that bank productivity in Ghana is primarily driven by efficiency changes rather than technological change) and Wheelock and Wilson (1999) (who found that productivity of US banks was largely as a result of the "catch-up effect" or efficiency change). The finding of this study, however, agrees with similar results of Casu et al. (2004), Chang et al. (2012), Grifell-Tatjé and Lovell (1997), Krishnasamy et al. (2004) and Moffat et al. (2009) who found technological change as the main driver of productivity change.

4.7 Ownership and Profit Productivity Change

The study's fourth objective is to examine the significant difference of productivity changes among local and foreign banks in Ghana. To achieve this objective, the Simar-Zelenyuk-Adapted-Li test was employed because of the non-normality of DEA estimates. Though the Li test is suitable for comparing the differences, the non-parametric Mann Witney U test and the parametric t-test have been included for robustness checks. The results from these analyses are shown in Table 4.8 below.

Table 4. 8 Test of difference of productivity of local and foreign banks

	LPI		TC		EC	
	Local	*Foreign*	*Local*	*Foreign*	*Local*	*Foreign*
Mean	0.0208	0.0082	0.0262	0.0158	-0.0054	-0.0076
Variance	0.0561	0.3055	0.0837	0.2624	0.0740	0.0559
Observations	133	167	133	167	133	167
Li test	0.0349 (0.4861)		-0.8798(0.8105)		0.0195(0.4922)	
Mann Witney U test	11490 (0.6073)		11334(0.7595)		10959(0.8405)	
T test	0.2655(0.7908)		0.2219(0.824)		0.0734(0.94157)	

p-values are shown in parentheses

The results from Table 4.8 indicate that though the profit oriented productivity of local banks numerically exceed that of foreign banks, the difference is not significant (Li=0.0349, p-value=0.4861). Similarly, the technological change (Li=-0.8798, p-value=0.8105) and efficiency change (Li=0.0195, p-value=0.4922) of local banks are numerically greater than those of the foreign banks, but the differences are not significant. These dynamics can be understood better using the kernel density plots of the distribution of the productivity indicators as presented in Figure 4. By this, the kind of local or foreign banks drive the structure of the distributional productivity scores can be obtained. The nonparametric kernel-based density estimates, which is basically a smoothed histogram of the actual productivity levels, are used because they are also nonparametric just like the productivity scores The Kernel density plot for the profit oriented productivity change (LPI), profit technological change (TC) and profit efficiency change (EC) as shown by Figure 4 indicate that both types of bank ownership gather greater probability mass at the center, suggesting that a greater number of the banks, irrespective of their ownership type were located around the average of the productivity scores.

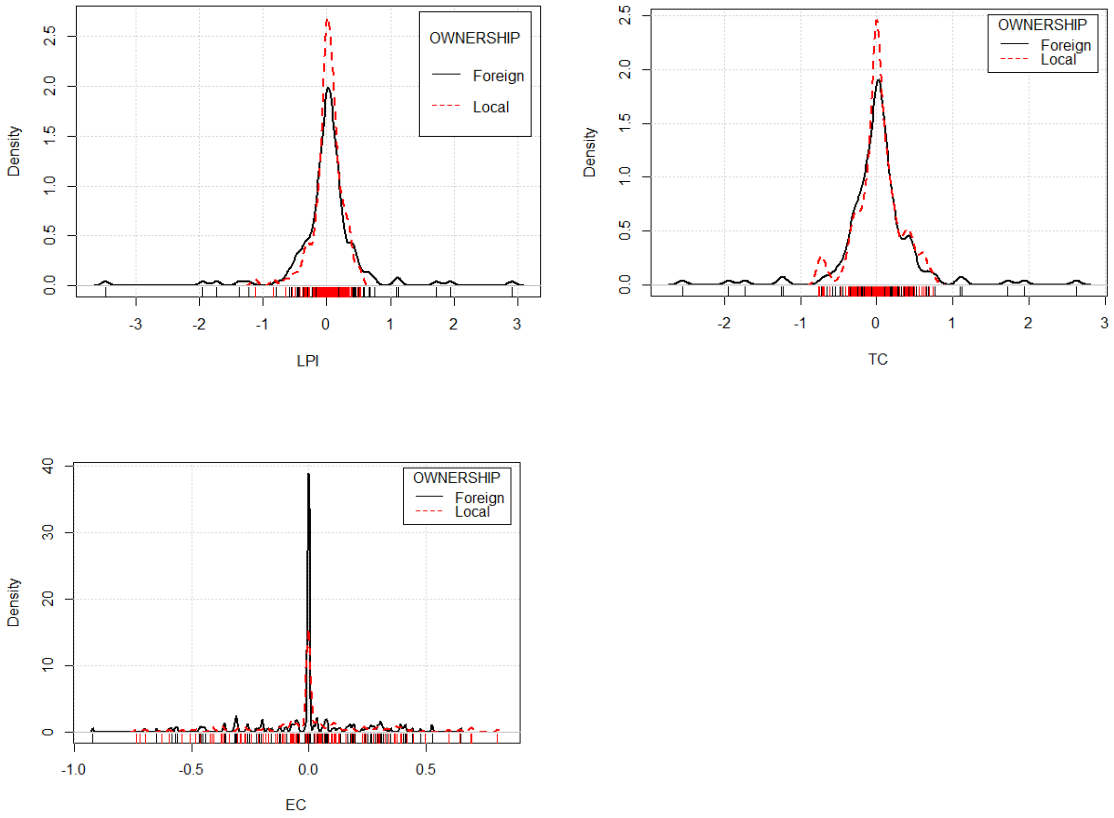

Figure 4.2: Kernel density plot of productivity, technological and efficiency changes

