Competitiveness and Efficiency of the Banking Sector and Economic Growth in Egypt[#]

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Abstract

This paper provides empirical evidence on the banking sector in Egypt by investigating whether a series of financial reforms introduced in Egypt have had any significant impact on improving financial sector's competitiveness and production efficiency. The paper also demonstrates whether increased banking sector competitiveness and efficiency had short and/or long term impact on Egypt's economic growth over the period 1992-2007. The results suggest that financial sector reforms appear to have a positive and significant effect on improving competitiveness and production efficiency of the Egyptian banking sector. There is a steady decline in the market share of the largest four banks over the whole sample period. Findings show that the state owned banks are generally less competitive than private banks and foreign banks are less competitive than domestic banks. The average x-inefficiency of Egyptian banks is around 30% which is comparable to those reported for other African countries. Finally, there is evidence to suggest a significant relationship between financial sector's economic and productive efficiency in the short run. However, consistent with some previous studies, we do not find any evidence of long-run relationship between increased efficiency and economic growth. The results have several important policy implications and strengthen the argument for continuing the financial sector reform programme in Egypt.

Key words: Egypt, Financial reforms, Banking sector competitiveness, Economic growth, X-inefficiency.

JEL Classification: O16, O43, O55

Introduction

The importance of financial sector in economic growth has long been discussed and debated [see for example, Bagehot, (1873), Schumpeter, (1912), Shaw, (1973), McKinnon, (1973), etc.] In a seminal study, Levin (1997) suggests that financial system mobilizes and allocates savings, supports trade, helps in diversification and hedging of risk, and by allowing easier access to investment opportunities it affects accumulation of capital and growth. A competitive and efficient financial sector is a prerequisite for economic development and growth especially in developing countries. Consequently, many developing countries have embarked on economic liberalisation and have initiated financial sector reforms. The policy reforms are aimed at enhancing competition in the financial sector. In many countries, financial institutions including banks are state owned. In comprehensive cross country study, Barth, et al., (2003) have shown that costs of state owned banks generally outweigh the benefits since they suffer from political interference which impairs their financial intermediation efficiency. Thus the main aim of the reforms is to restructure state-owned institutions through privatisation and lower the barriers for entry of international financial institutions to make the financial sector more competitive and efficient which could facilitate greater economic development and growth. Indeed, as a country's financial sector develops and becomes more efficient, it enables individuals and institutions to channel savings to more productive ventures in facilitating economic growth.

The economic liberalisation and financial sector reforms have been actively promoted and in some cases, supported by the International Monetary Fund and the World Bank. However, the available evidence on the effects of financial sector liberalisation and reforms in the academic literature is not unanimous. On one hand, studies have shown that financial reforms improve banking sector's competitiveness, its saving mobilisation and allocation efficiency for achieving better economic growth (Levine, 1997; Besanko and Thakor, 1992; Claessens et al., 2004). On the other, there is research which suggests that financial reforms are disruptive and increases the vulnerability of financial system to financial and economic crises (see Rajan, 1992; Allen and Gale, 2000). Thus the

conflicting evidence in the extant literature demands the need for an in-depth empirical analysis of the relationship between financial reforms and competitiveness and efficiency of the banking sector and its impact on economic growth.

Despite this, there is limited research on the relationship between financial reforms and efficiency of the banking sector which dominates the financial sector in most developing countries. The available evidence presents mixed results on the existence and direction of the relationship. Further, there are even fewer papers that have examined the relationship between efficiency improvements as a result of financial reforms and its impact on economic growth. Moreover, existing research has considered just one or a few dimensions of financial reforms and does not take into account the extent to which financial reforms have been carried out. Nor does it evaluate the effects of policy changes over time.

In this paper, we aim to fulfil this gap in the literature by conducting a thorough empirical examination of the effects of financial reforms initiated by the government of Egypt since 1992. We perform our analysis in three stages. In the first stage, we measure competitiveness and productive efficiency of the Egyptian banking sector using different empirical measures that provide a complete picture of the sector's development. Second, we empirically analyse the determinants of competition and efficiency with an aim to explore the impact of financial reforms. Finally, we examine the link between competitiveness, production efficiency and economic growth.

In view of the ongoing economic crisis, the importance of the financial sector in the economic development cannot be overemphasised. The current crisis has shown that the private sector has become highly dependent on credit markets in which banks and financial institutions play a critical role. The financial sector mobilizes savings and allocates credit across markets and time. Economic liberalisation programme followed by many countries in developing economies and the increase in cross-border trade and investment flows have globalised financial markets. The globalisation of financial markets has meant that credit has to flow smoothly across countries and continents to

facilitate investment and growth. Further, the global economy is undergoing some significant changes. Emerging markets in developing economies are assuming greater importance in the global economic growth. This is evident from the euphoria with which the recent news about China's 9 percent economic growth in the first quarter of 2009 was greeted by world leaders. This suggests that the world is becoming increasingly reliant on economic growth in developing countries. The increasing significance of developing countries demands that more research should be done on the efficiency and competitiveness of their financial sector.

Further, there is a link between economic activity and development of financial institutions because as the needs for broader financial services increase, pensions and other forms of institutional asset management begin to develop which in turn facilitates further expansion of equity and capital markets. These linkages and current developments in the global economy provide an interesting background for conducting research on this topical issue. Research has shown that despite financial reforms and deregulation actively pursued by developing countries around the world, banking sector in these countries is dominated by political expediencies which leads to inefficient use of banking resources which in turn impedes potential economic growth.

Like rest of the developing world, the African countries too have undergone a number of important structural and policy reforms in their financial sector. It is well acknowledged that the role of a competitive and efficient financial sector in African context is crucial for economic development and growth (see Kirkpatrick et al., 2008). Further, Kasekende et al, (2009) argue that competitiveness and efficiency of the financial sector in Africa's four largest economies i.e., South Africa, Algeria, Egypt and Nigeria, is critical since economies of these countries are service oriented. They further suggest that extensive research on different African economies but especially SANE economies is required since these countries have undergone a series of most advanced financial reforms and policy makers need to be informed on the outcomes and values of these reforms particularly in the wake of current global financial crisis. This is particularly relevant since in a study of 79 countries over the period 1980-1997, Beck, Demirguc-Kunt and

Levine (2002), have shown that crises are less likely in countries with fewer regulatory restrictions on banking activities and which have institutions that encourage more competition.

This paper examines the competitiveness and efficiency of Egypt's banking sector following a series of key reforms since 1992 using different theoretical paradigms and a number of advanced econometric models. The paper also provides empirical evidence on the key determinants of efficiency and competitiveness in Egypt's banking sector and whether efficiency improvements in the banking sector have had any positive effect on the overall economic growth in Egypt.

The findings suggest that Egypt's banking sector seems to have benefited from a series financial sector reforms launched in three different stages by the government over the sample period 1992-2007. There is definite evidence to suggest that the banking sector in Egypt has become more competitive and efficient over time. The results are consistent with the conventional view that the efficiency improvement enhances industry competition. Findings also suggest that competition and productive efficiency significantly influence economic growth in the short run. However, test results for a long-run relationship are not statistically significant.

The rest of the paper is organized as follows. The next section explains the background and major developments in Egypt's financial sector. Section 3 provides a review of the related literature. Section 4 explains data and sample and various methodologies employed in the analysis of data. Section 5 presents and discusses empirical results and section 6 concludes and summarizes main policy implication of this research.

2. Developments in Egypt's Financial Sector

2.1 Financial Sector in Egypt

Egypt's financial sector is one of the oldest and most vibrant in Middle East and North Africa (MENA) region. Despite a number of privatisations, the financial sector in Egypt has a huge potential in financial services ranging from commercial banking, insurance,

mortgage lending, and financial advisory services. The overwhelming majority of approximately 76 million people in Egypt have yet to use consumer banking and insurance services. Additionally despite a growing market for residential and leisure properties, the mortgage market is still in its infancy. Thus there is a huge potential for growth in the financial services sector.

There are 21 insurance and reinsurance companies in Egypt and recent policy changes now allow foreign institutions to own a majority stake in an Egyptian insurance company. Though still much lower by international comparison, insurance premium as a percentage of the GDP have reached 0.83% in 2007 from 0.59% in 2001 (GAFI, 2007 report). The government has been taking steps to restructure the insurance market and have set up Egyptian Insurance Supervisory Authority which will have the responsibility to monitor risk management and financial solvency in the insurance sector. Recently, the parliament has passed a bill for mandatory insurance covering civil liability in automobile accidents. This is likely to give a huge boost to the insurance services.

The private equity sector is also growing and Cairo based Citadel Capital has become a regional leader with US8.3bn investment under its control. The mortgage market too is rapidly growing and more than LE2bn worth of mortgages have been issued since the passing of Mortgage Finance Law in 2002. Besides banks, there are 5 specialised mortgage companies and with the establishment of Egyptian Mortgage Refinance Company (EMRC), the mortgage market is likely to experience rapid growth. The reduction is property registration fee to a maximum of LE 2,000 will further improve the eligibility for mortgage finance.

At end of 2004, there were 57 banks in Egypt out of which 28 were commercial banks and 4 were state owned banks. There were 26 investment banks of which 11 were joint venture banks and 15 banks were foreign owned banks. The remaining 3 banks were specialised banks of which 2 are state-owned. However, privatisation of state-owned banks and consolidation of smaller banks has reduced the number of banks to 37 in 2007.

Although the Egyptian financial sector is not as well integrated as in developed countries, the banking sector in Egypt is very important and commands a significant share in terms of its contribution to the overall economic growth. The banking sector performs a crucial role in Egypt's financial system and accounts for more than 60% of financial assets in the economy with bank deposits which are nearly 100% of the GDP.

Figure 1 provides an overview of the growth in bank deposits and loans. Both, bank deposits and loans have shown a steady growth over time. Deposits grew from LE58,249m in 1992 to LE353,746m registering a fivefold increase. On the other hand, bank loans have grown from LE110,171m in 1992 to LE649,953m in 2007 showing a huge increase of 490%.

2.2 Structural reforms in Egypt's Financial Sector

Prior to banking sector reforms in 1990s, the banking sector in Egypt was dominated by the state and as a consequence, the banking system was uncompetitive and offered a low level of financial intermediation. The banking sector lacked innovation and good quality of governance structures. The decisions to offer credit lacked commercial considerations and this distorted the incentive system and sound managerial practices. The inefficient management of banks led to building up of large volumes of non-performing loans and poor asset quality (Central Bank of Egypt, 2008 report).

The process of banking sector reforms in Egypt started in 1990 with the removal of state sector's monopoly by liberalisation of deposit and lending rates. More significantly, banks were allowed to set their own service charges and fees. In February 1991, the foreign exchange market was reformed and central bank's control on exchange rates was lifted. This was followed by elimination of any ceilings on bank loans in 1992. In 1994, the Egyptian government embarked on the privatisation with an aim to reduce concentration and increase competition and the four state owned banks were directed to sell their holdings. In the second stage of reforms, the government of Egypt continued to pursue the economic liberalisation programme. In 1996, the government amended the

banking and credit law that removed 49% ceiling on foreign ownership of Egyptian banks. In the third and most current phase of reforms starting from 2002, the government launched Financial Sector Reform programme with an aim to divest public sector ownership of banks, consolidation of smaller banks and restructuring of state owned banks. The programme also aimed to privatise one of the four largest state-owned banks, namely Bank of Alexandria that owns nearly 7% of banking sector assets. Since 2005, the non-performing loans in Egyptian banks have been reduced or eliminated through restructuring. Indeed between 2005 and 2007, 14 banks including some state-owned banks have been either taken over or merged with foreign banks (See Table 1 for details). Further, in the most recent phase of reforms, special courts have been set up to expedite resolution of cases mainly involving financial disputes and contractual defaults. The central bank has upgraded and modernised institutional framework for quicker processing of transactions between banks by introducing real time settlement and an automated clearing house.

2.3 Capital Markets

The Cairo and Alexandria Stock Exchange (CASE) is one of the oldest and largest stock exchanges in Africa. It has been modernised over the last decade and is considered as one of the most modern stock exchanges. CASE was one of the best performing stock markets in 2007 with its index of 30 top stocks grew by 51% compared to 2006. Market capitalisation as a percentage of GDP has reached 105 percent compared 29 percent in 2002. However, CASE30 Index dropped sharply during 2008 recording all time single year loss of 56.4% following the global financial crisis which hit the world financial market in September 2008 causing a global economic slowdown. Total market capitalization declined substantially in 2008 by 38.3% to LE474bn down from LE768bn in 2007. The decline is mainly attributable to the global financial crisis, which resulted in a selling frenzy that occurred in the last quarter of 2008. During 2008 the number of listed companies decreased by 15% to 373 companies, compared to 435 listed companies in 2007. The decrease in the number of listed companies may be attributable to the continuous implementation of strict listing and disclosure regulations. Although, the number of traded companies declined by about 5% in 2008 to 322 companies compared

to 337 in 2007, the ratio of traded companies to total listed companies increased by 86.1% in 2008, as opposed to 77.5% in 2007. However despite its poor performance in 2008, the Egyptian stock market is considered as one of the most attractive emerging markets at its current prevailing market prices relative to companies' earnings and dividends distributions.

Egypt's WTO financial services commitment in the securities sector provides for unrestricted access to its stock market and international investors are permitted to operate in the Egyptian stock market largely without restrictions. Several foreign brokers, including U.S. and European firms, have established or purchased stakes in brokerage companies. Participation of foreign investors in the Egyptian market has also been growing is estimated to be around 30 percent in 2007.

The mergers and acquisitions market has also been active. The total number of acquisitions amounted to LE105bn in 2008, compared to LE37bn in the previous year. The most notable of these was Lafarge's mega LE71bn takeover of Orascom Building Materials Holding. The value of this deal alone represents around 67% of the total value of all acquisitions that occurred in Egypt during 2008. In addition, Orascom Development Holding AG's deal to acquire 98% of Orascom Hotels and Development in May was also one of the major acquisitions of the year, valued at approximately LE16bn (Cairo and Alexandria Stock Exchange 2008 report).

Egypt's government bond market has developed rapidly during its short lifetime. The government has issued bonds in Egyptian pounds since 2007 and in foreign currencies, including a series of Eurobonds. Currently the value of listed bonds in the Egyptian market is LE20 billion with LE14 billion in government bonds and bills and LE6 billion in corporate bonds.

2.4 Developments in Financial Sector

The developments in Egypt's financial sector can be gleaned through figures provided in Table 2 and trends in Figure 2. As can be seen, the domestic credit provided by banks in the economy and credit provided to private sector in relation to the GDP have significantly increased over time. Though figures for 2006 and 2007 show a decline in credit by banks, this may have been due to onset of the current credit crisis. However compared to 1992, the levels of credit are still substantial higher. The rapid expansion of banking activities has resulted in more than 100 per cent growth in the banking sector's assets over time. The broad money (M2/GDP) ratio has also shown significant increase over time and reached 92% in 2006 compared to 77% in 1992. However, the ratio of gross savings to GDP shows a decline from 26% in 1992 to 22% in 2007. Most notable is the striking increase in the value of equity stocks traded in the Egyptian stock market. Market capitalisation as a percentage of the GDP has reached 106.75 by 2007 which though comparable to many other large developing markets, is lower than those reported for developed markets.

Figure 3 provides data on bank lending and deposit rates as well as interest rates and inflation during 1992 to 2007. The bank lending rates have declined from 20% in 1992 to 13% in 2007. Not surprisingly, the deposit rates too have declined from 12% in 1992 to 7% in 2007. Consequently the interest rates spread for banks have fallen from around 8% in 1992 to around 5.5% in 2007. The interest rate declines have kept pace with the declining inflation which fell sharply to around 1% in 1999 from around 20% in 1992. In 2007, the inflation rate was around 13%. Deposit rates remained above inflation before 2002. However since middle of 2002, they have been lower than inflation rate confirming the decline in savings to GDP ratio observed in Table 2. This may also partially explain the rapid rise in the market capitalization in the Egyptian stock market since negative interest rates may have channelled the savings to investments in the stock market and other alternative investments avenues.

2.5 Banking Sector Competitiveness

The Herfindahl index is a simple and widely used measure for determining the degree of concentration in a given industry. The more concentrated the industry is, the higher is the value of the index and lower is the extent of competition. Table 3, shows the values of Herfindahl index for various years and for a number of variables for the banking sector in Egypt. Going by the variables, BHHI which represents median values of income concentration based on the proportions of interest income, fee income and other operating income and SHHI that provides a measure of concentration based individual banks' total assets, it can be concluded that the degree of concentration in the Egyptian banking industry appears to be declining. The data indicate that the Egyptian banking sector has become more competitive over time. The declining values of CR4Land CR4D suggest that both the market share and the share of deposits of the four largest banks seem to have declined over time. Other measures such as BROA, BROE, and BOVH which indicate the operating efficiency of Egyptian banks also confirm that with the increase in competition, banks have had to reduce their overheads and their returns on total assets and equity capital also seem to have declined over time. The foreign bank penetration ratio (FBPR) has increased over time. The notable increase in FBPR in 2006 was on account of acquisition of the fourth largest public sector bank, i.e., Bank of Alexandria by Sanpaolo IMI.

3. Literature Review

3.1 Financial Sector Efficiency and Competitiveness

According to Claessens et al. (2004), competition in the financial sector is important since it affects the efficiency of production of financial services, the quality of financial products and the degree of innovation in the sector. They argue that the degree of competition in the financial sector can affect the access of firms and households to financial services which in turn influences overall economic growth. Thus greater competition in financial sector lowers cost of intermediation. Further, Besanko and Thakor (1992) also find that more competitive banking system leads to higher growth rates.

Previous literature has shown that methods for measuring bank competition can be classified as structural and non-structural. The structural approach to measurement of competition includes the Structure-Conduct-Performance paradigm (SCP) and the efficiency hypothesis. The SCP paradigm is used to investigate whether a highly concentrated market causes collusive behaviour amongst the larger banks resulting in superior performance, whereas, the Efficient Structure Hypothesis investigates whether it is the efficiency of larger banks that enhances their performance (Berger, 1995). The non-structural approach attempts to measure competition directly and does not rely on a relationship between structure, conduct and performance (Glöde, 2005). Some of these factors include revenue behaviour, risk profiles, entry and/or exit barriers and the general contestability of the market. Models such as those developed by Panzar and Rosse (1987), and Bresnahan (1989), test competitive conduct and the use of market power in examining banks' competitive behaviour in absence of structural measures.