Therefore, no support is found for the second hypothesis of the study, and likewise for the eclectic theory, the portfolio diversification theory, and the global advantage hypothesis concerning the profit productivity of banks in Ghana. Equally, though the local banks on the average have numerically higher profit oriented productivity scores than the foreign banks, the evidential difference is not significant enough to lend support for home field advantage hypothesis. Findings from previous studies of Havrylchyk (2006) and Lozano-Vivas et al. (2002) are confirmed in that they did not find any significant difference of the efficiency score of banks which local-owned and foreign-owned. However, this finding contrasts previous studies of Berger et al. (2000), Bokpin (2013), Jiang et al. (2013), Sturm and Williams (2004)

and Weill (2003) who found foreign-owned banks to have statistically significant greater efficiency scores than local-owned banks.

4.8 Corporate governance on bank productivity

Table 4. 9 Correlation coefficients of variables

	LPI	*BSIZE*	*BDIV*	*EXC*	*Lev*	*SIZE*	*SG*
LPI	1						
BSIZE	-0.0618	1					
BDIV	-0.0222**	0.0695	1				
EXC	0.1416	0.0203	-0.0480	1			
LEV	-0.1084	0.2142***	0.1913***	-0.0205***	1		
SIZE	0.0553***	0.2019	0.3465***	-0.0054	0.0571***	1	
SG	-0.117***	-0.0338***	-0.1539**	0.0150	-0.1312	-0.0536	1

. ***, **, * denotes significance level of 1%, 5% and 10% respectively

The correlation matrix in table 4.9 indicates that board (gender) diversity has significant negative association with LPI. Board size, and leverage also showed negative relationships but the associations are insignificant. Bank size has significant positive association with LPI. The correlations among the independent variables indicate that no pair of variables has a correlation coefficient above 0.5. Thus, multicollinearity is not an issue with respect to the variables used in the study. Checking for multicollinearity is necessary because where high correlation (correlation coefficients of more than 0.50) exists among independent variables, such variables with high correlations do not need to feature in the same model (Banker & Natarajan, 2008). Since multi-correlated independent variables assume similar roles, their inclusion in the same regression model makes the model very sensitive to minor specification changes. Since the multicollinearity problem has not occurred in this study, the need to test for it through the Variance Inflation Factor (VIF) is ignored.

4.8.1 Impact of corporate governance on bank productivity

The fifth and ultimate objective of this study is to determine the nexus between corporate governance and profit oriented productivity of Ghana's banking industry. To achieve this objective, the bootstrapped truncated regression model of Simar and Wilson (2007) was used. Other models including the fixed and random effects models and the systems GMM were also ran for comparison purposes. A Hausman test was carried out to find out which estimation technique (fixed effects or random effects) is best suited for the data. The Prob>chi2 of 0.3173 is greater than 0.05, hence the null hypothesis that random effect is suitable is not rejected, hence the adoption of the random effects model. A Hansen test was also carried out to check the validity of the instruments used in the systems GMM model to check endogeneity. The Wald tests, F-tests, R-squared and the log-likelihood all reveal that the models used are all good fits for the data. Robust standard errors are used for all models for heteroscedastic robustness. The results from this analysis are displayed in table 4.10 below:

Table 4. 10 Regression results for determinants of productivity change

Dependent Variable		LPI	
	RE	**SYS GMM**	**Truncated**
Variable	Coefficient		
C	0.1021	0.1586*	0.1002
	(0.3542)	(0.4685)	(0.1129)
LPI_{t-1}		-0.3569***	
		(0.1281)	
BSIZE	-0.0058	-0.0364	-0.0027*
	(0.0101)	(0.1281)	(0.0016)
BDIV	0.1377*	0.5565	0.0468*
	(0.1958)	(0.6132)	(0.0243)
EXC	16.0444**	53.6098**	0.0690***
	(7.377)	(26.1474)	(0.0231)
SIZE	0.0153	0.0412*	0.0072**
	(0.0160)	(0.0332)	(0.0036)
LEV	-0.3010*	-0.4814	-0.0080***
	(0.2191)	(0.9631)	(0.0021)
SG	-0.0152*	-0.3011	-0.0129**
	(0.0083)	(0.0301)	(0.0058)
Diagnostic Tests			
Wald chi2	12.47**		
R-squared	0.519		
Hausman	0.3173		
F (19, 27)		3.29***	
AR(1) Prob > z		0.018	
AR(2) Prob > z		0.646	
Hansen (prob > chi2)		0.075	
Instruments		23	
σ			0.0140***
			(0.0013)
Log-likelihood			150.97