Bresnahan (1989) uses the condition of general market equilibrium model where the basic idea is that profit-maximizing firms in equilibrium will choose prices and quantities such that marginal costs equal their (perceived) marginal revenue, which coincides with the demand price under perfect competition or with the industry's marginal revenue under perfect collusion. The alternative approach is Panzar and Rosse (1987). This methodology uses bank level data and investigates the extent to which a change in factor input prices is reflected in (equilibrium) revenues earned by a specific bank. Under perfect competition, an increase in input prices raises both marginal costs and total revenues by the same amount as the rise in costs. Under a monopoly, an increase in input prices will increase marginal costs, reduce equilibrium output and, consequently, reduce total revenues.

A number of papers have applied either the Breshnahan or the P-R methodology for analysing competition in the banking system in developed countries (see Claessenes, et al., 2003). However, tests on the competitiveness of banking systems for developing countries are relatively far less. Belaisch (2003) uses PR approach and reports evidence of a non-monopolistic market structure in Brazil. Gelos and Roldos (2002) using the PR-

methodology analyze a number of banking markets including some developing countries. They conclude that lowered barriers to entry, such as allowing increased entry to foreign banks, appeared to have prevented a decline in competitive pressures. Philippatos and Yildirim (2002) investigate competitiveness of banking sector of 14 Central and Eastern Europe using bank-level data and the PR-methodology. They find that except for Latvia, Macedonia, and Lithuania, banking systems can neither be characterized as perfectly competitive nor monopolistic. However, there are a number of papers which have investigated the effects of specific structures or other factors presumed to relate to the competitive environment. Claessens, Demirgüç-Kunt and Huizinga (2001) investigate the role of foreign banks in a cross-country study and show that entry by foreign banks makes domestic banking systems more efficient by reducing their margins. Further Barth Caprio and Levine (2003) find negative impact of state ownership on overall banking sector development and banking efficiency. Additionally, a number of recent studies have investigated the combined impact of structure and regulations. Using bank level data for 77 countries, Demirgüç-Kunt, Laeven, and Levine (2003) investigate the impact of bank concentration and regulations on bank efficiency. They find that bank concentration has a negative and significant effect on the efficiency of the banking system except in affluent countries that have a well-developed financial system.

There are studies that have investigated the impacts of economic liberalisation pursued by many developing countries. For example, Noland (1996) finds that liberalization of domestic financial markets leads to improved access to finance through convergence of borrowing rates across the formal and informal credit markets. He suggests that creation of a competitive environment encourages financial firms to adopt cost-reducing measures and use resources more efficiently by controlling internal consumption within the firm for high salaries or entertainment expenses. Finally, in a competitive environment, financial firms are forced to increase the quality of service such as faster clearing of payments, more rapid processing of loan applications, extended hours for customers, etc. Further, Eschenbach and Francois (2002) investigate the relationship between financial sector openness, competition and growth. Using a panel estimation of 130 countries and simultaneous equation models, they report a strong relationship between

competition/performance and financial sector openness and between growth and financial sector competition. Thus, there is evidence to suggest that liberalisation of domestic financial sector improves the overall efficiency of financial system.

3.2 Financial Development and Economic Growth

There is an extensive literature on the link between financial development and economic growth (see, e.g., Bencivenga and Smith, 1991; Pagano, 1993; King and Levine, 1993; Levine, 1997). The theoretical arguments can be attributed to the work of McKinnnon (1973) and Shaw (1973). According to the McKinnon (1973), investment in a typical developing economy is mostly self-financed and cannot materialize unless sufficient saving is accumulated in the form of bank deposits. Such a complementary role between money and physical capital is termed as the "complementarity hypothesis". On the other hand, the "debt-intermediation" view proposed by Shaw (1973) argues that financial intermediaries promote investment and raise output growth through borrowing and lending. These two arguments indicate that an increased level of financial development should lead to higher economic growth.

The subsequent research has presented more complex types of financial development models that incorporate financial institutions in endogenous growth models (e.g. see King and Levine, 1993; Pagano, 1993). In these studies, various techniques, such as externalities and quality ladders, have been applied to model financial intermediation explicitly instead of taking it for granted as in the McKinnon–Shaw framework. These models support the finance-led argument by demonstrating that financial development reduces informational frictions and improves resource allocation efficiency.

Empirical studies have lent support to the link between finance development and economic growth. Levine, Loayza, and Beck (2000) presented empirical evidence which suggests that the exogenous component of financial intermediary development is positively and robustly related to economic growth for 71 countries over the period 1960-1995. Other studies also provide consistent evidence on the benefits of financial

development in the process of economic development (see, e.g. Levine and Zervos, 1998; Beck and Levine, 2004, among others).

However, most studies only use quantity measures of finance development such as credit volumes in examining its impact on economic growth. The exception is Hasan, Koetter, and Wedow (2009), who use cost- and profit-efficiency estimates as quality measures of financial institutions and find positive impact of bank efficiency on regional growth in 11 European countries. In their paper, Romero-Avila (2007) also recommended the use of direct measures of quality of financial institutions rather than the credit volumes in measuring financial development since a mere expansion of credit does not necessarily indicate a qualitative improvement in the intermediaries' abilities to allocate capitals. It is expected that more credit provided by efficient banks will have an independent impact on economic growth in addition to direct quantity channel effects.

3.3 Financial Sector Reforms and Finance Sector Development

Another important issue in understanding the relationship between financial sector development and economic growth is whether financial reforms in developing countries stimulate finance development and growth. Many developing countries including Egypt started their financial sector reforms in the 1990s in order to facilitate the development of their finance sectors for increasing the rate of economic growth. The underlying economic rationale is that deregulation should reduce the regulatory cost imposed on banks and foster increased competition, which would induce banks to minimize costs to maintain market share and profitability.

Feldman and Wagner (2002) suggest that success of banking sector reforms significantly contribute to the fiscal and monetary stability of many transition economies. Reforms of domestic finance can help in the creation of a more efficient financial system that would provide better rates of return and opportunities for diversification and encourage more savings. This in turn increases the availability of domestic capital for investment, and improves the rate of economic growth. Also, greater competitiveness amongst the financial sector improves the efficiency of investment since greater competition for

business encourages financial institutions to invest in economically viable projects and discourages banks to invest in politically motivated but economically unsound projects. Further, transition economies typically offer higher rates of return on investments and deregulation of their financial markets help attract capital flows from developed countries. This increases supply of capital and lowers the cost of capital for businesses. Thus, efficient utilization of foreign capital and higher rate of returns on investment leads to greater economic growth.

However, empirical evidence on the impact of deregulation on the competition behaviour of banking sector is mixed. Some studies observe improved competition following deregulation (e.g., Angelini and Cetorelli, 2003; Claessens and Laeven, 2004) while others fail to find evidence of increased competition following the deregulation and liberalization of finance sectors (e.g. Maudos and Fernandez De Guevara, 2002; Matthews et al., 2007).

Likewise, there is no consistent evidence on the impact of financial reforms on productive efficiency of banking sector. Chen (2001) finds substantial increase in banks' productive efficiency in Taiwan's deregulated banking market during 1988 to 1997. Hassan and Marton (2003) observe that bank reforms in Hungary improved productive efficiency scores between 1993 and 1998. Based on a sample of Korean banks in the period 1985-1995, Hao, Hunter, and Yang (2001) find that financial reforms in Korea had little or no significant effect on banks' productive efficiency. Isik and Hassan (2002) report that in the period subsequent to liberalization (1988-1996), Turkish banks' productive efficiency actually worsened over time. Similar conclusions are reached by Hardy and Patti (2001), when they compute the productive efficiency of all Pakistani banks during 1993-1998 which coincided with a period of deregulation.

The conflicting evidence on the impact of financial reforms on finance sector development can be attributed to different proxies and approaches used in the past studies. Carbo et al. (2009) measure competition using indicators for 14 European countries over the period 1995 – 2001. They follow the New Empirical Industrial

Organization (NEIO) literature, including the mark-up of price (average revenue) over marginal costs (Lerner index) and the degree to which input price changes are reflected in average revenues (the H-statistic). These indicators are then compared with a standard market structure measure of concentration (Hirschman–Herfindahl index) and other bank performance indicators (net interest margin and return on assets). They find that different indicators yield different results about competitive behaviour within and across countries and over time. Likewise, studies using different efficiency measures are likely to produce different results about productive efficiency since they focus on different factors of banking operations (e.g. see Berger and Humphrey, 1997).

Another reason for conflicting evidence on the impact of reforms is that financial sector reforms followed by many countries are a mixed process of deregulation and prudential re-regulation (Zhao et al., 2008). Without carefully controlling the complex process of financial reforms, it is difficult to identify their net effect on efficiency and competition.

In summary, there are several empirical issues in understanding the link between financial sector development and economic growth in developing countries. First of all, the choice of a particular efficiency or competition measure in empirical studies is of particular policy relevance since it can influence interpretations of competitive behaviour and productive efficiency within a given country. Second, it is important to understand the impact of financial reforms on development with a careful design to control different stages of reforms, since this can help policy makers in improving the efficiency of reforms. Finally, researchers should examine the link between quality measures of finance development and economic growth, which has particular implication for policy focus in financial reform. Focusing on the Egyptian banking sector which experienced continuous financial reforms during 1992 and 2007, the present study addresses these critical issues by conducting a systematic examination on the interaction between financial reforms, competition, efficiency and economic growth.

4. Data and Methodology

4.1 Sample Data

The source of bank-specific data is primarily Bankscope, an international database covering over 29,000 banks worldwide. We started with the population of all Egyptian banks for all available dates in Bankscope. To supplement some missing data from Bankscope, we also downloaded financial reports of Egyptian banks from Bloomberg. After carefully checking the data availability and completeness, we had a final sample of 45 Egyptian banks during the period 1992 – 2007 which provided us a total of 423 bank-year observations.

As the main aim of the paper is to document a link between financial sector development and economic growth, we further collected macro-economic data for Egypt from World Development Indicators database of the World Bank. We also searched the Central Bank of Egypt website to collect aggregate statistics of the banking sector in Egypt. Table 4 provides summary statistics of variables used in subsequent empirical analyses.

4.2 Research Methodology

As indicated in the literature review section, few studies have conducted a systematic examination of the interaction between financial sector reforms, competition, efficiency and economic growth. Our research framework addresses this issue and thus comprises three stages. First, we measure industry competition and productive efficiency of Egyptian banking sector with different empirical measures, which provides a complete picture of finance development in Egypt. Second, we explore the determinants of competition and production efficiency of Egyptian banking sector, with a particular focus on the impact of financial sector reforms. Finally, we investigate the link between competitive conduct, productive efficiency and economic growth with an endogenous growth model approach, which addresses the endogeneity issue.

4.2.1 First-step Analysis: Measuring Competition and Efficiency

4.2.1.1 The Competition Measure of Panzar-Rosse Model

A frequently used competition measure is H-statistic suggested in Panzar and Rosse (1987), which uses bank-level data to investigate the extent to which changes in factor input prices are reflected in revenues earned by market participants with a market equilibrium assumption. In the case of perfect competition, an increase of input prices raises both marginal costs and total revenues by the same amount as the rise in costs. In the case of monopoly, an increase of input prices could result in higher marginal costs, reducing equilibrium output and hence declining revenues. The P-R model provides a competitive environment indicator (H-statistic), which summarizes the extent to which an increase in the input prices affects the total revenues of the market participants (i.e. the elasticity of total revenue to input prices). When H <= 0, the market is characterized as a collusive (joint monopoly) competition. When 0 < H <1, the market is of monopolistic competition. When H = 1, there is perfect competition in the market. However, the conclusion is not valid when there is no long-run equilibrium in the market. Therefore, P-R model also suggests a test on E-statistic, which is the elasticity of profitability to input prices. When E = 0, the market is in the long-run equilibrium.

Following Kasekende et al. (2009) and Claessens and Laeven (2004), we use the following two equations to estimate the H-statistic

$$\ln IR_{it} = \alpha_i + \beta_{1t} \ln PF_{it} + \beta_{2t} \ln PK_{it} + \beta_{3t} \ln TA_{it} + \beta_{4t} \ln EQA_{it} + \beta_{5t} \ln RSK_{it} + \beta_{6t} FOR_t + \beta_{7t} GOV_t + \beta_{8t} \ln INF_t + \beta_{9t} \ln RIR_t + \beta_{10t} REF96 + \beta_{11t} REF02 \quad (1)$$

$$\ln \pi_{it} = \alpha_i + \beta_{1t} \ln PF_{it} + \beta_{2t} \ln PK_{it} + \beta_{3t} \ln TA_{it} + \beta_{4t} \ln EQA_{it} + \beta_{5t} \ln RSK_{it} + \beta_{6t} FOR_t + \beta_{7t} GOV_t + \beta_{8t} \ln INF_t + \beta_{9t} \ln RIR_t + \beta_{10t} REF96 + \beta_{11t} REF02 \quad (2)$$

where

IR = interest income.

π = 1 + return on assets.

PF = interest expense / (total deposits + other funding).

PK = other operating expense / total assets.

TA = total assets.

EQA = equity / total assets.

RSK = loan loss provision / total loans.

FOR = 1 for foreign bank and 0 otherwise.

GOV = 1 for government bank and 0 otherwise.

INF = headline inflation rate.

RIR = interest rate spread.

REF96 = 1 for period between 1996 and 2001 and 0 otherwise.

REF02 = 1 for period from 2002 and 0 otherwise.

IR and π are revenue and profitability measures, respectively. To deal with loss-making banks we use $\ln(1 + \pi)$ rather than $\ln \pi$ in the model. PF and PK are our proxies for the input prices. We also include TA, EQA, RSK, FOR, and GOV to control exogenous bank-specific factors in the estimation. In addition, we consider some macro-economic variables such as INF and RIR that may shift the revenue schedule. Finally, we employ two financial reform indicators REF96 and REF02, which indicate different stages of financial reforms in Egypt. The H-statistic is the sum of coefficients of PF and PK in equation (1) and the E-statistic is the sum of coefficients of PF and PK in equation (2).

Despite the flexibility in including firm-specific factors in the production function, there are two major limitations with the H-statistic of P-R model. First, the method takes the factor prices as exogenous by assuming that the participants are price takers in the input market. Second, the long-run equilibrium is the necessary condition for the identification of market competition status from the model.

4.2.1.2 The Competition Measures of Conjectural Variation Approach

The Conjectural Variation (CV) approach makes different assumptions about market participants and gives three different parameters for measuring competition, the industry average degree of competition (θ), the industry demand elasticity (η), the Lerner index of competition (θ/η). Assuming that banks seek short-run profit maximization, the CV approach proposes that market participants will choose prices or quantities where

marginal costs equal marginal revenues. The measures are derived from three basic ingredients of participant's behaviour: price setting for inputs and outputs, managing costs, and the interdependence among the participants.

Following Uchida and Tsutsui (2005) and Brissimis et al. (2008), we jointly estimate the following three equations system using seemingly unrelated regression (SUR) approach.

$$\ln C_{it} = b_0 + b_1 \ln q_{it} + 1/2b_2 (\ln q_{it})^2 + b_3 \ln d_{it} + 1/2b_4 (\ln d_{it})^2 + b_5 \ln w_{it} + 1/2b_6 (\ln w_{it})^2 + b_7 \ln q_{it} \ln w_{it} + b_8 \ln q_{it} \ln d_{it} + b_9 \ln d_{it} \ln w_{it} + \varepsilon_{it}^c \quad (3)$$

$$R_i = \frac{\theta_t}{\eta_t} R_{it} + E_{it} \frac{q_{it}}{d_{it}} + C_{it}(b_1 + b_2 \ln q_{it} + b_7 \ln w_{it} + b_8 \ln d_{it}) + C_{it} \frac{q_{it}}{d_{it}} (b_3 + b_4 \ln d_{it} + b_8 \ln q_{it} + b_8 \ln w_{it}) + \varepsilon_{it}^R \quad (4)$$

$$\ln p_{it} = p_0 + (-\frac{1}{\eta_t}) \ln q_{it} + p_1 \ln GDPR_{it} + p_2 \ln TA_{it} + p_3 \ln EQA_{it} + \varepsilon_{it}^p \quad (5)$$

where

C = non-interest expense.

q = loans.

d = deposits + other funds.

w = non-interest expense / assets.

R = interest income.

θ = industry average degree of competition.

η = industry demand elasticity.

E = interest expense.

p = interest income / loans.

GDPR = GDP growth rate.

TA = assets.

EQA = equity / total assets.

Equation (3) is a multi-product translog cost function. The equation tries to measure the total cost with outputs (q and d) and costs other than funding (w). Equation (4) is a revenue function obtained from the first-order profit maximization condition of banks with regard to the quantity of loans. To control the funding cost, the RHS of equation

includes the interest expense (E) weighted by the ratio of loans to total loanable funds. Other variables in Equation (4) are defined the same as those in Equation (3). Equation (5) is an inverse loan demand function. The dependent variable is implicit price of loan (p). In the RHS of equation, we consider the impact of macro-economic condition and firm-specific characteristics on loan pricing behaviour by using GDP growth rate (GDPR), firm size (TA) and capitalization (EQA).

Following the practice in extant literature, we normalize each output quantity and input price variable by its geometric mean. Thus the estimated first-order coefficients can be explained as the cost elasticity of the sample mean. As a consequence, both b1 and b2 should be positive to meet the requirement of non-negative marginal cost.

The main focus of the system of equations is to estimate the parameters θt (industry average degree of competition) and η (industry demand elasticity). θ_t is the elasticity of total industry output with respect to the output of the *i*th bank and measures the degree of competition in the market at time t. The higher the value of θ_t, the lower the degree of competition. If the market structure is characterized by Cournot competition, θ_{it} will represent the market share of the *i*th bank at time t. Under perfect competition, $\theta_{it} = 0$. Under pure monopoly, $\theta_{it} = 1$. When $\theta_{it} < 0$, pricing is below marginal cost and it indicates a non-optimal behaviour of participants. Similar to Uchida and Tsutsui (2005) and Brissimis et al. (2008), we assume that $\theta_{it} = \theta_t$ in Equation (3) so that θ_t indicates the industry average degree of competition at time t. To capture the change of competition over time, we use yearly dummies to estimate θ. To measure industry demand elasticity over time, we use dummy variables for every two years since η is linearly dependent on the time-specific control variable GDPR and hence we cannot use year dummy variable for η. The Lerner index is the ratio of θ over η, which considers the impact of industry demand elasticity. Likewise, there is a negative relationship between the Lerner index and the degree of competition.

There are two advantages for the CV approach. First, as a structural approach, it explicitly models the demand, cost, and profit maximization conditions faced by

participants (Kasekende et al., 2009). Therefore, the results of CV approach are more rigorous and reliable than that of P-R model. Second, θ can be viewed as a continuous variable, allowing exploration of factors associated with the variation in the degree of competition (Shaffer, 2004).

4.2.1.3 The Competition Measure of Persistence of Profitability Model

The Persistence of Profitability (POP) model provides another measure for industry competition by examining the persistence of overcharge (abnormal profit). This approach is consistent with the test for market equilibrium as in P-R model. The basic argument is that high abnormal profit would attract new market entrants, thereby reducing the excess return. Consequently, if abnormal profits tend to persist over time, this indicates that there are barriers to entry or extant participants exercise monopoly power. Since it is difficult to formulate a structural model about the unobserved threat of entry, the standard POP study employs an auto-regressive model for overcharge on loans, proxied by the ratio of implicit price of loans to their marginal cost.

We first estimate the marginal cost by specifying the following translog cost function based on stochastic frontier approach.

$$\ln VC_{it} = \beta_0 + \sum_{m=1}^{3} \alpha_m \ln Y_{mit} + \sum_{n=1}^{2} \beta_n \ln W_{nit} + 1/2 \sum_{m=1}^{3} \sum_{j=1}^{3} \alpha_{mj} \ln Y_{mit} \ln Y_{jit} + 1/2 \sum_{n=1}^{2} \sum_{k=1}^{2} \beta_{nk} \ln W_{nit} \ln W_{kit}$$
$$+ 1/2 \sum_{n=1}^{2} \sum_{m=1}^{3} \gamma_{nm} \ln W_{nit} \ln Y_{mit} + \theta T + 1/2 \lambda T^2 + \sum_{m=1}^{3} \theta_m T \ln Y_{mit} + \sum_{n=1}^{2} \zeta_n T \ln W_{nit} + v_{it} + u_{it} \quad (6)$$

where

VC = variable cost.

Ym = three outputs including LOAN, OEAST, and TR.

LOAN = total loans.

OEAST = other earning assets.

TR = total revenue.

Wn = two input prices including PK and PF.

PF = interest expense / (deposits + other funds).

PK = non-interest expense / assets.

T = time trend variable with year 1992 taking value of 1 and year 2007 taking value of 16.

v = component of error term of translog cost function

u = non-negative cost inefficiency component of error term of translog cost function.

Equation (6) is similar to Equation (3) in the CV approach with the exception of the time trend variable included in the model, which captures a non-monotonic pattern of the changes in cost technology.

We then estimate the dynamics of competition by using the following partial adjustment model:

$$\ln MK_{it} = \alpha \ln MK_{i(t-1)} + \gamma REF96 \ln MK_{i(t-1)} + \zeta REF02 \ln_{i(t-1)} + \eta \ln TA + \kappa FOR + \nu GOV + \lambda_T TD + \varepsilon_{it} \quad (7)$$

where

MK = marginal cost as estimated from the results of Equation (6).

LMK = lag of marginal cost.

REF96 = 1 for period between 1996 and 2001 and 0 otherwise.

REF02 = 1 for period from 2002 and 0 otherwise.

TA = total assets.

FOR = 1 for foreign bank and 0 otherwise.

GOV = 1 for government bank and 0 otherwise.

TD = time dummy vector including YR93 – YR07, where each indicator is for corresponding year in the period 1993 – 2007.

In Equation (7), α indicates the persistence of LMK into MK, i.e. the measure for persistence of overcharge. We introduce two financial reform stage indicators REF96 and REF02 in the model. Their parameters γ and ζ can indicate the change of persistence of profitability in different time periods. We also control firm-specific factors such as size (TA) and ownership status (FOR, GOV) in the model. Finally, we introduce the time dummy vector (TD) to consider the impact of exogenous external industry and macroeconomic conditions on the pricing behaviour of banks.

4.2.1.4 The Efficiency Measure of Data Envelopment Analysis

We first use a non-parametric approach, Data Envelopment Analysis (DEA), to measure the productive efficiency of banks. DEA is a mathematical programming approach to estimate the production function of organizations and/or decision units and enables the assessment of their efficiency relative to the developed frontiers.

Charnes, Cooper, and Rhodes (hereafter CCR) (1978), propose a DEA model that assigns an efficiency score to each unit by comparing the efficiency score of each unit with that of its peers. It basically identifies an efficiency frontier comprising best performers. Those units that lie on the frontier are recognized as efficient, and those that do not, as inefficient. DEA involves the solution of a linear programming problem to fit a non-stochastic, nonparametric production frontier based on the actual input–output observations in the sample. In the CCR model, the objective is to maximize the efficiency value of a test firm k from among a reference set of s firms, by selecting the optimal weights associated with the input and output measures. The maximum efficiencies are constrained to 1. The formulation is represented below

$$\text{maximize } E_{kk} = \frac{\sum_{y} O_{ky} V_{ky}}{\sum_{x} I_{kx} U_{kx}} \tag{7}$$

$$\text{subject to } E_{kk} \leq 1 \ \forall \ firm\ s$$

$$u_{ks}, v_{ky} \geq 0$$

where E_{ks} is the efficiency score of firm s, using the weights of test firm k; O_{sy} is the value of output y for firm s; I_{sx} is the value for input x of firm s; V_{ky} is the weight assigned to firm k for output y; and U_{kx} is the weight assigned to firm k for input x.

This non-linear programming is the equivalent to the linear programming problem represented as follows.

$$\text{maximize } E_{kk} = \sum_{y} O_{ky} V_{ky} \tag{8}$$

subject to $E_{kk} \leq 1 \ \forall \ firm\ s$

$$\sum_x I_{kx} U_{kx} = 1$$

$u_{ks}, v_{ky} \geq 0$

The transformation is completed by constraining the efficiency ratio denominator from (7) to a value of 1, represented by the constraint $\sum_x I_{kx} U_{kx} = 1$.

The result of formulation (8) is an optimal simple or technical efficiency value (E^*_{kk}) that is at most equal to 1. If E^*_{kk} = 1, then no other firm is more efficient than firm *k* for its selected weights. Put differently, E^*_{kk} = 1 means that firm *k* is on the optimal frontier and is not dominated by any other firm. If $E^*_{kk} < 1$, then firm *k* is away from on the optimal frontier and there is at least one other firm which is more efficient for the optimal set of weights determined by (8).

The objective of the CCR model can also be shown as follows:

minimize θ (9)

subject to :

$$\sum_x \lambda_s I_{sx} - \theta I_{kx} \leq 0 \ \forall \ inputs\ x$$

$$\sum_y \lambda_s O_{sx} - O_{kx} \leq 0 \ \forall \ outputs\ y$$

$$\lambda_s \geq 0 \ \forall \ firm\ s$$

where θ is the efficiency score.

One limitation of the CCR model is that it assumes constant returns to scale for the inputs and outputs. To account for variable returns to scale, Banker, Charnes, and Cooper (hereafter BCC) (1984), provide a model which aids in determining the scale efficiency of a set of units (which is a technically efficient unit for the variable return to scale

model). This model has an additional convexity constraint defined by limiting the summation of the multiplier weights equal to 1, or formally: $\sum_s \lambda_s = 1$.

The BCC model evaluates whether increasing, constant, or decreasing returns to scale would impact the observed efficiency. In the case of constant returns to scale, the output changes proportionally to input, as it also does in the CCR model. However, in the case of variable returns to scale, a change in the input leads to a disproportional change in the output.

Currently there is no consensus about inputs and outputs for the DEA approach. We consider three types of outputs which are frequently used in the extant empirical literature[1]: total loans, total other earning assets and non-interest income. For inputs, we use four variables, interest expense, non-interest expense, fixed assets and total loanable funds (the sum of deposits and other funds).

There is one issue with the DEA approach since the DEA frontier shifts over time. Its impact on the bank productivity should be considered in modelling. A possible way to address this issue is using DEA-type Malmquist index, which requires a relatively large sample size to perform a year-to-year analysis. Since out sample only contains 423 bank/year observations, it is not feasible for us to use this approach without losing the degree of freedom in estimation. Following Bhattacharyya et al. (1997), we use a 'grand DEA frontier' approach, which identifies a single grand frontier by using pooled input-output data of all bank/year observations[2]. In this way, there is a single benchmark over the pooled sample and productive efficiency scores derived contain information on the change in productivity over time.

[1] See Table 1 of Mostafa (2009) for a survey of inputs and outputs used in the extant bank efficiency studies employing the DEA approach.

[2] In unreported results, we test the sensitivity of DEA measure to time change. Specifically, we split sample data into different periods and estimate the DEA scores for each sub-sample separately. Then we use the new DEA scores in data analysis and find that the new results are qualitatively similar.

The extant empirical literature has shown that the application of the CCR and BCC models together helps determine the overall technical and scale efficiencies of the firm and whether the data exhibits varying returns to scale (e.g. see Sarkis, 2000). To control the impact of firm size on efficiency score, we scale the output variables and input quantity variables by total assets. Therefore, we use the BCC model to compute efficiency scores for sample firms.

There are two reasons for selecting the DEA for measuring the bank efficiency in this study. First, a most significant advantage of DEA is that it is applicable to small samples, which is particularly relevant to this study. Maudos, Pastor, and Perez (2002) argue that, "Of all the techniques for measuring efficiency, the one that requires the smallest number of observations is the non-parametric and deterministic DEA, as parametric techniques specify a large number of parameters, making it necessary to have available a large number of observations." (p.511). Second, the application of DEA does not require the specification of a particular functional form for the production frontier.

4.2.1.5 The Efficiency Measures of Parametric Approach

Existing studies have shown that productive efficiency can be measured in terms of cost efficiency and profit efficiency.

Cost efficiency measures the extent to which a bank's costs approximate those of the "best practice" or least cost banks. The measure is derived from a cost function where the dependent variable is each bank's total costs, and independent variables include the prices of inputs, the quantities of variable outputs, and a composite error term (Berger and Mester, 1997). A general version of this cost function for a bank can be specified as follows:

$$\ln C = f(p, q, z) + \ln e_c \qquad (10)$$

where

C = total costs.

p = input prices.

q = output quantities.

z = control variables.

$e_c = u_c + v_c$.

u_c = an inefficiency factor that may raise costs above the best practice level.

v_c = random error.

Therefore, the cost inefficiency of bank *i* can be derived as follows:

$$\cos t\ inefficiency = 1 - \frac{C^{\min}}{C^i} = 1 - \frac{e_c^{\min}}{e_c^i} \tag{11}$$

Profit efficiency measures the extent to which a bank's profits approximate those of the "best practice" or most profitable banks. It can be based on either a standard profit or an alternative profit function. The standard profit function aims to maximize profits at a given level of input and output prices. It assumes that the output prices are exogenous, implying that profit maximization is determined by the input inefficiencies. The standard profit function can be represented as follows:

$$\ln(\pi + \theta) = f(p, s, z) + \ln e_\pi \tag{12}$$

where

π = profit.

θ = a constant added to avoid negative profit before taking the natural logarithm form.

p = input quantities.

s = output prices.

z = control variables.

$e_\pi = u_\pi + v_\pi$.

u_π = an inefficiency factor that may reduce profits below the best practice level.

v_π = random error.

Therefore, the profit inefficiency of bank *i* can be derived as follows:

$$profit\ inefficiency = 1 - \frac{\pi^i}{\pi^{\max}} = 1 - \frac{e_\pi^i}{e_\pi^{\max}} \tag{13}$$

The alternative profit function is a hybrid of the cost and standard profit function, where the LHS of the function is the same as that of standard profit function and the RHS of the function is the same as that of cost function. Therefore, it can be represented as follows:

$$\ln(a\pi + \theta) = f(p, q, z) + \ln e_{a\pi} \tag{14}$$

Thus the alternative profit inefficiency is derived as follows:

$$alternative\ profit\ inefficiency = 1 - \frac{a\pi^{i}}{a\pi^{\max}} = 1 - \frac{e_{a\pi}^{i}}{e_{a\pi}^{\max}} \tag{15}$$

In this study, we consider cost efficiency and alternative profit efficiency since Berger and Mester (1997) argue that alternative profit efficiency is more robust than profit efficiency. For the cost efficiency, we specify the following translog multiproduct cost function:

$$\ln TC_{it} = \beta_0 + \sum_{m=1}^{3} \alpha_m \ln Y_{mit} + \sum_{n=1}^{2} \beta_n \ln W_{nit} + 1/2 \sum_{m=1}^{3} \sum_{j=1}^{3} \alpha_{mj} \ln Y_{mit} \ln Y_{jit} + 1/2 \sum_{n=1}^{2} \sum_{k=1}^{2} \beta_{nk} \ln W_{nit} \ln W_{kit} + 1/2 \sum_{n=1}^{2} \sum_{m=1}^{3} \gamma_{nm} \ln W_{nit} \ln Y_{mit} + v_{it} + u_{it} \tag{16}$$

where

TC = total cost.

Ym = three outputs including LOAN, OEAST, and TR.

LOAN = total loans.

OEAST = other earning assets.

TR = total revenue.

Wn = two input prices including PK and PF.

PF = interest expense / (deposits + other funds).

PK = non-interest expense / assets.

v = noise component of error term of translog cost function.

u = non-negative cost inefficiency component of error term of translog cost function.

e = v + u (error term).

Following the standard practice, linear homogeneity of input prices is obtained by dividing TC and PK by PF before taking the log.

Under the Stochastic Frontier Approach (SFA), bank-specific inefficiency measure u_{it} can be obtained by using the distribution of inefficiency tem conditional on the estimate of the entire composite error term, as proposed by Jondrow et al. (1982). The mean of this conditional distribution assuming half normal distribution is shown below[3]:

$$E(u \mid e) = \frac{\sigma}{1+\lambda^2}\left[\frac{\Phi(e\lambda/\sigma)}{1-\Psi(e\lambda/\sigma)} + \frac{e\lambda}{\sigma}\right] \quad (17)$$

where

u = non-negative cost inefficiency.

e = error term of translog cost function.

$\sigma = (\sigma_u^2 + \sigma_v^2)^{0.5}$.

σ_u = standard deviation of non-negative cost inefficiency component of error term.

σ_v = standard deviation of noise component of error term.

$\lambda = \sigma_u / \sigma_v$.

$\Phi(.)$ = the standard normal density function.

$\Omega(.)$ = the cumulative standard normal density function.

For the ease of comparison with DEA efficiency score, we then convert the cost inefficiency in Equation (17) to cost efficiency measure by taking 1/exp(u).

Another approach to derive cost efficiency is to avoid the strong distribution assumption of the stochastic cost frontier approach by introducing a distribution free approach. Specifically, the model is as follows:

$$\ln C_{it} = f(p_{it}, q_{it}, z_{it}) + \ln u_t + \ln v_t \quad (18)$$

[3] Extant empirical studies have used various assumptions about the distribution of error tem, including half normal, exponential and truncated normal. The empirical results of SFA approach with different distribution assumptions are broadly similar according to Berger and Humphrey (1997) and Berger and Mester (1997).

where the variables are defined similarly as those in equation (10). Only the systematic error term u_t remains fixed over time while the rest of coefficients and variables vary. For each bank and time period t, an average of the residuals for the sample period is estimated, denoted $\ln u_{it}$. This average is an estimate of $\ln u_t$, assuming that the random errors will cancel out over the sample period. The estimated average residual is then transformed into a measure of cost efficiency under DFA approach:

$$efficiency_{\cos t} = \exp(\min(\ln u_t) - \ln u_{it}) \quad (19)$$

where $\min(\ln u_t)$ is the minimum $\ln u_{it}$ for the period of estimation t.

We obtain profit efficiency measure under SFA and DFA approaches by using a similar procedure. The profit efficiency measure under SDA approach is simply taking exp(u) as given in Equation (17). The profit efficiency measure under DFA approach is as follows, with the same terminology as in Equation (18):

$$efficiency_{profit} = \exp(\ln u_{it} - \max(\ln u_{it})) \quad (20)$$

4.3 Second-step Analysis: Determinants of Competition and Efficiency

4.3.1 Determinants of Industry Competition

We examine the determinants of competition status with the following model:

$$competiton = f(market\ structure, \ln GDPC, REF96, REF02) \quad (21)$$

where

competition = degree of competition such as Theta and Lerner index.

Theta (θ) = industry average degree of competition with value of 1 for pure monopoly or perfectly collusive oligopoly and value of 0 for perfect competition.

Lerner(θ/η) = theta / industry demand elasticity.

market structure = proxies for structure of operating market such as CR4 and SHHI.

CR4 = annual average of total loan market share and total deposit market share for the four largest banks.

SHHI = sector concentration Herfindahl-Hirschman index based on individual banks' total assets.

GDPC = GDP per capita.
REF96 = 1 for period between 1996 and 2001 and 0 otherwise.
REF02 = 1 for period from 2002 and 0 otherwise.

The dependent variable is the industry average degree of competition (θ) or the Lerner index (θ/η), which are derived from the first-step analysis. The main focus of our model is on the impact of two stages of financial reforms on the industry competition. Using proxies for different stages of financial reform facilitates a better understanding of the competition implications of various reform policies. To control the impact of market structure, we use two alternative measures, CR4 and SHHI. The prediction of traditional Structure-Conduct-Performance (SCP) paradigm is that market concentration will restrict competition. However, a counter argument is that market concentration can arise from the increase in the market share of more efficient market participants (Demsetz, 1973). Therefore, the sign of market structure in the model is not clear. Finally, we use log of GDP per capita to take into account the change in economic fundamentals on the evolution of competition (Barnea and Kim, 2007).