*Robust standard errors which measure the precision of coefficient estimates are in the parenthesis. Other diagnostics tests included in the table are the Wald tests, F-tests and R-squared which reveal models are a good fit of the data and the Hausman test of which results reveal random effects best fits the data. AR(1) and AR(2) are tests for first and second order serial correlations respectively. The Hansen tests was used to check the validity of the instruments used to check endogeneity.***, **, * denotes significance level of 1%, 5% and 10% respectively.*

4.8.1.1 Board size and profit productivity

Board side showed a significant negative effect on profit oriented dynamic productivity of banks in Ghana in the truncated regression model estimation. This is in direct contrast with the positive impact indicated by the study's third hypothesis. The coefficient of the variable via the bootstrapped truncated regression suggests that an additional board member to the board of directors of banks lead to a 0.27 percent decline in productivity of banks, all things being equal. This finding is in tandem with some literature which found negative relationship between board size and performance. Previous literature suggests that bigger sizes of the board, that is board consisting of more than six directors may be ineffective, resulting from conflicts among directors, dispersed powers in the boardroom, amongst others which may lead to declining performance guest (Black & Kim, 2012; Chrisostomos, 2008; Guest, 2009; Mashayekhi & Bazaz, 2008; Yoshikawa & Phan, 2003). This however, contrasts the propositions of the resource dependency theory (which gives an indication of how a bigger board size enables a firm to obtain the requisite resources for efficient operations) and previous studies such as who found significant impact of board size on technical and cost efficiencies of banks (Bokpin, 2013; Hsu & Petchsakulwong, 2010; Olson, 2000; Tanna, Pasiouras, & Nnadi, 2011).

4.8.1.2 Board diversity and profit productivity

Consistent with the fourth hypothesis of the study, board gender diversity significantly improves the profit oriented productivity of banks in Ghana per the random effect and truncated regression models. This conforms to the predictions of both the agency theory and the resource

dependency theory. Whereas the former stipulates that a more diversified board creates a balance of board membership and guarantees that no single person is able to control the firm decision-making process (Kang et al., 2007), the latter predicts that the presence of diversities of the board is in any organizational interests because more diversified boards link their organizations better to the environment, and generates strategic input for performance enhancement (Carter et al., 2010). The direct impact of board gender diversity on productivity of banks is in agreement with previous literature which indicated that a more gender diversified board enhances financial and market performance (Adams & Ferreira, 2009; Erhardt et al., 2003; Kang et al., 2007; Nguyen et al., 2015; Rosa et al., 1996). The finding however, contrasts with that of Al-Musalli and Ismail (2012) who could not find any significant influence of gender diversity of the board on banks' intellectual capital performance in the Gulf Cooperation Council (GCC) countries.

4.8.1.3 Executive share compensation

The effect of share-based compensation of director generate a significant positive impact on the profit oriented productivity of banks in Ghana in all three models, and this is consistent with the fifth hypothesis of the study. The positive effect of equity settled compensation on bank productivity is in conformity with the propositions of the agency theory. The theory of agency posits that since managers are risk-averse, tying their compensation to firm performance through equity-settled payments provides them with incentives to undertake more value-maximizing corporate decisions (Core et al., 1999; Elston & Goldberg, 2003; Grossman & Hart, 1983a; Harris & Raviv, 1979; Holmström, 1999; Mehran, 1995). This finding also contradict previous studies of Bebchuk (2009) who found significant negative impact of equity compensation on firm value or sales growth.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This last chapter of the study is put into three sections. The first section provides a summary of key findings obtained from the study. This is followed by the second section which gives out the conclusions drawn from the study. The last section brings to bear the practical and policy implications of the study by making useful recommendations for improving the profit oriented productivity of banks in Ghana, and also suggesting guidelines for future research.

5.2 Summary of findings

The study's first is to test the returns to scale property of the Ghanaian banking industry. The second is to estimate the profit Luenberger indicators of banks in Ghana. The third objective is to identify the source of profit oriented productivity change of banks in Ghana. The fourth objective is to examine the difference of productivity change between foreign-owned and locally-owned banks in Ghana. The last and key objective of this study is to determine the impact of corporate governance of banks in Ghana on their profit oriented productivity change. The Returns to scale (RTS) property of the Ghanaian Banking industry was tested using the nonparametric test of returns to scale (RTS) of Simar and Wilson (2002). The study employed the non-parametric DEA-based profit oriented Luenberger productivity indicator and its decomposition, with Spearman's correlation analysis to meet the second and third objectives. The Simar-Zelenyuk-Adapted-Li (SZAL) test to meet the fourth objective of the study. Also, the nonparametric bootstrapped truncated regression model of Simar and Wilson (2007,2011), alongside other comparative models, was used to meet the study's fifth objective. Previous literature that examined the nexus between bank performance and corporate governance relied heavily on accounting and financial ratios. These ratios, however, are not able to incorporate

multiple inputs and multiple outputs in the analysing performance. This study, therefore, is the first to employ the profit oriented productivity in assessing the performance of the banking industry of Ghana, and the first to investigate the nexus between corporate governance and bank productivity.

The study used an unbalance panel 29 banks from 2000 to 2014 to achieve the research objectives. The data was sourced from the annual report of universal banks, with the financial amounts cross-validated from financial statements obtained from the Bank of Ghana. The following findings were made from the study:

a. Banks in Ghana on the average, were 1.37 percent profit productive. This means they have been able to improve on their productivity over the period. This improvement in productivity was as a result of improvement in technological change by 2.04 percent on the average of the banks over the years. Efficiency change had declined on the average by 0.66 percent on the average over the years, hampering productivity change. Therefore, productivity changes in the banking industry of Ghana is driven by technological advancements, rather than managerial efficiency.

b. Though local banks had numerically higher scores of productivity, technological and efficiency changes than foreign banks, the difference of these scores are not significant enough to conclude that local banks are more profit productive than foreign banks. Subsequently, the study found no support for the eclectic and portfolio diversification theories, and the global advantage and home field advantage hypotheses.

c. Corporate governance has significant impact on the profit oriented productivity of banks in Ghana. Though board size is negatively and significantly related to bank productivity, board diversity and executive compensation positively impact profit bank

productivity in Ghana.

d. Of the control variables, bank size, have significant positive effect on the profit oriented productivity of banks in Ghana. Bank leverage and sales growth, on the other hand, negatively and significantly affect profit oriented productivity of banks in Ghana.

5.3 Conclusions

From the findings of the study, the following conclusions can be drawn from the study.

a. Firstly, the Ghanaian banking industry mainly exhibited Variable returns to scale over the 15-year period considered.

b. Second, productivity changes in the banking industry of Ghana is driven by technological advancements, rather than managerial efficiency.

c. With the insignificance in the difference between efficiency scores of both local and foreign banks, the study could not provide support for the eclectic theory of Dunning (1977), the portfolio diversification theory of Markowitz (1952), the global advantage and the home field advantage hypotheses of Berger et al. (2000).

d. Consistent with the postulations of the agency theory but contrary to the resource dependence theory, the study concludes that large board sizes have significant negative impact on bank productivity in Ghana.

e. It is concluded that board gender diversity significantly enhances the profit oriented productivity of banks in Ghana, consistent with the propositions of both the agency theory and the resource dependence theory.

f. Concerning remuneration of the board, the study conclude that share based payment of directors of banks positively influences bank productivity, which is consistent with the agency theory.

5.4 Recommendations

The findings and conclusions drawn from the study have vital implications for policy, practice and further studies. Subject to the study's findings, recommendations are made as follows.

5.4.1 Recommendations for practice

a. Bank managers should consider improving their managerial acumen so that they can maximize the "catch-up" effect to complement of the technological advancements in the banking industry.

b. Banks with very large sizes, especially the government owned banks should consider downsizing membership of their boards, and rather consider diversifying the membership, so as to improve productivity.

c. Other banks in Ghana that do not pay their directors through equity settlements should consider doing so. This is because equity settled payment as part of directors' remuneration limits the conflict of interest, making them act more in the interest of shareholders by taking value-maximizing decisions which lead to improved

productivity.

5.4.2 Recommendations for policy

a. The Bank of Ghana should also come out with a policy toward the gender diversity of boards of banks that will indicate minimum quota of females to include on the board. Such a policy will not only ensure gender equity, but also have the potential to improve the productivity of banks in Ghana.

5.4.3 Recommendations for future research

The current study provide a first-hand discussion on the nexus between corporate governance and profit oriented productivity of banks in Ghana. Future studies should therefore, consider the following recommendations.

a. The present study did not include undesirable output like non-performing loans (NPL) in assessing productivity of banks. Further studies should consider including undesirable output such as non-performing loans (NPL) in productivity assessment.

b. The assessment of productivity of different groups of banks was not undertaken with respect to each group profit frontier. Therefore, further research can be done using the profit metafrontier approach to capture the relative productivity in terms of the different groups. This should be coupled with their decomposition, which would provide useful information for improving further management performance relative to their groups.

c. The present study presented a two-factor decomposition of the profit oriented productivity of banks in Ghana into profit technological change and profit efficiency

change. To provide a better picture of the source of productivity, further studies should consider decomposing profit technological change into technical change and price effect, whiles obtaining technical efficiency change and allocative efficiency change of banks as the decomposed factors of the profit efficiency change.

d. Since profit efficiency change was lowest in 2008, but profit technological change reached its highest in the same period leading low level of bank productivity, further studies can investigate the impact of the 2008 global financial crisis on efficiency and/or productivity of the banking industry of Ghana.