4.3.2 Determinants of Productive Efficiency

We specify the following model to explore the main determinants of efficiency measures for Egyptian banks:

$$EFF = f(ROA, EQA, LIQ, RHHI, \ln TA, FOR, GOV, CR4, \ln GDPC, REF96, REF02) \quad (22)$$

where,

EFF = efficiency measure derived from the first-step analysis, including DEAEFF, SFAPROF, DFAPROF, SFACOST and DFACOST.
DEAEFF = productive efficiency measure with data envelopment analysis approach.
SFAPROF = profit efficiency measure with stochastic frontier approach
DFAPROF = profit efficiency measure with distribution free approach.
SFACOST = cost efficiency measure with stochastic frontier approach.
DFACOST = cost efficiency measure with distribution free approach.
ROA = net profit / total assets.

RSK = loan loss provision / total loans.

EQA = equity / total assets.

LIQ = liquid assets / total assets.

RHHI = revenue concentration Herfindahl-Hirschman index based on individual bank's interest income, fees and commissions and other operating income.

TA = total assets.

FOR = 1 for foreign bank and 0 otherwise.

GOV = 1 for government bank and 0 otherwise.

CR4 = annual average of total loan market shares and total deposit market shares for the largest 4 banks.

GDPC = GDP per capita.

REF96 = 1 for period between 1996 and 2001 and 0 otherwise.

REF02 = 1 for period from 2002 and 0 otherwise.

The predicted behaviour of the explanatory variables in the regression model can be explained as follows.

The bank profitability variable, ROA, is generally assumed to lead to an increase in bank efficiency. This is because, as reported by Berger (1995) and Goldberg and Rai (1996), there is a positive relationship between profitability and market structure measures, such that highly profitable banks tend to consolidate their position in the market, even at the expense of cost efficiency. However, profitable banks could afford talented human resources who could improve operational efficiencies. Therefore, the relationship between bank profitability and bank efficiency is indeterminate.

The variable RSK represents the bad loans hypothesis. It is argued that inefficiency mainly arises from bad loans, most often due to bad management of the bank. Hence, according to the bad loans hypothesis, bad loan problems are predicted to be negatively correlated with bank efficiency.

The explanatory variable EQA represents regulatory capital adequacy rules. As noted by Berger and Mester (1997), high capital ratios force banks to keep high capital and reserves at an opportunity cost, since such funds could be invested somewhere else to earn higher returns. Maintaining high mandatory capital ratios and reserves increases operation costs and reduces potential profits. Accordingly capital ratios should have a negative relationship with bank profit inefficiency. However, theoretically, there is an optimum level of capital ratio for each bank. When a bank's capital ratio reaches the optimum level, its efficiency will rise, mainly because well-capitalised banks may obtain external finance at lower costs than poorly capitalised banks. Thus, the impact of capital ratios on bank efficiency may be positive or negative.

The explanatory variable LIQ represents bank liquidity. When banks hold more liquid assets and have higher liquidity ratios, they forego some valuable investment options which could generate higher returns. Thus, it is expected that a bank's liquidity negatively influences its efficiency.

The variable RHHI measures the income diversification of banks using the Herfindahl index, which is computed by summing the squares of the segment revenue shares of each bank. The segment sales that we consider are interest income, fee income and other operating income. Goddard, McKillop and Wilson (2008) argue that the impact of income diversification on financial performance can be positive or negative. Thus, this relationship between income diversification and efficiency is indeterminate.

The variable lnTA measures the bank size. Although this variable is typically associated with scale and scope inefficiencies, Berger, Hunter, and Timme (1993) find that larger firms tend to be closer to the efficient frontier than smaller firms. Moreover, since bank efficiency is a proxy of management quality (DeYoung 1998), larger banks have the resources to attract higher calibre personnel, who may deliver superior performance by reducing inefficiencies. Hence, it is predicted that lnTA should be positively related to bank efficiency.

The variables FOR and GOV are used as proxies for the ownership status of banks. According to the agency theory, there are potential conflicts of interest between bank managers and other stakeholders. Directors and top managers of government owned banks are normally government appointees whose professional ethos are subordinated by political allegiance. Therefore, agency-related costs are expected to be higher in government controlled banks which make them less efficient. In the light of the foregoing, it is expected that GOV is inversely related to bank efficiency. Moreover, it may be argued that foreign bank ownership and foreign bank penetration may lead to better corporate governance, mitigate agency costs and enhance performance to reduce inefficiency. On the other hand, foreign banks have a disadvantage compared to domestic banks and since the former lack local knowledge, they face higher costs. Hence, the coefficient of FOR in the model would be either positive or negative.

Another explanatory variable in the model, lnGDPC, is included to capture the average income of bank customers, measured by natural logarithm of real GDP per capita. The variable represents general economic performance, or business cycle behaviour, and consequently the predicted impact on bank efficiency is not clearly defined (Kirkpatrick et al., 2008).

Finally, we consider the impact of financial sector reforms on the productive efficiency of Egyptian banks by using two indicators (REF96 and REF02) for different stages of reform. As argued earlier, different reform policies were implemented in different stages in Egypt, which could have varying influence on banks' efficiency.

4.4 Third-step Analysis: Finance Development and Economic Growth

Our final step in the analysis is to investigate the link between competitiveness and efficiency of the banking sector and economic growth. The measures of finance development include both competition proxies and efficiency scores derived in the first-step analysis.

As mentioned earlier, the endogenous growth literature also stresses the significance of financial development for long-run economic growth through the impact of financial sector services on capital accumulation and technological innovation. These services include mobilizing savings, acquiring information about investments and allocating resources, monitoring managers and exerting corporate control, and facilitating risk amelioration.

On the other hand, many economists contend that the role of financial sector is either overstated or that financial development follows expansion of the real economy (e.g. see Robinson, 1952; Kuznets, 1955). This would suggest that contrary to McKinnon-Shaw framework, the causality (if it exists) could run from economic growth to financial sector development.

We conduct the cointegration test in examining the link between finance development indicators and economic growth in Egypt, which can give a more reliable inference about the outcome of financial sector development. To explore this link, we use the cointegration technique. Granger (1988) argues that if two or more variables are cointegrated, they would share a common trend. As long as the relevant variables have a common trend, Granger causality must exist in at least one direction. Although cointegration indicates presence of Granger causality, it does not indicate the direction of causality between the variables, which can be detected using the vector error-correction model (VECM) which is derived from the vectors of cointegration.

To implement the cointegration approach in testing the link between financial sector development and economic growth, we consider the following vector-autoregression (VAR) model of order p:

$$Y_t = \mu + A_1 Y_{t-1} + \ldots A_{p-1} Y_{t-p} + \varepsilon_t \qquad (23)$$

where

Yt = 3×1 vector of $I(1)$ variables consisting of $Y1$ = GDP growth rate, $Y2$ = Finance Development indicator such as efficiency and competition measures, and $Y3$ = trade openness measured by the ratio of export to nominal GDP.

Assuming all variables are $I(1)$ in their levels, if these variables trend together towards a long-run equilibrium, then the VAR model in Equation (23) can be expressed as the following VECM with the Johansen (1988) cointegration techniques.

$$\begin{aligned}
\Delta Y_{1t} &= u_1 + \sum_{h=1}^{r} \alpha_{1,h} ECT_{h,t-1} + \sum_{k=1}^{p-1} \beta_{11,k} \Delta Y_{1,t-k} + \sum_{k=1}^{p-1} \beta_{12,k} \Delta Y_{2,t-k} + \sum_{k=1}^{p-1} \beta_{13,k} \Delta Y_{3,t-k} + \varepsilon_{1t} \\
\Delta Y_{2t} &= u_2 + \sum_{h=1}^{r} \alpha_{2,h} ECT_{h,t-1} + \sum_{k=1}^{p-1} \beta_{21,k} \Delta Y_{1,t-k} + \sum_{k=1}^{p-1} \beta_{22,k} \Delta Y_{2,t-k} + \sum_{k=1}^{p-1} \beta_{23,k} \Delta Y_{3,t-k} + \varepsilon_{2t} \\
\Delta Y_{3t} &= u_3 + \sum_{h=1}^{r} \alpha_{3,h} ECT_{h,t-1} + \sum_{k=1}^{p-1} \beta_{21,k} \Delta Y_{1,t-k} + \sum_{k=1}^{p-1} \beta_{32,k} \Delta Y_{2,t-k} + \sum_{k=1}^{p-1} \beta_{33,k} \Delta Y_{3,t-k} + \varepsilon_{3t}
\end{aligned} \tag{24}$$

where ECT$h,t-1$ is the hth error-correction term, the residuals from the hth cointegration equation, lagged one period, and $\beta ij,k$ describes the effect of the kth lagged value of variable j on the current value of variable i: $i,j = Y1, Y2, Y3$.

Moreover, the VECM approach can help distinguish between the two types of Granger causality: short- and long-run causality. In the above model (24), long-run Granger causality from variable Yi to variable Yj in the presence of cointegration is evaluated by testing the null hypothesis that $\alpha j,h = 0$ for h=1, . . ., r, whereas short-run Granger causality from variable Yi to variable Yj is evaluated by testing the null hypothesis that $\beta ij,1 = . . . \beta ij,P-1 = 0$, using the standard F test. By rejecting either one or both of the two null hypotheses, we would be able to conclude that variable Yi Granger-causes variable Yj. Finally we also analyse the causality between industry competition and productive efficiency using the same VECM framework. This will provide further insights to understand the interaction between competition and efficiency in the Egyptian banking sector.

5. Empirical Results

This section provides results of the empirical analysis. First, we measure two important indicators of financial sector development, industry competition and productive efficiency. For each indicator we compute five different empirical measures to gain a complete understanding of the developments in the Egyptian banking sector. Second, we explore the factors determining the variations in the industry competition and individual bank's productive efficiency, with a particular focus on studying the impact of financial reforms in Egypt. Finally, we examine the link between the determinants of financial sector development obtained in stage two and economic growth in Egypt using an endogenous growth model.

5.1 Results of First-step Analysis

5.1.1 Degree of Competition based on Panzar-Rosse model

We estimate the H-statistic, which is the sum of the elasticities of two input prices of a multi-product revenue equation following the methodology suggested in Kasekende et al. (2009). The results are reported in Table 5. The panel is estimated by a random effect model based on the Breusch and Pagan Lagrangian multiplier test result. The test supports the model choice, showing significant random effects with a p-value less than 0.0001. The overall fitness of model is high with the reported R-square of 0.887.

The H-statistic value is 0.583, which is comparable with the findings of prior studies on emerging markets. For example, Kasekende et al. (2009) calculate H-statistic for Egyptian banks on a yearly basis and their values of H-statistic vary from 0.554 to 0.701 for the period 1993 – 2007. Similarly, Claessens and Laeven (2004) report H-statistics of 0.58 for Kenya, 0.67 for Nigeria, and 0.85 for South Africa during the period 1994 – 2001. The Wald-tests for the full model indicate that our H-statistic is significantly different from zero with Chi-square of 207.930 (p-value < 0.0001) and it is also significantly different from one with Chi-square of 106.740 (p-value < 0.0001). Therefore, our results indicate monopolistic competition ($0 < H < 1$) in Egyptian banking sector for the sample period.

To see whether competitive behaviour of different types of banks differ, we estimate the H-statistic for disaggregated samples based on the ownership types i.e., government-owned banks, private banks, foreign banks, and domestic banks. The ownership classification is generally based on the identity of owners holding more than 50% shares[4]. Table 6 gives the breakdown of H-statistics for different types of banks. As seen from the table, government bank with H-statistic of 0.425 is generally less competitive than private bank with H-statistic of 0.547. This may be due to the fact that there are just four public sector banks and all of these are significant players and are able to use their monopolistic position. Not surprisingly, foreign banks with H-statistic of 0.487 are less competitive than domestic banks with H-statistic of 0.582. This may be because many foreign banks are relatively newcomers in the markets and they tend to face higher costs than domestic banks in building relationship with local businesses in generating income. In other words, it takes foreign banks a significant amount of time to acquire knowledge of local financial markets.

Given that the H-statistic is only valid when the market is in the long-run equilibrium, we need to inspect the long-run market equilibrium of Egyptian banking sector before drawing any firm conclusions from the reported H-statistics. We test the hypothesis of market equilibrium by estimating the E-statistic, which is the sum of the elasticities of two input prices of a multi-product profitability equation as used in Kasekende et al. (2009). The estimated results are reported in Table 7. The panel is again estimated by a random effect model based on the Breusch and Pagan Lagrangian multiplier test result. The overall fitness of model is continues to be high with R-square of 0.610. The E-statistic is -0.003 for the sample period. The Wald test of E-statistic cannot reject the null hypothesis that the E-statistic equals zero (p-value of 0.266). Therefore, we conclude that the banking sector in Egypt is in a long-run equilibrium and thus our earlier conclusions based on H-statistic remain unchanged

[4] Where there is no ultimate owner holding more than 50% shares, we classify the bank as private bank along the government-private dimension and as domestic bank along the foreign-domestic dimension.

5.1.2 Degree of Competition based on Conjectural Variation Approach

The P-R model assumes that market participants are price-takers in the input market and the market is in the long-run equilibrium, thus creating problems in the economic interpretation of the H-statistic (Kasekende et al., 2009). To address this issue, we estimate the average degree of competition in the banking industry following the conjectural variation approach (Uchida and Tsutsui, 2005; Brissimis et al. 2008), which explores multiple factors associated with the variation of the estimated competitive conduct (Shaffer, 2004). Specifically, we jointly estimate a system of three equations corresponding to a translog cost function, a revenue function, and an inverse loan demand function. The estimated results are presented in Table 8. In general, the models are well fitted as adjusted R-square ranges from 0.707 (for inverse loan demand function equation) to 0.985 (for revenue function equation). The coefficients of independent variables are generally highly significant. In addition, the parameters of b1 (for loans) and b3 (for funds) are both positive, indicating that the estimated cost function meets the non-negative marginal cost regularity condition.

Despite its statistical insignificance, the negative value of p_1 (for GDP growth rate) indicates that the economic growth leads banks to charge lower interest rate. This may be due to the increased competition in financial services following the removal of interest rate ceiling and lending limits in Egypt in 1992 and 1993. The statistically significant and positive size-price relationship shown by P_2 may be attributed to the fact that large banks have better service network than small banks and could charge higher implicit interest rate. The significant negative value of P_3 indicates that well-capitalized banks may have cushion for potential losses and are thus less risk averse in their lending practices.

Table 9 shows the time series of three competition indicators derived from the conjectural variation approach. The values of θ gradually declines from 0.581 in 1992 to 0.418 in 1998 and then increases to 0.677 in 2007. Our results are comparable to other studies on Egypt. For example, Kasekende et al. (2009) document a V pattern of θ values for their Egyptian bank sample with a slightly different value range. The time series pattern is also depicted in Figure 2 along with the 95% confidence interval of θ. As seen from the

figure, over the whole sample period, the 95% upper bound of θ never exceeds the value of 1 and the 95% lower bound of θ is always above 0. Therefore, it can be concluded that the Egyptian banking sector seems to be characterized by a super competition situation. The Lerner index shows a similar V pattern over time. This is because the average industry demand elasticity in Egypt has been very stable around 1.15 over the sample period.

The evidence on theta suggests that the competition in Egyptian banking sector initially improved between 1992 and 1996 as we see a downward trend of theta value in the period. The competition status remains stable between 1996 and 2002. However, there is an upward trend since 2002 which reverse after 2005.

The changes in the competition in Egyptian banking sector can be interpreted in the context of financial reforms in Egypt. The period of 1992-1996 was the first stage of financial reforms implemented in Egypt, witnessing the elimination of interesting rate ceiling in 1992 and lending limits in 1993. Those policy changes seem to have significant and positive impact on the banking sector competition. In the second stage of reforms (1996-2002), Egyptian government continued the financial liberalization by privatizing government's stake in commercial banks and by easing industry regulations. In this period, the bank competition seems to respond well in the first three years but then it seems to have stabilized. Notably, the magnitude of impact of policies pursued during 1996-2002 on the competitive behaviour in the banking sector seems to be less than those in the first stage of financial reform. The post-2002 period in our sample period is the third stage of financial reform, involving enhancement of monitoring mechanisms and comprehensive restructuring of financial sector. In particular, Egyptian banks were required to raise their capital adequacy ratio to meet Basel II standards in 2003. Also, because of this the number of total banks reduced and the remaining banks may have had to increase capital requirement in a short time which could have caused significant disruptions in bank's normal business. Hence, some banks may have temporarily scaled back their business activities to meet the new capital adequacy requirements. After the initial transition period the banking sector seems to have benefited from lower

bankruptcy risk due to higher capital reserves and more efficient use of resources. This could explain the decrease of industry competition between 2003 and 2005 and the subsequent improvement in the competitive behaviour. The Lerner index has a similar pattern as theta and hence our inferences remain unchanged.

5.1.3 Degree of Competition based on Persistence of Profitability Model

Another approach to investigate the status of industry competition is to examine whether abnormal profit persists. To test this issue, we conduct empirical analysis on the bank competition with the Persistence of Profitability (POP) model, which directly examines the extent of persistent profitability over time.

The POP model estimation includes two steps. In the first step, we measure the marginal cost by estimating a translog cost function, whose results are reported in Table 10. As seen from the table, the cost elasticity of loans (0.418) is similar to that of other earning assets (0.417) and both are much larger than that of total income (0.228). The coefficient of T, our proxy for technology change, has a negative sign which is significant at the 1% level. However, the coefficient of T*T is positive and also highly significant. The results suggest reduction in the costs in Egyptian banking sector over time in the whole sample period but at a reduced speed.

In the second step, we estimate the dynamics of competition in the Egyptian banking sector with a partial adjustment model. The estimation results are shown in Table 11. The coefficient for the one period lag of the overcharge on loans (lnLMK) for the period 1992 – 2007 is α (0.810). As we have two time dummies for different stages of financial reforms, the coefficient of lag overcharge will be adjusted for coefficients of time dummies. For the second stage of financial reform (1996 – 2002), the coefficient is $\alpha+\gamma$ (0.834). For the third stage of financial reform (2003 – 2007), the coefficient is $\alpha+\zeta$ (0.832). However, the coefficients for two financial reform stage indicators are not statistically significant. We conclude that the persistent overcharge parameter of Egyptian banks is around 0.810 over the sample period. This number is quite high compared with

those obtained in other studies. For instance, Goddard et al. (2004) report a persistence of profitability parameter of 0.439 for banks in six largest European countries. This difference in the POP measure may not be surprising since the banking sector in developed countries is more competitive than in developing countries like Egypt.

The size impact on persistence of profitability is significant and positive since the parameter of lnTA is 0.040 and significant at the 1% level. This confirms that large banks in Egypt are able to extract higher abnormal profits than small banks. Our results also show that foreign banks have lower abnormal profit than domestic banks while government banks have higher abnormal profit than private banks. However, the parameters of those ownership type indicators are not statistically significant.

5.1.4 Productive Efficiency from Parametric and Non-parametric Approaches

We use both parametric and non-parametric approaches to compute productive efficiency for Egyptian banks. The descriptive statistics of different efficiency measures are presented in Panel A of Table 12. The results show that the mean value of various efficiency measures is around 0.70, with the highest from the DEA approach (0.779) and the lowest from the profit efficiency of SFA approach (0.672). Alternatively speaking, the average x-inefficiency is about 30%. The average inefficiency score is in the range of results reported in earlier studies. Berger et al. (1993) reviewed the US findings on bank x-inefficiency and found that the average x-inefficiency is about 20-25% based on studies using the efficient frontier. Altunbas et al., (2001) documented similar results for European banks. Kirkpatrick, Murinde and Tefula (2008) examined the bank efficiency for 89 commercial banks in Sub-Saharan Africa and documented that the average of x-inefficiency scores varies from 19.29 to 33.65 for different measures.

Panel B of Table 12 shows the correlation statistics of five different profit and cost efficiency measures. The efficiency measure from DEA approach is positively correlated with other efficiency measures. However, the correlation between profit and cost efficiency from stochastic frontier (distribution free) approach is negative. Since cost

efficiency and profit efficiency measures focus on different aspects of banking efficiency (e.g. see Berger et al., 1993), such difference is not unexpected.

Figure 6 presents how average bank efficiency scores from different approaches have behaved over time. The patterns of different efficiency measures are very distinct. DEAEFF efficiency score shows a V patter over time. It starts at 0.828 in 1992, then drops down to 0.703 in 2000, and gradually goes up to 0.800 in 2007. In contrast, the average scores of cost efficiency (SFACOST and DFACOST) are generally stable around 0.760 over the whole sample period. Finally, the average scores of profit efficiency (SFAPROF and DFAPROF) move around 0.75 in the most of sample period and abruptly drop down below 0.60 after 2005.

The conflicting messages from the pattern as seen in Figure 6 may reflect the comprehensiveness of financial reform in Egyptian banking sector. For instance, we can see that all efficiency measures except for DFACOST showed an upward trend from 1992 to 1997, indicating that bank efficiency in Egyptian banking sector improved in the first stage financial reforms. The trends diverged after 1997 as financial reforms became more intensive. As seen from the information given in Table 1 many commercial banks went through privatization, restructuring, mergers and acquisitions under the guidance of Egyptian government. Although banking sector may have generally benefited from reforms in the long term, those banks involved could have faced significant disruptions in business activities during the restructuring process as well high re-organisation costs. This may explain why our profit efficiency measures have a noticeable downward trend following 1999. Since we use net profit as the dependent variable of multiproduct function to estimate profit efficiency, all restructuring charges are possibly included in calculating net profit figures and thus may have affected our estimates of profit efficiency significantly.

We further examine whether efficiency measures differ across different types of banks since this has interesting regulatory implications. Results reported in Table 13 Panel A, show a comparison of the efficiency measures between government and private banks. In

general, private banks are more profit efficient than government banks. The difference in SFAPROF (or DFAPROF) between private and government banks is highly significant with both parametric and non-parametric difference in mean tests. Private banks are more efficient than government banks in terms of DEAEFF but the difference is not statistically significantly. In contrast, government banks are marginally more cost efficient than private banks despite, however the difference in cost efficiency is not statistically significant. In Panel B, we compare the efficiency measures between domestic and foreign banks. Although the differences in profit, cost and efficiency measures are no statistically significant, domestic banks are marginally more efficient than foreign banks. This is consistent with our earlier argument that for many foreign banks, Egypt is a new market and hence they have to incur higher business development costs which may have adverse effect on their efficiency relative to competing domestic banks.

5.2 Results of Second-step Analysis

In the second stage of analysis, we examine the determinants of industry competition and productive efficiency of the Egyptian banking sector.

5.2.1 Determinants of Industry Competition

Test results related to the determinants of competition status in banking sector are reported in Table 14. The results confirm that financial reform policies in Egypt have had a positive impact on competition behaviour in the banking sector. The coefficient of REF96 is -0.202 and significant at the 1% level. The coefficient of REF02 is -0.052 but it is not statistically significant. Since Theta is inverse of industry competition, the negative coefficients of the two reform indicators confirm that financial reforms have improved competition. The coefficient of CR4, the market share occupied by the largest four banks, is negative but statistically insignificant. This is contradictory to the traditional Structure-Conduct-Performance (SCP) prediction that increased market concentration facilitates the degree of collusion in the market. There is a steady decline in the market share of the largest four banks as a result of privatization over the whole sample period and hence the coefficient may been influenced by these developments. When we use industry concentration ratio (Herfindahl-Herschman index) in the regression, the coefficient for

SHHI is positive and consistent with the SCP prediction. Finally, we find no evidence that the improvements in the economic environment have had any influence on the competition status since the coefficient of lnGDPR is statistically insignificant.

5.2.2 Determinants of Productive Efficiency

Next we estimate the determinants of productive efficiency in Egyptian banking sector. First, we check the correlations amongst main explanatory variables in the regression. Table 15 shows the correlation matrix of explanatory variables. We can see that some variables are highly correlated. For example, the correlation between GOV and LnTA is 0.397. This is not surprising as government banks are the largest players in the Egyptian banking sector in our sample period. However, most other variables are not highly correlated. We also check for multicollinearity by VIF test statistic (not reported but available on request) and find that multicollinearity is not a significant concern for our model.

Table 16 reports the regression results for different productive efficiency score measures. We only report results for DEAEFF, SFAPROF and DFAPROF to save the space. The results for SFACOST and DFACOST are broadly similar to DEAEFF with generally lower significance.

As can be seen from the table, fundamental-based explanatory variables sometimes have different signs in regression results across different efficiency measures. This can be explained by the fact that different efficiency measures focus on different input and output variables in their estimation process. We turn our focus to the coefficients for bank ownership and financial reform stage indicators. Foreign banks generally are more inefficient than domestic banks since the coefficient of FOR is consistently negative across regression models although it is only significant at the 10% level in case of SFAPROF. Private banks are more efficient in terms of profitability than government banks since the coefficients for GOV are negative and significant in SFAPROF and DFPROF. In contrast, the coefficient for GOV in the model for DEAEFF is 0.048 and significant at the 5% level. Since our DEAEFF is estimated with minimum input

approach and government banks are generally more cost efficient than private banks (as shown in Table 12), this finding is not surprising. Finally, we document significant and positive coefficients for financial reform indicators across three models. This evidence suggests that the financial reforms in Egypt seem to have a significant and positive impact on the efficiency of the banking sector.

5.3 Results of Third-step Analysis

In the third and final stage of our analysis, we examine the relationship between industry competition, productive efficiency and economic growth with an endogenous growth approach. We first conduct Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests at both level and first difference for all variables in the model in order to analyze the time-series properties of the data. Results of the unit root tests are presented in Table 17. As seen from the table, all variables in the endogenous growth model are found to be I(1).

We then specify the relevant order of lag p =2 of the VAR model to conduct cointegration tests. The results are shown in Table 18. At 5 percent significance level, the trace test indicates 1 cointegration equation for the productive efficiency measures but 2 cointegration equations for the industry competition measures.

The outcome of this test makes it possible to conduct Granger Causality test and the Error Correction Model tests using the Johansen method. The results of causality tests Table 19 suggest that there is a significant relationship between productive efficiency and economic growth in the short run as the null hypotheses in both Panel A and Panel B are rejected at the 10% level. Similarly, the results in Panels C and D confirm a significant relationship between industry competition and economic growth in the short run. However, test results for long-run causality are insignificant and in some cases bear unexpected signs. We believe that this may be due to the lack of availability of Egyptian data for longer time period since cointegration results can be very sensitive to the presence of outliers. However, the absence of a long term relationship is not entirely surprising since in a comprehensive study of 50 countries, Claessens and Laeven (2004) show that their competitiveness measure is negatively associated with countries' growth

and that the effects of banking system competitiveness on growth vary with the level of countries' financial sector development.

Finally, we examine the causality between industry competition and productive efficiency with the vector error correction model framework. We also conduct cointegration tests for the vector of competition and efficiency measure pairs with the relevant order of lag p = 2. The test results are presented in Table 20. As we can see from the table, there are three combinations which have 1 cointegration equation, including (DEAEFF, Theta), (SFACOST, Theta), (DFACOST, Theta), (SFACOST, Lerner) and (DFACOST, Lerner). We did change the lag order and considered more cointegration equations for the other combinations. However, we did not find significant cointegration results for other combinations.

We then conduct causality tests for the three vectors such as (DEAEFF, Theta), (DFACOST, Theta), and (DFACOST, Lerner). Test results are shown in Table 21. In general, there is a significant causal relationship between efficiency and competition in the short run since all the relevant test statistics are significant at the 10% level. For the long-run causal relationship, we observe a significant causal relationship only for DFACOST and industry competition measures. It seems that the cost efficiency measure is positively affecting industry competition measures at the 5% significance level. This finding is consistent with the conventional view that the efficiency improvements enhance industry competition. In contrast, the industry competition measures are negatively affecting the cost efficiency measure in the long run. This may be attributed to the fact that the cost efficiency for established banks can reduce over time in our sample period since their operational scale declines with the arrival of more competitors due to first two stages of financial sector reforms.

6. Conclusions

The role of a competitive and efficient financial sector has been well investigated for many developed countries. However, research on African countries is relatively sparse. Further, as suggested by Kasekende et al (2009), the issue of competition in the financial

services sector in African context has many important implications for improvements in productive efficiency, financial stability, and effective regulation and supervision. Egypt is identified as one of the highly reforming economies and hence a thorough research using Egyptian banking sector data is likely to offer useful policy lessons and implications for stimulating productivity and growth via improved financial service sector efficiency. This is critical since policy makers need to be informed on the outcomes and values of the reforms particularly in the wake of current global financial crisis.

Further, the review of existing literature suggests that there are relatively very few studies that have conducted a systematic examination of the interaction between financial reforms, competition, efficiency and economic growth. This paper fulfils this gap in the existing literature by providing empirical evidence on the banking sector in Egypt. The paper investigates whether a series of financial reforms introduced in Egypt have had any significant impact on improving financial sector's competitiveness and efficiency. Further, the paper aimed to demonstrate whether increased banking sector competitiveness and efficiency have had any short and/or long term relationship with Egypt's economic growth over the period 1992-2007.

The paper uses a number of well established theoretical paradigms and advanced econometric approaches in analyzing Egyptian banking sector data. The analysis is conducted in three stages. First, industry competition and productive efficiency of Egyptian banking sector is analysed with different empirical measures, which provide a complete picture of financial sector developments in Egypt. Second, the determinants of competition and production efficiency of Egyptian banking sector are estimated with a particular focus on the impact of financial reform. Finally, the link between competitive conduct, productive efficiency and economic growth is estimated with an endogenous growth model approach.

The findings suggest that the degree of competition in Egypt's banking sector as measured by H-statistic of Panzar-Rosse model is comparable with those reported by

previous studies on African markets including Egypt. The chi-square test results confirm a monopolistic competition in Egyptian banking sector. Further tests on different types of banks suggest that government banks are generally less competitive than private banks and foreign banks are less competitive than domestic banks. Competition indicators from the conjectural variation approach show temporal variations in the level of competition. The evidence on theta suggests that the competition in Egyptian banking sector initially improved between 1992 and 1996 but declined during 1996-2002, before increasing once again from 2002 onwards. The competition measures based on the POP model suggest reduction in the costs in Egyptian banking sector over time and there is evidence of persistent overcharge by Egyptian banks which is higher when compared with banks in developed countries. The difference is not surprising since the banking sector in developed countries is more competitive than in developing countries like Egypt. Further analysis reveals that foreign banks return lower abnormal profits than domestic banks while government banks show higher abnormal profits than private banks. However, the differences in abnormal profits are not statistically significant. Overall, the results using different methodologies for measuring competitiveness suggests that there is evidence that the Egyptian banking sector has become more competitive overtime.

For measuring productive efficiency, the paper uses both parametric and non-parametric approaches. The findings indicate that the average x-inefficiency of Egyptian banks is around 30% which is similar to those reported for other African countries. However, somewhat conflicting results for cost and profitability measures are found. This can be attributed to the comprehensiveness of financial reform in Egyptian banking sector since reforms introduced in different time periods may have had mixed effects due to restructuring and reorganisation costs. Further examination of efficiency measures across different types of banks is conducted since this has interesting regulatory policy implications. Results suggest that generally, private banks are more profit efficient than government banks. In contrast, government banks are marginally more cost efficient than private banks. However, the differences in profit, cost and efficiency measures are no statistically significant, domestic banks are marginally more efficient than foreign banks.

The evidence with regard to determinants of competition confirm that financial reform policies in Egypt have had a positive impact on competition in the banking sector. There is a steady decline in the market share of the largest four banks as a result of privatization over the whole sample period. The analysis of determinants of production efficiency reveals that domestic banks are generally more efficient than foreign banks and private banks are more efficient in terms of profitability than government banks. The evidence of significant and positive coefficients for financial reform indicators across three models, suggests that the financial reforms in Egypt seem to have a significant and positive impact on production efficiency of banking sector.

Finally, the relationship between industry competition, productive efficiency and economic growth is examined by employing an endogenous growth model. Findings suggest that there is significant relationship between productive efficiency and economic growth in the short run. However, consistent with some previous studies, no evidence of long-run relationship between increased efficiency and economic growth is found. However, there is significant causal relationship between efficiency and competition in the short run and it seems that the cost efficiency measure is positively affecting industry competition. This finding is consistent with the conventional view that the efficiency improvement enhances industry competition. In contrast, the industry competition measures are negatively affecting the cost efficiency measure in the long run. This may be because the cost efficiency for established banks in our sample seems to have declined over time due to reduced operational scale caused by the arrival of more competitors as a result of financial reforms.

Policy Implications

The results presented in this paper have several important policy implications. First and foremost, the evidence confirms that financial sector reforms have had a positive and significant impact on production competitiveness and efficiency of the Egyptian banking sector. Second, the findings strengthen the arguments for improving competitiveness and production efficiency of the financial sector since there is clear evidence that this leads to improved economic growth at least in the short run. Finally, the impact of reform

process cannot be immediate since restructuring and reorganisation of large state owned banks have implicit costs. The efficiency gains are therefore likely to be realised over longer time period. Nevertheless, findings presented in this paper suggest that the Egyptian policy makers should continue with their reforms programme with renewed vigour.

Bibliogrpahy

Allen, F. and D. Gale, 2000, Comparing Financial Systems, MIT press, Boston, MA.

Altunbas, Y., Gardener, E.P.M., Molyneux, P., and Moore, B., 2001. Efficiency in European Banking. European Economic Review 45: 1931-1955.

Angelini, P. and Cetorelli, N., 2003. The effects of regulatory reform on competition in the banking industry. Journal of Money, Credit and Banking 35: 663-684.

Bagehot, W., 1873. Lombard Street: A Description of the Money Market. London: H. S. King.

Banker, R. Charnes, A. and Cooper, W., 1984. Some models for estimating technical and scale inefficiencies in data envelopment analysis. Management Science 30: 1078-1092.

Barnea, E., Kim, M., 2007. Interest rate margins: A decomposition of dynamic oligopolistic conduct and market fundamentals. Applied Financial Economics 17: 487-499.

Barth, J., Caprio G. and Levine, R., 2003. Bank supervision and regulation: What works best? Journal of Financial Intermediation 13, 2:205-248.

Beck, Thorsten, Asli Demirgüç-Kunt and Ross Levine, 2002. Bank Concentration and Crises. mimeo, World Bank and University of Minnesota

Beck, T. and Levine, R., 2004. Stock markets, banks, and growth: Panel evidence. Journal of Banking and Finance 28: 423-442.

Belaisch, A, 2003. Do Brazilian Banks Compete? International Monetary Fund.

Bencivenga, V.R. and Smith, B.D., 1991. Financial intermediation and endogenous growth. Review of Economic Studies 58: 195-209.

Berger, A.N. 1995. The profit-structure relationship in banking: Tests of market power and efficient structure hypotheses. Journal of Money, Credit and Banking 27: 404–31

Berger, A.N., and Humphrey, B.C., 1997. Efficiency in financial institutions: International survey and directions for future research. European Journal of Operational Research 98: 175–212.

Berger, A.N., Hunter, W.C., and Timme, S.G., 1993. Efficiency in financial institutions: A review and preview of research, past, present and the future. Journal of Banking and Finance 17: 221–49.

Berger, A.N., and Mester, L.J., 1997. Inside the black box: What explains differences in the efficiencies of financial institutions? Journal of Banking and Finance 21: 895–947.

Besanko, D., and Thakor, A., 1992, Banking deregulation: Allocational consequences of relaxing entry barriers. Journal of Banking and Finance 16, 909-932.

Bhattacharyya, A., Lovell, C.A.K., and Sahay, P., 1997. The impact of liberalization on the productive efficiency of Indian commercial banks. European Journal of Operational Research 98: 332-345.

Bresnahan, T., 1989. Studies of Industries with Market Power. In: Richard Schmalensee and Robert D. Willig (eds.), Handbook of Industrial Organization, Volume *II* (North Holland, New York).

Brissimis, S.N., Delis, M.D. and Papanikolaou, N.I., 2008.Exploring the nexus between banking sector reform and performance: Evidence from newly acceded EU countries. Journal of Banking & Finance 32: 2674-2683.

Casu, B., Girardone, C., and Molyneux, P., 2004. Productivity change in European banking: A comparison of parametric and non-parametric approaches. Journal of Banking and Finance 28: 2521-2540.