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APPENDICES

Appendix A: Derivation of Models

1. Derivation of Profit Efficiency

To derive profit efficiency of DMU $_o$ (PE $_o$), a proportion of actual profit, Π^o to the maximum profit, Π^* is found. Thus

$$PE_o = \frac{\Pi^o}{\Pi^*} = \frac{\sum_{r=1}^{s} p_{ro} y_{ro} - \sum_{i=1}^{m} w_{io} x_{io}}{\sum_{r=1}^{s} p_{ro} y_{ro}^* - \sum_{i=1}^{m} w_{io} x_{io}^*} \quad (1)$$

Though the model (1) method of computing profit efficiency is well grounded in literature, it has been criticized for some of its axioms which make it impractical in the real market system (Coelli et al., 1998; Coelli et al., 2005). The major assumptions which are criticized include the indications that the costs of inputs and prices of outputs are fixed and are known with certainty, with outputs and inputs being homogenous. However, these unrealistic assumption have been dealt with by Cooper et al. (2006) who used the approach of Tone (2002) to formulate a new profit efficiency as:

$$\bar{\Pi}^* = \max \; p\bar{y} - w\bar{x} = \sum_{r=1}^{s} p_{ro} \bar{y}_{ro} - \sum_{i=1}^{m} w_{io} \bar{x}_{io}$$

s.t.

$$\begin{aligned} &\sum_{j=1}^{n} \lambda_j y_{rj} \geq \bar{y}_{ro}; r = 1, \ldots, s \\ &\sum_{j=1}^{n} \lambda_j x_{ij} \leq \bar{x}_{io}; i = 1, \ldots, m \\ &\sum_{j=1}^{n} \lambda_j = 1 \, (vrs) \\ &\lambda_j \geq 0; \; j = 1, \ldots, n \end{aligned} \quad (2)$$

In this model, $\bar{x}$ and $\bar{y}$ are respectively the cost-weighted inputs and the price-weighted outputs, which explain heterogeneity of inputs and outputs, and their prices. Consequently, the new profit efficiency of DMUo becomes:

$$NPE_o = \frac{\bar{\Pi}^0}{\bar{\Pi}^*} = \frac{\sum_{r=1}^{s} p_{ro} \bar{y}_{ro} - \sum_{i=1}^{m} w_{io} \bar{x}_{io}}{\sum_{r=1}^{s} p_{ro} \bar{y}_{ro}^* - \sum_{i=1}^{m} w_{io} \bar{x}_{io}^*} \quad (3)$$

It is further argued that in some circumstances, model (3) gives negative scores for profit efficiency, which are not interpretable, and cannot be useful for efficiency targeting (Cooper

et al., 2006; Cooper, Seiford, & Tone, 2007; Sahoo et al., 2014; Tone, 2002). To illustrate this, take an instance from decreasing the inputs of a technically efficient firm by 20%. This feasibly lead to 20% decrease in the cost of the firm. However, in a profit efficiency analysis, varying the quantity of inputs and outputs of the firm by a given proportion does not necessarily lead to the proportionate profit change. In order to solve this problem with profit efficiency, Tone (2002) and Cooper et al. (2006) proposed the revenue/cost efficiency ratio (profit ratio model) which is adapted to this study, and is given as:

$$
\begin{aligned}
&\max_{x,y,\lambda} \frac{p_{ro}\, y_{ro}}{w_{io}\, x_{io}} \\
&s.t. \\
&\sum_{j=1}^{n} \lambda_j\, y_{rj} \geq y_{ro}; \quad r = 1,\ldots,s \\
&\sum_{j=1}^{n} \lambda_j\, x_{ij} \leq x_{io}; \quad i = 1,\ldots,m \\
&\sum_{j=1}^{n} \lambda_j = 1\,(vrs) \\
&\lambda_j \geq 0; \quad j = 1,\ldots,n
\end{aligned}
\tag{4}
$$

By use of the Charnes-Cooper transformation of fractional programming, equation (4) can be written in the linear optimization form by bringing to bear a variable $t \in \Re$ and setting $\hat{y}_{ro} = t y_{ro}; \hat{x}_{io} = t x_{io}; \hat{\lambda} = t\lambda$. By multiplying every term by $t > 0$, model (4) becomes:

$$
\begin{aligned}
&\max_{\hat{x},\hat{y},\hat{\lambda},t} p_{ro}\, \hat{y}_{ro} \\
&s.t. \\
&\sum_{j=1}^{n} \hat{\lambda}_j\, y_{rj} \geq t y_{ro}; r = 1,\ldots,s \\
&\sum_{j=1}^{n} \hat{\lambda}_j\, x_{ij} \leq t\, x_{io}; i = 1,\ldots,m \\
&\sum_{j=1}^{n} \hat{\lambda}_j = 1(vrs) \\
&\lambda_j \geq 0; j = 1,\ldots,n
\end{aligned}
$$

Revenue-Cost efficiency then becomes:

$$
PE_{RC} = \frac{\sum_{r=1}^{s} p_{ro}\, y_{ro} \Big/ \sum_{i=1}^{m} w_{io}\, x_{io}}{\sum_{r=1}^{s} p_{ro}\, y^{*}_{ro} \Big/ \sum_{i=1}^{m} w_{io}\, x^{*}_{io}}
$$