Carbo, S., Humphrey, D., Maudos, J. and Molyneux, P., 2009. Cross-country comparisons of competition and pricing power in European banking. Journal of International Money and Finance 28:115–134.

Cairo and Alexandra Stock Exchange, Annual Report, 2008.

Central Bank of Egypt, Annual Report, 2008

Charnes, A. Coopers, W. and Rhodes, E. 1978. Measuring the efficiency of decision-making units. European Journal of Operational Research 2: 429-444.

Chen, T.Y., 2001. An estimation of X-inefficiency in Taiwan's banks. Applied Financial Economics 11: 237-242.

Claessens, S., Asli Demirgüç-Kunt and H. Huizinga., 2001. How Does Foreign Entry Affect Domestic Banking Markets? Journal of Banking and Finance 25, 891–911.

Claessens, S. and Laeven, L., 2003. Financial Development, property rights and growth. Journal of Finance, 58: 2401-2436.

Claessens, S. and Laeven, L., 2004. What drives bank competition? Some international evidence. Journal of Money, Credit and Banking 36: 563-584.

Demsetz, J., 1973. Industry structure, market rivalry and public policy. Journal of Law and Economics 16: 1-9.

Demirguc-Kunt, Asli, Laeven L., and R. Levine, R., 2003. The Impact of Bank Regulations, Concentration, and Institutions on Bank Margin, World Bank Policy Research Working Paper No. 3030. http://ssrn.com/abstract=636392

DeYoung, R. 1998. Management quality and x-inefficiency in national banks. Journal of Financial Services Research 13: 5–22.

Eschenbach, F., and Francois, J., 2002. Financial Sector Competition Services Trade and Growth. CEPR Discussion Paper No. 3573 (October).

Feldman, R., Wagner, N., 2002. The financial sector in Central Europe: Interlinkages with macroeconomic policy and performance on the road to the EU, paper presented at the 2002 EIB Conference on economics & finance, January 17, 2002, Luxemburg.

Goddard, J., McKillop, D., and Wilson, J.O.S., 2008. The diversification and financial performance of US credit unions. Journal of Banking and Finance 32: 1836-1849.

Gelos, G. and Roldos, J., 2002. Consolidation and Market Structure in Emerging Market Banking Systems. IMF Working Paper No. 02/186, November.

Glode, P., 2005. Measuring competition in the banking industry, http;//www.mi.uni-erlangen.de/~snpagloe/competition-paper.pdf

Goddard, J., Molyneux, P., and Wilson, O.S., 2004. The profitability of European banks: a cross-sectional and dynamic panel analysis. The Manchester School 72: 363-381.

Goldberg, L.G., and A. Rai., 1996. The structure – performance relationship for European banking. Journal of Banking and Finance 20: 745–71.

Granger, C.W.J., 1988. Some recent developments in a concept of causality. Journal of Econometrics 39: 199-211.

Hao, J., Hunter, W.C., and Yang, W.K., 2001. Deregulation and efficiency: The case of private Korean banks. Journal of Economics and Business 53: 237-254.

Hardy, D.C., and Patti, E.B., 2001. Bank reform and bank efficiency in Pakistan. IMF Working Paper, WP/01/138.

Hasan, I. Koetter, M., and Wedow, M., 2009. Regional growth and finance in Europe: Is there a quality effect of bank efficiency? Journal of Banking and Finance 33: 1446-1453.

Hasan, I. and Marton, K., 2003. Development and efficiency of the banking sector in a transitional economy: Hungarian experience. Journal of Banking and Finance 27: 2249-2271.

Isik, I. and Hassan, M.K., 2002. Technical, scale and allocative efficiencies of Turkish banking industry. Journal of Banking and Finance 26: 719-766.

Johansen, S., 1988. Statistical analysis of cointegration vectors. Journal of Economic Dynamics and Control 12: 231-254.

Jondrow, J., Lovell, C.A.K., Materov, I.S., and Schmidt, P., 1982. On estimation of technical inefficiency in the stochastic frontier production function model. Journal of Econometrics 19: 233-238.

Kasekende, L., Mlambo, K., Murinde, V. and Zhao, T., 2009. Restructuring for competitiveness: The financial services sector in Africa's largest economies. In World Economic Reform (ed.), Africa Competitiveness Report 209, Washington DC. The World Bank (Chapter 3: 49-81).

Kirkpatrick, C. Murinde, V. and Tefula, M., 2008. The measurement and determinants of x-inefficiency in commercial banks in Sub-Saharan Africa. The European Journal of Finance 14: 625-639.

King, R.G. and Levine, R., 1993. Finance and growth: Schumpeter might be right. Quarterly Journal of Economics 108: 717-737.

Kuznets, S. 1955. Economic growth and income inequality. American Economic Review 45: 1-28.

Levine, R., 1997. Financial development and economic growth: Views and agenda. Journal of Economic Literature 35: 688-726.

Levine, R., 1998. The legal environment, banks, and long-run economic growth. Journal of Money, Credit, and Banking 30: 596-613.

Levine, R., Loayza, N., and Beck, T., 2000. Financial intermediation and growth: Causality and causes. Journal of Monetary Economics 46: 31-77.

Levine, R. and Zervos, S., 1998. Capital control liberalization and stock market development. World Development 26: 1169-1183.

McKinnon, R.I., 1973. Money and capital in economic development. Washington D.C.: Brookings Institution.

Matthews, K., Murinde, V. and Zhao, T., 2007. Competitive conditions among the major British banks. Journal of Banking and Finance 31: 2025-2042.

McKinnon, R.I., 1973. Money and capital in economic development. Washington D.C.: Brookings Institution.

Maudos, J. Ray, S.C. and Miller, S.M., 2001. Productivity growth in large US commercial banks: The initial post-deregulation experience. Journal of Banking and Finance 25: 913-939.

Maudos, J., Pastor, J.M., and Perez, F., 2002. Competition and efficiency in the Spanish banking sector: The importance of specialization. Applied Financial Economics 12: 505-516.

Mostafa, M.M., 2009. Modelling the efficiency of top Arab banks: A DEA-neural network approach. Expert Systems with Applications 36: 309-320.

Noland, M., 1996. The North Korean economy. Joint US–Korea Academic Studies 6: 127–178.

Pagano, M., 1993. Financial markets and growth: An overview. European Economic Review 37: 613-622.

Panzar, J. and Rosse, J., 1987. Testing for monopoly equilibrium. Journal of Industrial Economics 35: 443-456.

Philippatos, G. and Semith Yildirim, H., 2002. Competition and contestability in Central and Eastern European banking markets. Mimeo University Tennessee (February).

Rajan, R., 1992. "Insider and Outsiders, the Choice between Informed and Arm's-Length Debt," *Journal of Finance* 47:1367-1400.

Robinson, J., 1952. The rate of interests and other essays. London: MacMillan.

Romero-Avila, D., 2007. Finance and growth in the EU: New evidence from the harmonisation of the banking industry. Journal of Banking and Finance 31: 1937-1957.

Sarkis, J., 2000. An analysis of the operational efficiency of major airports in Istanbul Stock Exchange using Malmquist DEA. Journal of American Academy of Business 8: 145-155.

Schumpeter, J.A. (1912), Theorie der wirtschaftlichen Entwicklung, 2d ed., München und Leipzig: Duncker & Humblot, 1926. Engl.ed. The theory of economic development, New York: Oxford University Press, 1934.

Shaffer, S., 2004. Comment on “What drives bank competition? Some international evidence” by Stijin Claessens and Luc Laeven. Journal of Money, Credit and Banking 36: 585-592.

Shaw, E.S., 1973. Financial deepening in economic development. New York: Oxford University Press.

Uchida, H. and Tsutsui, Y., 2005. Has competition in the Japanese banking sector improved? Journal of Banking and Finance 29: 419-439.

Zhao, T., Casu, B., and Ferrari, A., 2008. The impact of regulatory reforms on cost structure, ownership and competition in Indian banking. Unpublished working paper, City University, London.

Figure 1 Banking sector loans and deposits
Data are of June ends. Source: Central Bank of Egypt.

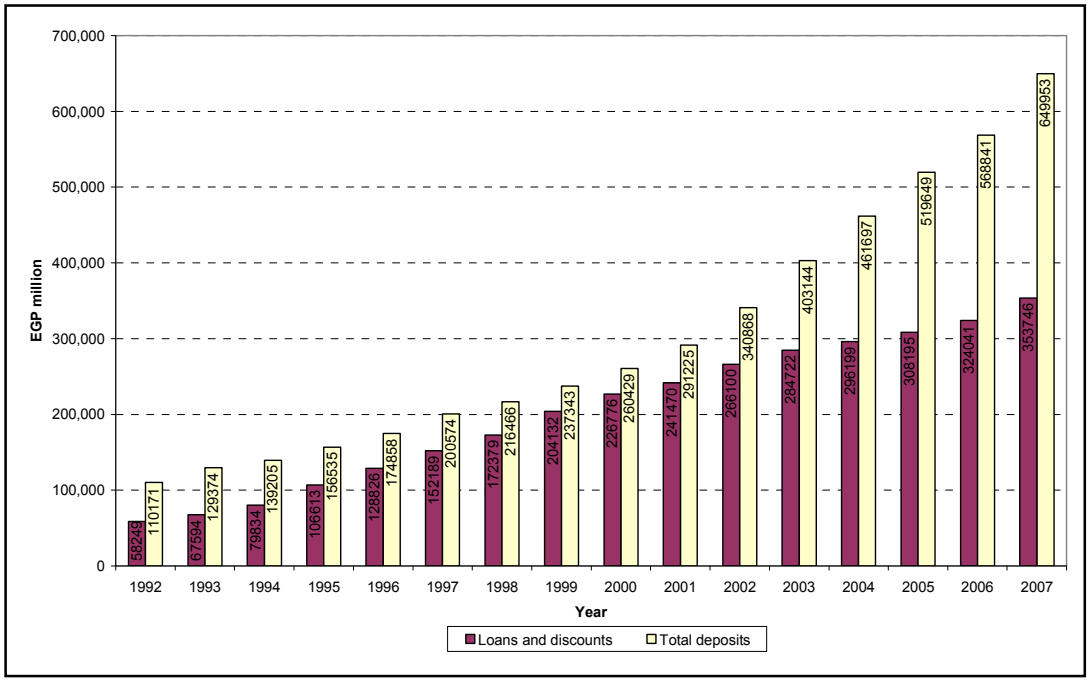

Table 1 Selected M&A activity in banking sector (2005 – 2007)
Source: Cairo and Alexandria Stock Exchanges

Buyer / Investor	Acquired
National Bank of Kuwait	Al-Watany Bank of Egypt (2007)
Abu Dhabi Islamic Bank and Emirates International for Investments	National Development Bank (2007)
Sanpaolo IMI	Bank of Alexandria (2006)
Ahli United Bank of Bahrain and consortium	Delta International Bank (2006)
Union National Bank	Alexandria Commercial and Maritime Bank (2006)
Banque Audi	Cairo Far East Bank (2006)
Credit Agricole and Mansour-Maghrabi Investment and Development	Egyptian American Bank (2006)
Blom Bank	Misr Romanian Bank (2005)
National Societe Generale Bank	Misr International Bank (MIBank) (2005)
Arab International Bank	Suez Canal Bank (2005)
Societe Arabe Internationale de Banque (SAIB)	Port Said National Development Bank (2005)
Piraeus	Egyptian Commercial Bank (2005)
Arab African International Bank	Misr America International Bank (2005)
Societe Generale	National Societe Generale Bank (2005)

Table 2 The development of financial sector in Egypt, 1992-2007

This table reports selected indicators for the development of Egyptian finance sector over the period 1992 – 2007. The data source is World Development Indicators of World Bank.

Year	Domestic Credit Provided by Banks(% of GDP)	Domestic Credit to Private Sector (% of GDP)	Money and quasi money (M2) as % of GDP	Market Capitalization of listed companies (% of GDP)	Gross savings (% of GDP)
1992	82.981	26.194	77.663	7.789	26.646
1993	79.918	27.864	80.788	8.180	27.289
1994	80.613	32.146	80.366	8.208	21.880
1995	80.632	37.040	76.195	13.444	21.778
1996	82.033	41.484	74.797	20.957	18.099
1997	82.136	44.889	71.501	26.556	17.322
1998	90.588	52.681	73.279	28.741	18.568
1999	95.830	58.717	74.005	36.201	20.072
2000	96.401	58.682	72.759	28.788	18.716
2001	102.434	62.104	77.570	24.925	18.439
2002	109.565	61.943	82.912	29.702	19.998
2003	112.422	61.146	88.197	32.648	19.457
2004	111.616	60.401	89.902	48.850	20.490
2005	104.649	57.372	92.091	88.835	21.299
2006	99.258	55.278	90.996	86.969	22.029
2007	89.512	50.642	88.454	106.755	22.530

Figure 2 The development of financial sector in Egypt, 1992-2007

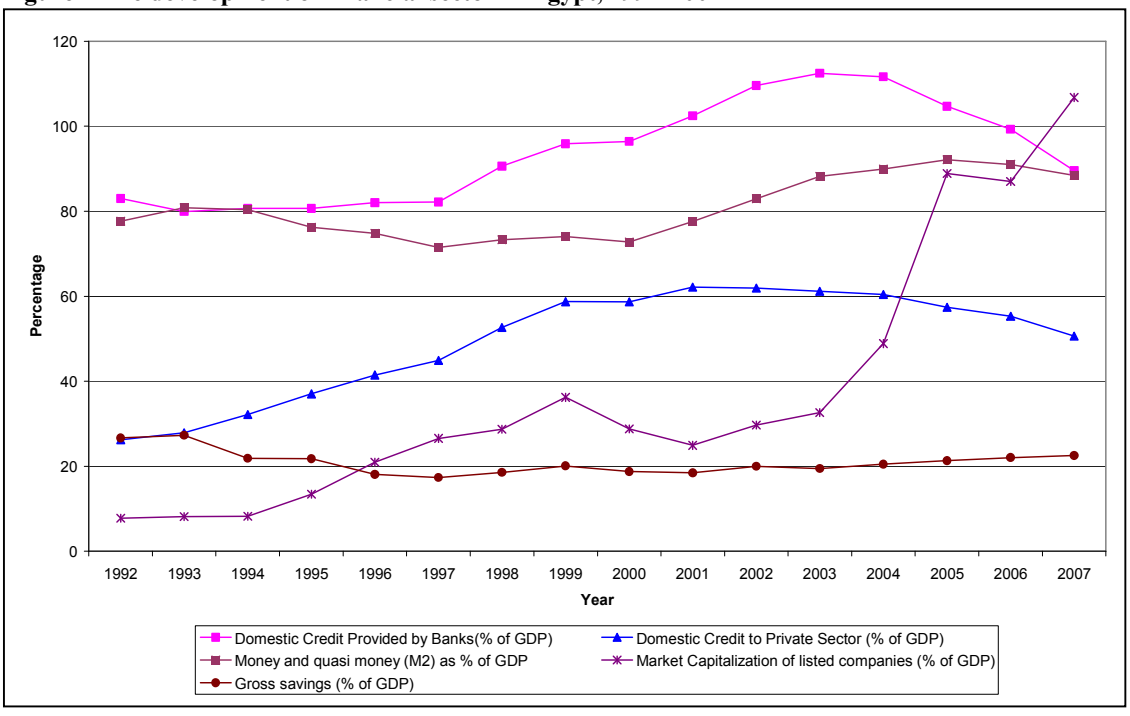

Figure 3 Interest rates and inflation rate in Egypt, 1992 - 2007

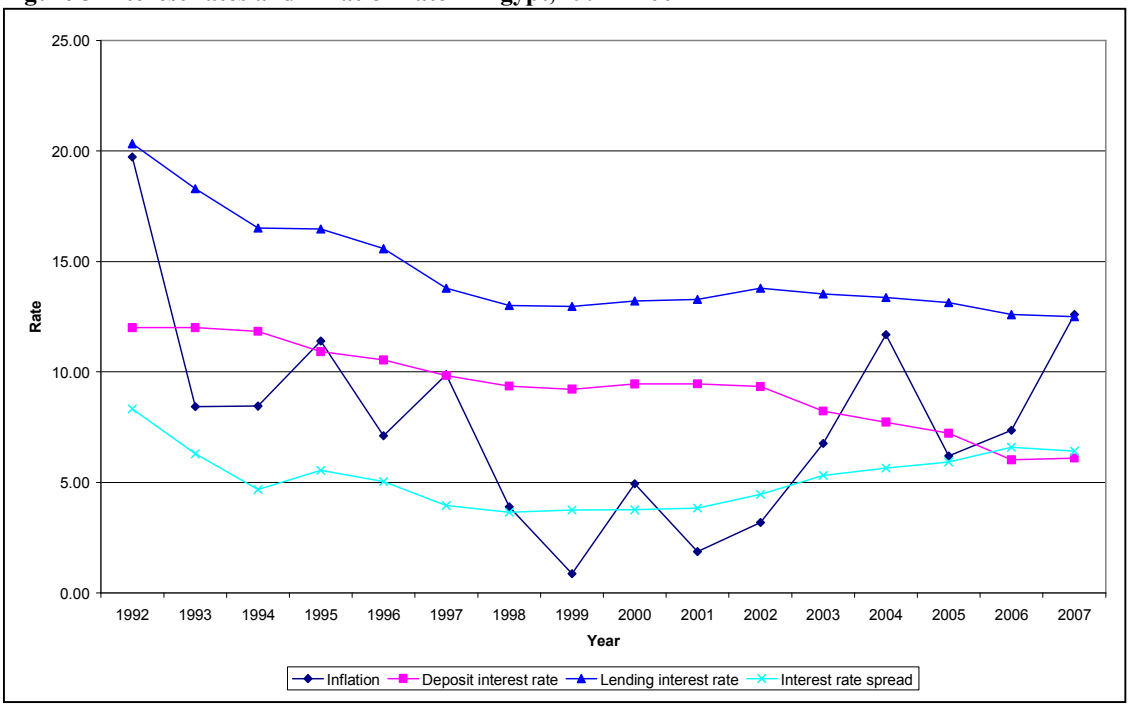

Table 3 Performance and market structure of Egyptian bank sector, 1992-2007

This table reports the performance and market structure for Egyptian banks. Variable definitions are as follows. BHHI = sector median of income concentration Herfindahl-Hirschman index based on banks' segment income. BROA = sector median return on assets. BROE = sector median return on equity. BOVH = sector median overhead expense over total assets. CR4L = the market share of largest 4 banks by loans. CR4D = the market share of largest 4 banks by deposits. SHHI = sector Herfindahl-Hirschman index based on individual banks' total assets. FBPR = foreign bank penetration rate defined as the ratio of foreign banks' assets over total assets of bank sector.