2. Derivation of LPI

Having formulated the profit efficiency, the profit oriented LPI is also derived. derived as follows. Given that DMUs make use of the input vector, $x^t(x^t \in \Re_+^m)$ to produce the output vector, $y^t(y^t \in \Re_+^s)$ in time period $t(t = 1,2,\ldots,T)$, where the vectors of input costs and output prices for period t are given as $w^t \in \Re_+^m$ and $p^t \in \Re_+^s$, respectively. The production technology is given as $S^t = \left\{(x^t, y^t): x^t \; can \; produce \quad y^t\right\}$ and the profit frontier as $\Pi^t(p^t, w^t)$. Following Juo, Fu, et al. (2015), the profit oriented Luenberger productivity indicator (πL) spanning two time periods, t and $t+1$, is given by:

$$\pi L = \frac{1}{2}\left\{\begin{array}{l}\left[\dfrac{\pi^t(p^t,w^t)-(p^t y^t - w^t x^t)}{p^t g_y + w^t g_x} - \dfrac{\pi^t(p^t,w^t)-(p^t y^{t+1} - w^t x^{t+1})}{p^t g_y + w^t g_x}\right] + \\ \left[\dfrac{\pi^{t+1}(p^{t+1},w^{t+1})-(p^{t+1} y^t - w^{t+1} x^t)}{p^{t+1} g_y + w^{t+1} g_x} - \dfrac{\pi^{t+1}(p^t,w^t)-(p^{t+1} y^{t+1} - w^{t+1} x^{t+1})}{p^{t+1} g_y + w^{t+1} g_x}\right]\end{array}\right\} \quad (1)$$

The πL in model (1) above is measured in terms of profit frontier of each time period, where the directional vector, $(-g_x, g_y)$ functions as a factor for normalizing differentials in profit, and also for adjusting the direction of the vector, $(-x, y)$ which is projected unto the profit frontier. Because the index is composed of own-period and intertemporal (cross-period) inefficiencies, the average score of the two terms are taken, as suggested by Färe and Primont (1995).

In the profit oriented LPI model (1), the first element in the first squared bracket is the profit inefficiency assessed at the weighted value of the observed values in period t based on the profit frontier of period t. Equally, the second element found in the first squared bracket is a measures the profit inefficiency, which is assessed at the weighted value of the observed values in period t and measured at (x^{t+1}, y^{t+1}). As a result, the score of the first squared bracket is the productivity change measured by ratio differential of profit inefficiency against the period t profit frontier. Also, the score of the second squared bracket is the productivity change measured by the ratio differential of profit inefficiency against the profit frontier of period $t+1$. If the value of πL is greater than 0, it means productivity progress (increase or improvement), whereas a score lower than 0 indicates productivity regress (decline or decrease), and a score of 0 denotes productivity stagnation.

A two-factor decomposition of the profit oriented Luenberger indicator (πL) into profit efficiency change ($\Delta \pi E$), and profit technology change ($\Delta \pi T$), is given as:

$$\pi L = \underbrace{\left[\frac{\pi^t(p^t,w^t)-(p^t y^t - w^t x^t)}{p^t g_y + w^t g_x} - \frac{\pi^{t+1}(p^{t+1},w^{t+1})-(p^{t+1} y^t - w^{t+1} x^t)}{p^{t+1} g_y + w^{t+1} g_x}\right]}_{Profit\ efficiency\ \ change\ \ (\Delta\pi E)} +$$

$$\underbrace{\frac{1}{2}\left\{\left[\frac{\pi^{t+1}(p^{t+1},w^{t+1})-(p^{t+1} y^t - w^{t+1} x^t)}{p^{t+1} g_y + w^{t+1} g_x} - \frac{\pi^t(p^t,w^t)-(p^t y^t - w^t x^t)}{p^t g_y + w^t g_x}\right] + \left[\frac{\pi^{t+1}(p^{t+1},w^{t+1})-(p^{t+1} y^t - w^{t+1} x^t)}{p^{t+1} g_y + w^{t+1} g_x} - \frac{\pi^t(p^t,w^t)-(p^t y^{t+1} - w^t x^{t+1})}{p^t g_y + w^t g_x}\right]\right\}}_{Profit\ technology\ change\ \ (\Delta\pi T)} \quad (2)$$

The productivity indicator suggested in models (1) and (2) can result in negative profit values, which lack economic interpretation, making the use of the revenue/cost ratio (profit ratio) model (10) more appropriate. Since the revenue/cost ratio is applied in deriving the indicator, the linear programming model is used to derive the maximum revenue and the minimum cost. Assume that in period $t\,(t=1,2,\ldots,T)$, the $hth(h=1,2,\ldots,n)$ DMU employs a vector of m inputs, $x_h^t=(x_{h1}^t,x_{h2}^t,\ldots,x_{hm}^t)$ to produce a vector of s outputs, $y_h^t=(y_{h1}^t,x_{h2}^t,\ldots,y_{hs}^t)$, with cost of inputs and price of outputs given as $w_h^t=(w_{h1}^t,w_{h2}^t,\ldots,w_{hm}^t)$ and $p_h^t=(p_{h1}^t,p_{h2}^t,\ldots,p_{hs}^t)$, respectively. The maximum revenue achievable in period t is given as:

$$R^t(y^t)=\max\ p^t y^t=\sum_{r=1}^{s} p_{rh}^t y_{rh}^t$$

$$s.t.$$

$$\sum_{j=1}^{n}\lambda_j^t x_{ij}^t \le x_{ih}^t; i=1,\ldots,m$$

$$\sum_{j=1}^{n}\lambda_j^t y_{rj}^t \ge y_{rh}^t; r=1,\ldots,s \quad (3)$$

$$\sum_{j=1}^{n}\lambda_j^t = 1\,(vrs)$$

$$\lambda_j^t \ge 0;\ j=1,\ldots,n$$

In computing the optimum revenue in period $t+1$, t is replaced with $t+1$in model (3) above. The minimum cost attainable is equally computed using a similar approach in period t, as:

$$C^t(x^t) = \min\ w^t x^t = \sum_{i=1}^{m} w_{ih}^t x_{ih}^t$$

s.t.

$$\sum_{j=1}^{n} \lambda_j^t x_{ij}^t \le x_{ih}^t; i = 1,\ldots,m$$

$$\sum_{j=1}^{n} \lambda_j^t y_{rj}^t \ge y_{rh}^t; r = 1,\ldots,s \qquad (4)$$

$$\sum_{j=1}^{n} \lambda_j^t = 1\,(vrs)$$

$$\lambda_j^t \ge 0;\ j = 1,\ldots,n$$

Replacing t with $t+1$ in model (7) gives the minimum cost for period $t+1$. Therefore, the profit oriented Luenberger Productivity Indicator is given by:

$$\pi L = \frac{1}{2}\left\{\left[\frac{p^t y^t / w^t x^t}{R^t(y^t)/C^t(x^t)} - \frac{p^t y^{t+1} / w^t x^{t+1}}{R^t(y^t)/C^t(x^t)}\right] + \left[\frac{p^{t+1} y^t / w^{t+1} x^t}{R^{t+1}(y^{t+1})/C^{t+1}(x^{t+1})} - \frac{p^{t+1} y^{t+1} / w^{t+1} x^{t+1}}{R^{t+1}(y^{t+1})/C^{t+1}(x^{t+1})}\right]\right\} \qquad (5)$$

Appendix B: Technological change of banks

NO	DMU	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14
1	ACCESS										-0.3083	0.0018	0.0354	0.2174	0.0941
2	ADB	-0.2752	-0.2622	0.0041	0.1213	-0.1524	-0.0481	-0.2129	0.2231	0.4733	0.2468	-0.2082	0.2176	-0.3122	0.3465
3	AMAL	0.0000	0.0087	0.0048	0.0000	-0.0988	0.0128	-0.0840	-0.2356	0.4822	0.2878	0.1736	0.4111	0.1327	-0.2749
4	BARODA										1.7227	0.1834	0.0204	0.3294	-1.2248
5	BBG	-1.7325	1.1214	0.0838	-0.1184	0.2610	-0.0178	-0.1131	0.0950	-0.0985	0.0000	-0.1627	0.1893	0.0118	-0.6500
6	BPI							-0.3387	0.0230	1.9374					
7	BSIC									-2.5540	0.2782	0.1079	-0.0177	0.7633	-0.0114
8	CAL	0.4456	-0.1021	0.1113	0.0571	-0.7197	0.2342	-0.0468	0.0443	0.5987	-0.6207	-0.0031	0.3473	0.0571	-0.0822
9	ECOBANK	-0.3069	0.4269	0.0086	-0.0762	0.3593	0.1383	0.0490	-0.2070	0.1622	0.0000	0.4946	-0.1124	0.2089	-0.0883
10	ENERGY												0.0556	0.0719	-1.2471
11	FAMB	0.0000	0.1110	0.3914	0.0755	0.0000	-0.0009	-0.0023	0.0774	-0.3391	-0.0937	-0.2947	0.1539	0.0274	0.0745
12	FBL							0.0000	-0.1386	0.6912	-0.2994	0.0901	0.4009	0.2654	0.2681
13	FCPB														0.4948
14	GCB	0.1438	0.0000	0.0000	0.0000	-0.1502	0.0000	0.0000	-0.0471	-0.0182	0.0000	-0.0133	0.2470	-0.0079	-0.1029
15	GTB							-0.3518	0.0848	-0.4772	0.4351	0.2047	0.0396	0.5188	2.6218
16	HFC				-0.2882	0.1220	-0.1230	-0.0171	0.0018	0.6195	-0.2411	-0.1366	0.4366	0.0599	-0.2214
17	IBG							0.1318	0.3256	0.4565	-0.2510				
18	ICB	0.0255	0.0000	-0.1910	0.0794	0.0712	-0.1163	0.0341	-0.4485	1.1006	-0.2920	0.0255	-0.1617	0.0988	-0.1379
19	MBG	-0.4084	0.2957	0.0129	-0.0587	0.1605	0.2255	-0.0240	0.0506	-0.7066	-0.6932	0.5975	0.0144	0.1232	
20	METRO	0.3601	-0.5385	-0.1712	-0.2930	-0.4699									
21	NIB	0.4075	-0.3769	0.1542	-0.1230	-0.2183	-0.3571	0.0312	0.0871	0.4999	-0.2734	-0.1211	0.1626	0.5622	-0.7692
22	PBL	-0.0028	-0.1013	0.3709	0.0525	-0.1742	-0.0018	-0.0011	0.1648	0.7433	-0.7546	-0.0466	0.3755	0.0774	-0.0239
23	ROYAL														0.0008
24	SCB	0.0000	-0.1996	0.1903	0.4617	-0.1547	0.0000	0.0000	-0.0832	-0.1549	-0.0057	-0.0890	-0.3436	0.4192	-0.2781
25	SG-SSB	-0.0646	0.1091	0.1092	0.1277	-0.2076	-0.2860	-0.1025	0.0000	0.4198	-0.3249	-0.5859	0.6537	0.4721	0.3958
26	STANBIC	-0.0232	-0.3458	-0.2628	-0.1465	0.1292	-0.2163	-0.2561	-0.0392	0.6803	-0.2025	-0.1608	-0.0413	-0.0630	-0.7213
27	TTB	-0.4715	-0.0760	0.0967	-0.0479	0.1387	0.1569	0.0000	0.1717	0.6382	-0.1747				
28	UBA						0.1300	0.0396	-0.1085	0.0840	0.2205	0.2172	0.0200	-0.0060	0.0439