Year	BHHI	BROA	BROE	BOVH	CR4L	CR4D	SHHI	FBPR
1992	0.761	0.008	0.107	0.020	0.750	0.759	0.321	0.011
1993	0.747	0.019	0.162	0.016	0.746	0.755	0.201	0.011
1994	0.704	0.018	0.193	0.018	0.739	0.751	0.176	0.012
1995	0.668	0.017	0.241	0.016	0.742	0.749	0.115	0.019
1996	0.674	0.016	0.198	0.017	0.690	0.734	0.095	0.022
1997	0.656	0.016	0.188	0.016	0.673	0.719	0.092	0.024
1998	0.637	0.017	0.171	0.018	0.646	0.669	0.081	0.023
1999	0.680	0.016	0.174	0.018	0.549	0.636	0.079	0.024
2000	0.685	0.010	0.106	0.018	0.458	0.597	0.115	0.049
2001	0.665	0.008	0.079	0.018	0.477	0.617	0.112	0.050
2002	0.683	0.003	0.031	0.016	0.485	0.630	0.109	0.050
2003	0.572	0.005	0.047	0.016	0.492	0.628	0.112	0.059
2004	0.624	0.003	0.044	0.016	0.482	0.587	0.111	0.065
2005	0.638	0.007	0.058	0.016	0.499	0.598	0.128	0.089
2006	0.701	0.003	0.058	0.015	0.500	0.594	0.131	0.180
2007	0.654	0.014	0.109	0.016	0.478	0.615	0.119	0.196

Figure 4 The evolution of market structure of Egyptian banking sector, 1992 - 2007

Variable definitions are as follows. CR4L = 4-bank concentration ratio by loan. CR4D = 4-bank concentration ratio by deposits. SHHI = sector concentration ratio. FBPR = foreign bank penetration rate defined as the ratio of foreign banks' assets over total assets of bank sector.

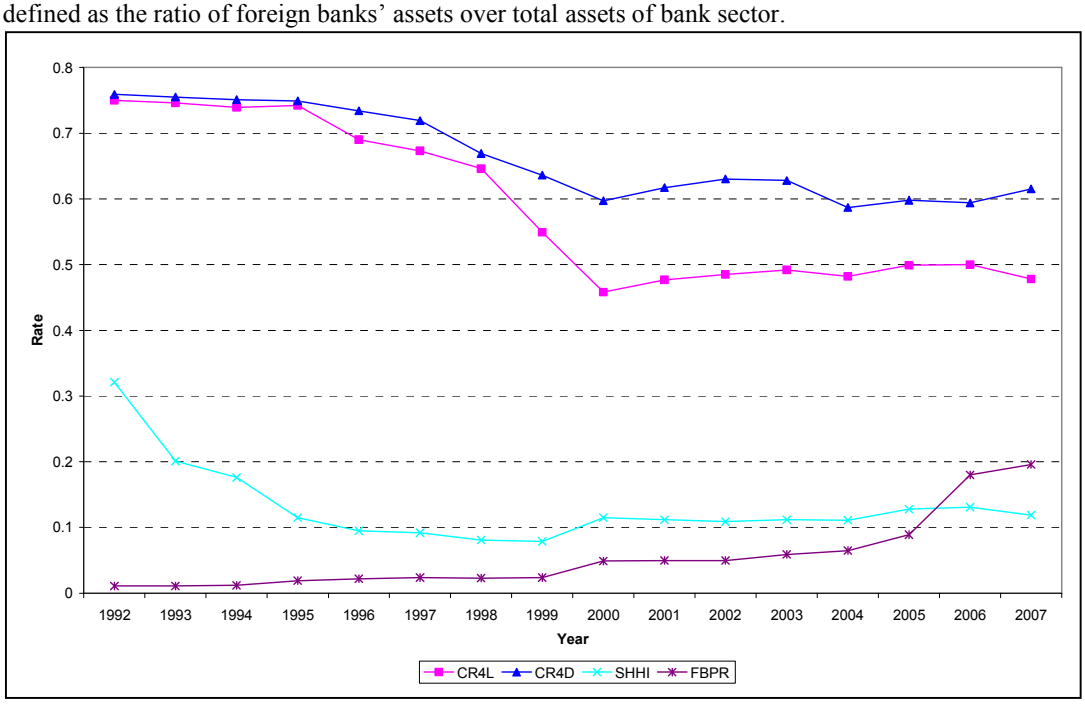

Table 4 Descriptive statistics of sample data

This table reports descriptive statistics of sample data. GDP per capita denoted in Egyptian pounds. The remaining data, if not expressed in ratio, are measured in Egyptian pounds million. All economic data are adjusted by GDP deflator using year 1992 as the base year. Income concentration is individual bank's income concentration Herfindahl-Hirschman index based on the proportions of interest income, fee income and other operating income. 4-bank concentration is the annual average of total loan market shares and total deposit market shares for the largest 4 banks. Industry concentration is the sector Herfindahl-Hirschman index based on individual banks' total assets. Data are collected Bankscope, Bloomberg, World Bank World Economic Indicators, and Central Bank of Egypt.

Variable	Mean	Median	Std. Dev.	Min.	Max.	Obs.
Interest income	377.991	143.404	711.349	5.542	5603.840	423
Interest expense	301.758	105.704	600.915	1.735	4568.957	423
Loan loss provision	56.999	15.927	139.581	0.186	1138.276	423
Operating expense	87.408	38.678	162.360	0.037	2188.604	423
Net profits	41.048	19.460	83.170	-232.648	900.929	423
Total loans	2766.389	1006.681	4927.849	7.933	33698.154	423
Other earning assets	2390.445	876.287	5280.623	0.263	46228.648	423
Deposits	4619.377	1674.462	9503.519	84.647	68507.500	423
Other funds	158.955	3.839	409.087	0.000	3462.918	423
Total assets	5514.945	2194.833	10702.715	139.024	78047.683	423
Financial capital	386.519	205.522	512.498	0.007	3459.671	423
Loss provision / loans	0.031	0.016	0.116	0.000	1.971	423
Equity / assets	0.123	0.083	0.132	0.000	0.808	423
Liquid assets / assets	0.143	0.115	0.141	0.004	0.907	423
Return on assets	0.011	0.009	0.021	-0.244	0.157	423
Income concentration	0.564	0.547	0.124	0.350	1.000	423
GDP growth rate (%)	4.672	4.424	1.302	2.804	7.088	16
GDP per capita	3060.312	3081.453	297.900	2424.796	3617.652	16
Real interest rate (%)	6.834	6.475	3.405	0.497	11.995	16
Inflation rate (%)	6.566	6.777	3.715	0.866	19.733	16
4-bank concentration	0.588	0.548	0.073	0.528	0.754	16
Industry concentration	0.117	0.112	0.033	0.079	0.321	16

Table 5 Random effects regression for industry competition test with Panzar-Rosse model

This table reports estimation results of the industry competition measurement equation following the Panzar-Rosse model with a panel of Egyptian banks during the period 1992 - 2007:

$$\ln IR_{it} = \alpha_i + \beta_{1t} \ln PF_{it} + \beta_{2t} \ln PK_{it} + \beta_{3t} \ln TA_{it} + \beta_{4t} \ln EQA_{it} + \beta_{5t} \ln RSK_{it}$$
$$+ \beta_{6t} FOR_t + \beta_{7t} GOV_t + \beta_{8t} \ln INF_t + \beta_{9t} \ln RIR_t + \beta_{10t} REF96 + \beta_{11t} REF02$$

IR = interest income. PF = interest expense / (total deposits + other funding). PK = other operating expense / total assets. TA = total assets. EQA = equity / total assets. RSK = loan loss provision / total loans. FOR = 1 for foreign bank and 0 otherwise. GOV = 1 for government bank and 0 otherwise. INF = headline inflation rate. RIR = interest rate spread. REF96 = 1 for period between 1996 and 2001 and 0 otherwise. REF02 = 1 for period from 2002 and 0 otherwise. Random effect regression model is selected based on Breusch and Pagan Lagrangian multiplier test for random effects.

Variable	Estimate	Std. Err.	t-value	p-value
CONST	-2.187	0.898	-2.440	0.015
lnPF	0.569	0.038	15.150	<.0001
lnPK	0.014	0.013	1.030	0.303
lnTA	1.076	0.021	50.470	<.0001
lnEQA	-0.032	0.016	-2.000	0.046
lnRSK	0.012	0.008	1.590	0.114
FOR	0.056	0.108	0.520	0.606
GOV	-0.159	0.129	-1.230	0.220
lnINF	0.064	0.254	0.250	0.800
lnRIR	2.425	5.134	0.470	0.637
REF96	-0.226	0.258	-0.880	0.381
REF02	-0.614	0.240	-2.560	0.011
Dependent variable	lnIR			
R-squared	0.887			
H-statistic	0.583			
H_0: H-statistic <= 0	(monopoly)			
Chi-sq	207.930			
Prob > Chi-sq	<0.0001			
H_0: H-statistic = 1	(perfect comp.)			
Chi-sq	106.740			
Prob > Chi-sq	<0.0001			
Breusch and Pagan	(random eff. test)			
LM	122.950			
Prob > LM	<0.0001			

Table 6 H statistics for Egyptian banks by ownership types, 1992 – 2007

This table reports H-statistics based on the Panzar-Rosse model for different ownership types of Egyptian banks during the period 1992 – 2007. The ownership type classification is based on identity of the owner with over 50% holdings. * indicates that Chi-sq statistic is significant at the 1% level.

Test	Government	Private	Foreign	Domestic
H-statistic	0.425	0.547	0.487	0.582
Chi-sq for testing H_0: H = 0	35.60*	149.78*	51.50*	129.14*
Chi-sq for testing H_0: H = 1	65.37*	102.62*	56.93*	66.91*

Table 7 Random effects regression for long-run equilibrium test with Panzar-Rosse model

This table reports estimation results of the long-run equilibrium measurement equation following the Panzar-Rosse model with a panel of Egyptian banks during the period 1992 - 2007:

$$\ln \pi_{it} = \alpha_i + \beta_{1t} \ln PF_{it} + \beta_{2t} \ln PK_{it} + \beta_{3t} \ln TA_{it} + \beta_{4t} \ln EQA_{it} + \beta_{5t} \ln RSK_{it} + \beta_{6t} FOR_t + \beta_{7t} GOV_t + \beta_{8t} \ln INF_t + \beta_{9t} \ln RIR_t + \beta_{10t} REF96 + \beta_{11t} REF02$$

Variable definitions are as follows. π = 1 + return on assets. PF = interest expense / (total deposits + other funding). PK = non-interest expense / total assets. TA = total assets. EQA = equity / total assets. RSK = loan loss provision / total loans. FOR = 1 for foreign bank and 0 otherwise. GOV = 1 for government bank and 0 otherwise. INF = headline inflation rate. RIR = interest rate spread. REF96 = 1 for period between 1996 and 2001 and 0 otherwise. REF02 = 1 for period from 2002 and 0 otherwise. Random effect regression model is selected based on Breusch and Pagan Lagrangian multiplier test result.

Variable	Estimate	Std. Err.	t-value	p-value
CONST	-0.014	0.029	-0.490	0.628
lnPF	-0.002	0.003	-0.880	0.380
lnPK	-0.001	0.001	-0.870	0.384
lnTA	0.007	0.001	5.290	<.0001
lnEQA	0.025	0.001	22.290	<.0001
lnRSK	-0.003	0.001	-4.480	<.0001
FOR	0.005	0.006	0.900	0.368
GOV	-0.003	0.007	-0.350	0.725
lnINF	0.004	0.008	0.520	0.601
lnRIR	0.080	0.154	0.520	0.602
REF96	-0.004	0.008	-0.450	0.650
REF02	-0.016	0.008	-2.170	0.031
Dependent variable	lnπ			
R-squared	0.610			
E-statistic	-0.003			
H_0: E-statistic = 0	(LR equilibrium)			
Chi-sq	1.210			
Prob > Chi-sq	0.266			
Breusch and Pagan	(random eff. test)			
LM	87.060			
Prob > LM	<0.0001			

Table 8 Results of simultaneous estimation for conjectural variations equations

This table reports estimation results for measuring three equations (translog cost, revenue, and inverse loan demand) system following the conjectural variation approach:

$$\ln C_{it} = b_0 + b_1 \ln q_{it} + 1/2 b_2 (\ln q_{it})^2 + b_3 \ln d_{it} + 1/2 b_4 (\ln d_{it})^2 + b_5 \ln w_{it} + 1/2 b_6 (\ln w_{it})^2 + b_7 \ln q_{it} \ln w_{it} + b_8 \ln q_{it} \ln d_{it} + b_9 \ln d_{it} \ln w_{it} + \varepsilon_{it}^c$$

$$R_i = \frac{\theta_t}{\eta_t} R_{it} + E_{it} \frac{q_{it}}{d_{it}} + C_{it}(b_1 + b_2 \ln q_{it} + b_7 \ln w_{it} + b_8 \ln d_{it}) + C_{it} \frac{q_{it}}{d_{it}} (b_3 + b_4 \ln d_{it} + b_8 \ln q_{it} + b_8 \ln w_{it}) + \varepsilon_{it}^R$$

$$\ln p_{it} = p_0 + (-\frac{1}{\eta_t}) \ln q_{it} + p_1 \ln GDPR_{it} + p_2 \ln TA_{it} + p_3 \ln EQA_{it} + \varepsilon_{it}^p$$

Variable definitions are as follows. C = non-interest expense. q = loans. d = deposits + other funds. w = non-interest expense / assets R = interest income. θ = industry average degree of competition. η = industry demand elasticity. E = interest expense. p = interest income / loans. GDPR = GDP growth rate. TA = assets. EQA = equity / total assets. $\varepsilon_{it}^c, \varepsilon_{it}^R$, and ε_{it}^p are error terms. Reported standard errors are adjusted for white heteroscedasticity. Linear homogeneity of input prices is obtained by dividing C by w before taking the log. Hence some coefficient estimates associated with w are omitted from the table.

Parameter	Estimate	StdErr	t-value	p-value	95% lower	95% upper
b0	9.537	0.040	236.810	<.0001	9.456	9.617
b1	0.514	0.073	7.040	<.0001	0.368	0.660
b2	0.166	0.059	2.810	0.005	0.048	0.284
b3	0.501	0.073	6.890	<.0001	0.356	0.646
b4	-0.109	0.073	-1.480	0.139	-0.255	0.038
b8	-0.078	0.056	-1.380	0.167	-0.190	0.035
θ 1992	0.581	0.140	4.160	<.0001	0.301	0.860
θ 1993	0.660	0.116	5.700	<.0001	0.428	0.891
θ 1994	0.644	0.126	5.120	<.0001	0.392	0.895
θ 1995	0.524	0.100	5.230	<.0001	0.324	0.724
θ 1996	0.456	0.091	5.010	<.0001	0.274	0.638
θ 1997	0.438	0.083	5.300	<.0001	0.273	0.603
θ 1998	0.418	0.072	5.810	<.0001	0.274	0.562
θ 1999	0.445	0.067	6.610	<.0001	0.311	0.580
θ 2000	0.473	0.029	16.260	<.0001	0.415	0.532
θ 2001	0.475	0.028	17.210	<.0001	0.420	0.530
θ 2002	0.484	0.027	18.010	<.0001	0.431	0.538
θ 2003	0.552	0.029	19.360	<.0001	0.495	0.609
θ 2004	0.605	0.031	19.830	<.0001	0.544	0.666
θ 2005	0.699	0.030	23.700	<.0001	0.640	0.758
θ 2006	0.692	0.030	23.350	<.0001	0.632	0.751
θ 2007	0.677	0.031	22.150	<.0001	0.616	0.738
η 92-93	1.171	0.044	26.870	<.0001	1.084	1.259
η 94-95	1.156	0.040	29.150	<.0001	1.077	1.236
η 96-97	1.155	0.038	30.260	<.0001	1.078	1.231
η 98-99	1.164	0.038	30.660	<.0001	1.088	1.240
η 00-01	1.164	0.038	30.650	<.0001	1.088	1.240
η 02-03	1.118	0.036	30.970	<.0001	1.045	1.190
η 04-05	1.108	0.035	31.260	<.0001	1.037	1.179
η 06-07	1.108	0.037	30.260	<.0001	1.035	1.181
p0	-2.308	0.294	-7.850	<.0001	-2.895	-1.720
p1	-0.016	0.087	-0.180	0.854	-0.190	0.158
p2	0.855	0.029	29.180	<.0001	0.796	0.913
p3	-1.412	0.130	-10.900	<.0001	-1.672	-1.153
Adj. r-squared for translog cost function equation						0.812
Adj. r-squared for revenue function equation						0.985
Adj. r-squared for inverse loan demand function equation						0.707

Table 9 Empirical measures of competitive conditions in Egyptian banking sector, 1992-2007

This table reports the time series of industry average degree of competition (θ), industry demand elasticity (η), and Lerner index (θ/η) for Egyptian banking sector over the period 1992 – 2007. The three empirical measures of competitive conditions are based on the estimation results of three equations system following the conjectural variation approach.