29	UNIBANK		-0.1026	0.0905	0.0000	-1.9475	-0.1431	0.0768	-0.2836	0.6126	-0.3737	0.0637	0.1704	0.1231	0.0000
30	UT BANK										-0.3224	0.0000	0.2107	0.4627	0.0669
31	ZENITH							0.2289	-0.4441	0.7695	0.0147	0.0458	0.1628	0.2876	0.2321

Appendix C: Efficiency change of banks

NO	DMU	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14
1	ACCESS										0.0000	0.0000	-0.3044	-0.0460	0.1
2	ADB	-0.0089	-0.0524	0.3756	-0.3048	0.3048	0.0000	-0.0777	-0.0743	-0.5052	0.2737	-0.1402	0.1078	0.1294	-0.2
3	AMAL	0.0000	0.0000	0.0000	0.0000	0.0000	-0.3554	0.1880	0.1674	0.0000	-0.3114	0.1008	-0.1968	-0.2022	0.2
4	BARODA										0.0000	0.0000	0.0000	0.0000	0.0
5	BBG	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.1969	0.1969	0.0000	0.0000	0.0000	0.0000	0.0
6	BPI							0.4152	0.0000	0.0000					
7	BSIC									-0.9227	0.2978	-0.0147	0.0698	-0.0941	-0.0
8	CAL	-0.1951	0.1922	0.1578	-0.1141	0.1828	-0.0144	-0.1738	0.0530	-0.4648	0.6931	0.0000	0.0000	0.0000	0.0
9	ECOBANK	0.3326	-0.3617	0.1919	-0.1585	0.0378	0.0335	-0.0053	0.0214	0.2409	0.0000	-0.4425	0.4425	0.0000	0.0
10	ENERGY												-0.2238	0.1116	-0.1
11	FAMB	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.5410	-0.0731	0.0411	-0.0
12	FBL							0.0000	0.0000	-0.5977	0.5977	0.0000	-0.3397	-0.1009	0.0
13	FCPB														-0.3
14	GCB	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0
15	GTB							0.0000	0.0000	-0.3105	0.1605	-0.2624	0.4125	-0.4665	0.2
16	HFC				0.0000	-0.2453	0.2453	0.0000	0.0000	-0.7372	0.4971	-0.0642	-0.1079	0.1143	0.2
17	IBG							-0.2636	-0.1021	-0.4593	0.3185				

18	ICB	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.5855	0.0801	-0.0614	0.0
19	MBG	0.4469	-0.3647	0.3647	0.0000	0.0000	0.0000	0.0000	0.0000	-0.4197	0.4197	-0.7220	0.0277	-0.0416	
20	METRO	-0.1973	-0.0431	0.1767	0.3936	0.0000									
21	NIB	-0.4059	0.2928	0.2373	0.0661	-0.2733	-0.0673	0.1015	0.0495	-0.4822	0.3680	0.3913	-0.2884	-0.2705	0.3
22	PBL	0.0850	0.3275	-0.3703	0.0281	0.3422	0.0000	0.0000	-0.2157	-0.6287	0.6465	-0.1155	-0.1346	-0.0717	0.1
23	ROYAL														0.0
24	SCB	0.0000	0.0000	0.0000	-0.3094	0.3094	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0
25	SG-SSB	-0.3606	0.0798	0.0234	-0.0074	0.2647	-0.0735	0.0735	0.0000	-0.6499	0.6499	0.0000	-0.4506	-0.0739	0.3
26	STANBIC	0.0344	0.0369	0.5274	-0.3164	0.2759	-0.2551	0.2957	0.0000	-0.5613	0.3095	-0.1200	-0.0074	0.1259	0.2
27	TTB	-0.1819	0.0968	0.2294	0.1135	-0.0403	0.0403	0.0000	0.0000	-0.6968	0.6968				
28	UBA						-0.5696	0.0584	-0.0543	0.0756	0.1362	-0.0505	0.4042	0.0000	0.0
29	UNIBANK		0.0000	0.0000	0.0000	0.0000	0.0000	-0.2117	-0.0534	-0.5951	0.5278	0.0650	0.2674	0.0000	0.0
30	UT BANK										0.8063	0.0000	0.0000	-0.4134	0.0
31	ZENITH							-0.3058	0.3058	-0.6992	0.4779	-0.1740	0.0027	0.3926	0.0

0