Year	Average competition (θ)	Industry demand elasticity (η)	Lerner index (θ/η)
1992	0.581	1.171	0.496
1993	0.660	1.171	0.563
1994	0.644	1.156	0.557
1995	0.524	1.156	0.453
1996	0.456	1.155	0.395
1997	0.438	1.155	0.379
1998	0.418	1.164	0.359
1999	0.445	1.164	0.383
2000	0.473	1.164	0.407
2001	0.475	1.164	0.408
2002	0.484	1.118	0.433
2003	0.552	1.118	0.494
2004	0.605	1.108	0.546
2005	0.699	1.108	0.630
2006	0.692	1.108	0.624
2007	0.677	1.108	0.611

Figure 5 The industry average of bank competition in Egypt, 1992 - 2007

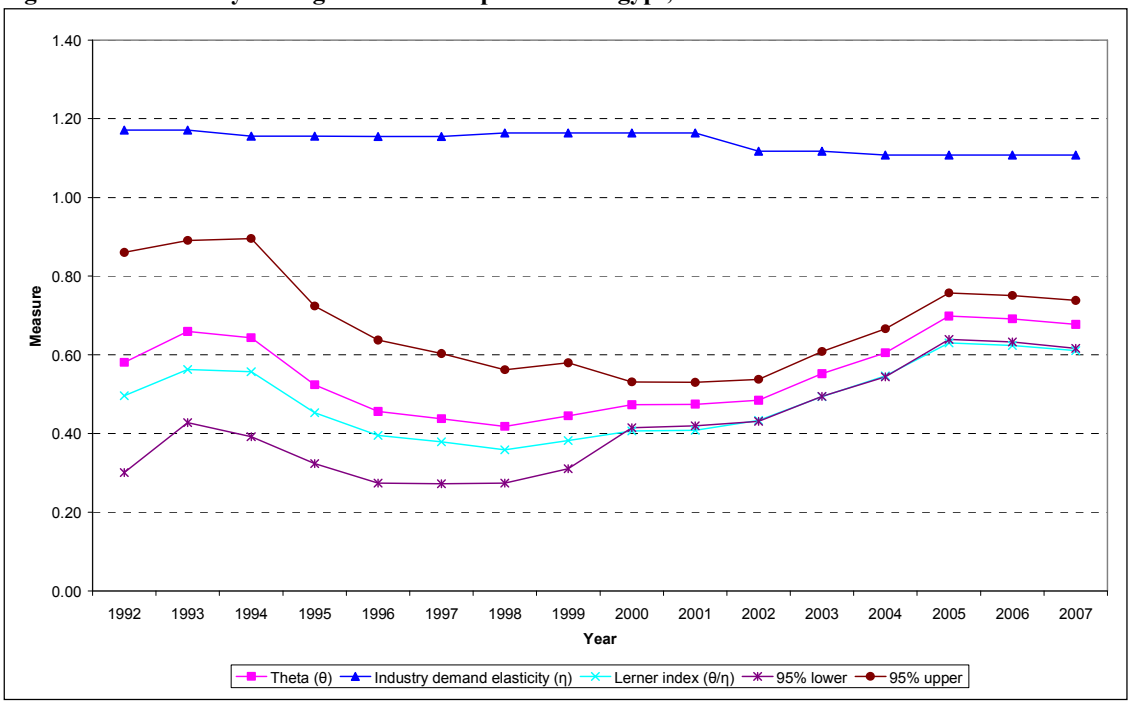

Table 10 Estimates of the translog cost function for Persistence of Profitability model

This table reports the estimation results for the translog cost function following the Persistence of Profitability model:

$$\ln VC_{it} = \beta_0 + \sum_{m=1}^{3} \alpha_m \ln Y_{mit} + \sum_{n=1}^{2} \beta_n \ln W_{nit} + 1/2 \sum_{m=1}^{3} \sum_{j=1}^{3} \alpha_{mj} \ln Y_{mit} \ln Y_{jit} + 1/2 \sum_{n=1}^{2} \sum_{k=1}^{2} \beta_{nk} \ln W_{nit} \ln W_{kit}$$

$$+ 1/2 \sum_{n=1}^{2} \sum_{m=1}^{3} \gamma_{nm} \ln W_{nit} \ln Y_{mit} + \theta T + 1/2 \lambda T^2 + \sum_{m=1}^{3} \theta_m T \ln Y_{mit} + \sum_{n=1}^{2} \zeta_n T \ln W_{nit} + v_{it} + u_{it}$$

Variable definitions are as follows. VC = variable cost. Y_m = three outputs including LOAN, OEAST, and TR. LOAN = total loans provision. OEAST = other earning assets. TR = total revenue. W_n = two input prices including PK and PF. PF = interest expense / (deposits + other funds). PK = non-interest expense / assets. T = time trend variable with year 1992 taking value of 1 and year 2007 taking value of 16. σ_v = standard deviation of noise component of error term of translog cost function. σ_u = standard deviation of non-negative cost inefficiency component of error term of translog cost function. Linear homogeneity of input prices is obtained by dividing TC and PK by PF before taking the log. Hence some coefficient estimates associated with PF are omitted from the table.

Variable	Estimate	Std.Err.	t-value	p-value
CONST	7.802	0.059	131.570	<.0001
lnPK	1.089	0.030	36.420	<.0001
lnLOAN	0.418	0.067	6.280	<.0001
lnOEAST	0.417	0.041	10.230	<.0001
lnTR	0.228	0.090	2.530	0.011
lnLOAN*lnLOAN	0.102	0.011	8.890	<.0001
lnOEAST*lnOEAST	0.093	0.006	15.140	<.0001
lnTR*lnTR	-0.045	0.048	-0.930	0.353
lnLOAN*lnOEAST	-0.236	0.019	-12.360	<.0001
lnLOAN*lnTR	0.055	0.027	2.010	0.045
lnOEAST*lnTR	0.117	0.021	5.560	<.0001
lnLOAN*lnPK	-0.011	0.014	-0.850	0.398
lnOEAST*lnPK	0.039	0.007	5.520	<.0001
lnTR*lnPK	-0.014	0.017	-0.820	0.414
T	-0.032	0.008	-4.000	<.0001
T*T	0.001	0.000	2.890	0.004
lnLOAN*T	0.002	0.005	0.380	0.705
lnOEAST*T	0.001	0.003	0.440	0.658
lnTR*T	-0.007	0.007	-0.950	0.341
lnPK*T	-0.010	0.002	-4.060	<.0001
σ_v	0.045	0.005	9.360	<.0001
σ_u	0.115	0.008	14.300	<.0001
Dependent variable	lnTC			
Log likelihood function	451.614			
Akaike information ratio	-859.227			

Table 11 Estimates of banking competition dynamics for Persistence of Profitability model
This table reports the estimation results of alpha measure following the MK = marginal cost estimated from translog cost function.

$$\ln MK_{it} = \alpha \ln MK_{i(t-1)} + \gamma REF96 \ln MK_{i(t-1)} + \zeta REF02 \ln_{i(t-1)} + \eta \ln TA + \kappa FOR + \nu GOV + \lambda_T TD + \varepsilon_{it}$$

Variable definitions are as follows. LMK = lag of MK. REF96 = 1 for period between 1996 and 2001 and 0 otherwise. REF02 = 1 for period from 2002 and 0 otherwise. TA = total assets. FOR = 1 for foreign bank and 0 otherwise. GOV = 1 for government bank and 0 otherwise. TD = time dummy vector including YR93 – YR07, where each indicator is for corresponding year in the period 1993 – 2007. Reported standard errors are adjusted for white heteroscedasticity.

Variable	Estimate	Std.Err.	t-value	p-value
lnLMK	0.810	0.150	5.390	<.0001
REF96*lnLMK	0.024	0.148	0.160	0.871
REF02*lnLMK	0.022	0.148	0.150	0.881
lnTA	0.040	0.017	2.390	0.017
FOR	-0.010	0.015	-0.630	0.529
GOV	0.024	0.064	0.380	0.705
YR93	-0.300	0.145	-2.060	0.040
YR94	-0.267	0.143	-1.860	0.064
YR95	-0.221	0.136	-1.630	0.105
YR96	-0.243	0.128	-1.900	0.058
YR97	-0.232	0.124	-1.870	0.062
YR98	-0.198	0.121	-1.630	0.103
YR99	-0.229	0.119	-1.930	0.054
YR00	-0.290	0.117	-2.480	0.014
YR01	-0.299	0.123	-2.430	0.016
YR02	-0.277	0.120	-2.300	0.022
YR03	-0.347	0.140	-2.470	0.014
YR04	-0.342	0.125	-2.740	0.007
YR05	-0.316	0.130	-2.440	0.015
YR06	-0.339	0.131	-2.590	0.010
YR07	-0.332	0.134	-2.480	0.014
Dependent variable	LnMK			
Adj. r-squared	0.915			
F-statistic	188.02			
Prob > F	<0.0001			

Table 12 Empirical measures of productive efficiency for Egyptian banks, 1992 – 2007

This table reports statistics of productive efficiency measures of Egyptian banks over the period 1992 – 2007. Panel A reports the descriptive statistics. Panel B reports the pearson correlation statistics between different productive efficiency measures. Variable definitions are as follows. DEAEFF = productive efficiency measure with data envelopment analysis approach. SFACOST = cost efficiency measure with stochastic frontier approach. SFAPROF = profit efficiency measure with stochastic frontier approach. DFACOST = cost efficiency measure with distribution free approach. DFAPROF = profit efficiency measure with distribution free approach.

Panel A: Descriptive statistics for productive efficiency using DEA, SFA and DFA approaches					
Stat.	DEAEFF	SFACOST	SFAPROF	DFACOST	DFAPROF
Mean	0.779	0.748	0.672	0.775	0.708
Median	0.768	0.765	0.668	0.795	0.706
Std. Dev.	0.131	0.132	0.159	0.138	0.166
Skewness	0.124	-0.479	-0.601	-0.519	-0.607
Kurtosis	-0.605	0.095	1.424	0.109	1.398
Panel B: Pearson correlation between various productive efficiency measures					
Corr.	DEAEFF	SFACOST	SFAPROF	DFACOST	
SFACOST	0.128				
SFAPROF	0.149	-0.273			
DFACOST	0.171	0.977	-0.243		
DFAPROF	0.171	-0.263	0.976	-0.232	

Figure 6 Average efficiency score of Egyptian banking sector over time, 1992 – 2007

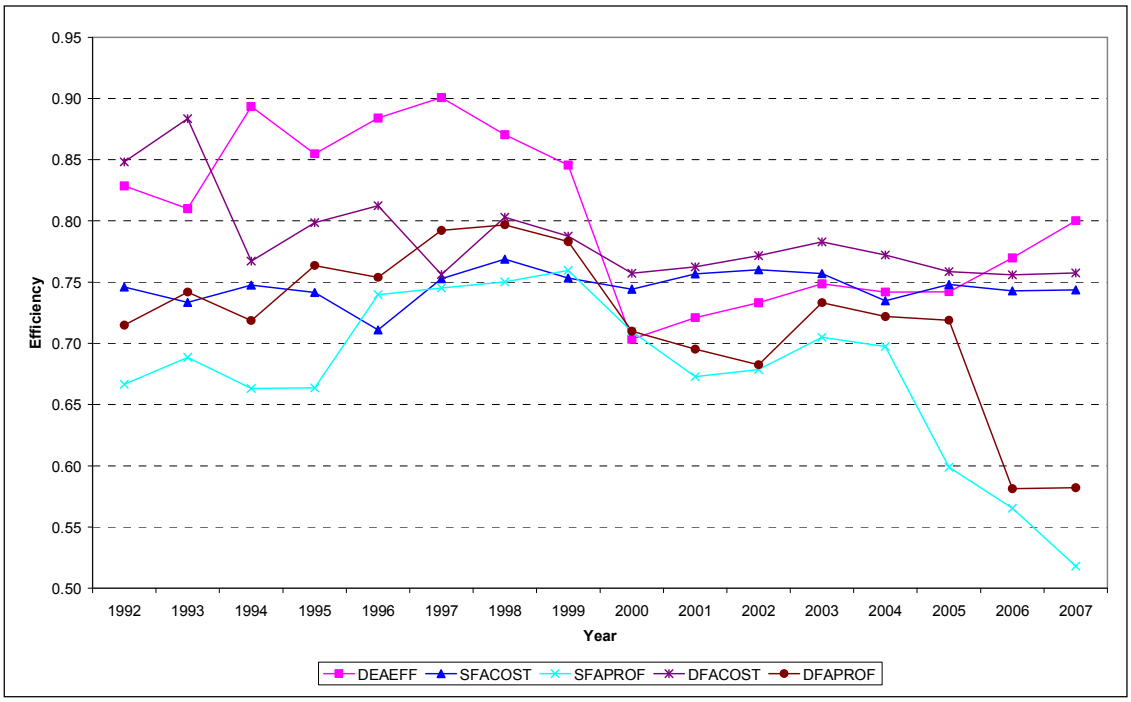

Table 13 Productive efficiency scores of Egyptian banks by ownership types

This table reports different productive efficiency scores of Egyptian banks by ownership types. Variable definitions are as follows. DEAEFF = productive efficiency measure with data envelopment analysis approach. SFAPROF = profit efficiency measure with stochastic frontier approach. DFAPROF = profit efficiency measure with distribution free approach. SFACOST = cost efficiency measure with stochastic frontier approach. DFACOST = cost efficiency measure with distribution free approach. Significance of group difference is tested with t-statistic for parametric approach and with Wilcoxon rank sums z scores for non-parametric approach.

Statistic	DEAEFF	SFAPROF	DFAPROF	SFACOST	DFACOST
Panel A: private banks versus government banks					
Mean for private banks	0.780	0.686	0.723	0.746	0.774
Mean for government banks	0.767	0.525	0.551	0.767	0.784
t-stat. for group difference	0.580	5.710	5.870	-0.910	-0.420
prob > t	0.559	<0.001	<0.001	0.362	0.673
z-stat. for group difference	-0.621	-5.329	-5.505	0.656	0.170
prob > z	0.267	<0.001	<0.001	0.256	0.433
Panel B: domestic banks versus foreign banks					
Mean for domestic banks	0.781	0.673	0.708	0.752	0.779
Mean for foreign banks	0.771	0.667	0.704	0.732	0.759
t-stat. for group difference	0.580	0.240	0.190	1.140	1.100
prob > t	0.560	0.814	0.849	0.256	0.271
z-stat. for group difference	-0.352	-0.582	-0.570	-0.810	-0.844
prob > z	0.363	0.280	0.284	0.209	0.199

Table 14 Determinants of competition status of Egyptian banking sector, 1992 – 2007

This table reports the estimation results for the determinants of competition status in Egyptian banking sector over the period 1992 – 2007. Variable definitions are as follows. Theta (θ) = industry average degree of competition with value of 1 for pure monopoly or perfectly collusive oligopoly and value of 0 for perfect competition. CR4 = annual average of total loan market shares and total deposit market shares for the largest 4 banks. SHHI = sector concentration Herfindahl-Hirschman index based on individual banks' total assets. GDPC = GDP per capita. REF96 = 1 for period between 1996 and 2001 and 0 otherwise. REF02 = 1 for period from 2002 and 0 otherwise.

Variable	Est.	Std Err	t-value	p-value	Est.	Std Err	t-value	p-value
CONST	0.741	0.261	2.840	0.016	0.494	0.088	5.600	0.000
REF96	-0.202	0.060	-3.370	0.006	-0.136	0.059	-2.330	0.040
REF02	-0.052	0.080	-0.640	0.533	0.025	0.052	0.470	0.648
CR4	-0.243	0.345	-0.710	0.495				
SHHI					0.321	0.389	0.820	0.427
lnGDPC	0.021	0.013	1.630	0.132	0.021	0.013	1.620	0.134
Dependent variable	theta				theta			
R-squared	0.730				0.735			
Adj. r-squared	0.632				0.638			
Durbin-Watson test for autocorrelation								
DW	2.105				2.038			
Prob < DW	0.182				0.161			
Prob > DW	0.818				0.839			
White test for heteroscedasticity								
Chi-sq	7.290				10.120			
Prob > Chi-sq	0.775				0.520			
Breusch-Pagan test for heteroscedasticity								
Chi-sq	5.130				7.430			
Prob > Chi-sq	0.274				0.115			

Table 15 Correlation between variables explaining efficiency and competition of Egyptian banks

This table reports pearson correlation statistics between variables explaining productive efficiency and competition status of Egyptian banks. Variable definitions are as follows. ROA = net profit / total assets. RSK = loan loss provision / total loans. EQA = equity / total assets. LIQ = liquid assets / total assets. RHHI = revenue concentration Herfindahl-Hirschman index based on individual bank's interest income, fees and commissions and other operating income. TA = total assets. FOR = 1 for foreign bank and 0 otherwise. GOV = 1 for government bank and 0 otherwise. CR4 = annual average of total loan market shares and total deposit market shares for the largest 4 banks. SHHI = sector concentration Herfindahl-Hirschman index based on individual banks' total assets. GDPC = GDP per capita. REF96 = 1 for period between 1996 and 2001 and 0 otherwise. REF02 = 1 for period from 2002 and 0 otherwise.

Corr.	ROA	RSK	EQA	LIQ	RHHI	lnTA	FOR	GOV	CR4	SHHI	lnGDPC	REF96
RSK	-0.234											
EQA	0.295	-0.031										
LIQ	0.225	-0.036	0.294									
RHHI	-0.276	0.165	-0.142	-0.060								
lnTA	-0.069	-0.081	-0.354	0.064	0.092							
FOR	0.079	-0.049	-0.142	-0.013	-0.060	-0.052						
GOV	-0.007	-0.018	0.036	0.093	-0.031	0.397	-0.152					
CR4	0.139	-0.075	-0.108	-0.116	0.219	-0.174	-0.005	-0.177				
SHHI	-0.041	0.006	-0.002	0.029	0.203	0.006	0.068	0.000	0.258			
lnGDPC	-0.120	0.038	0.133	0.167	-0.258	0.236	0.031	0.169	-0.853	-0.196		
REF96	0.091	0.045	-0.077	-0.097	0.082	-0.151	-0.055	-0.099	0.137	-0.416	-0.376	
REF02	-0.132	-0.022	0.115	0.128	-0.216	0.211	0.036	0.153	-0.554	0.034	0.744	-0.827

Table 16 Determinants of productive efficiency measures of Egyptian banks, 1992 – 2007

This table reports the estimation results for the determinants of productive efficiency measures in Egyptian banking sector over the period 1992 – 2007. Variable definitions are as follows. DEAEFF = productive efficiency measure with data envelopment analysis approach. SFAPROF = profit efficiency measure with stochastic frontier approach. DFAPROF = profit efficiency measure with distribution free approach. ROA = net profit / total assets. RSK = loan loss provision / total loans. EQA = equity / total assets. LIQ = liquid assets / total assets. RHHI = revenue concentration Herfindahl-Hirschman index based on individual bank's interest income, fees and commissions and other operating income. TA = total assets. FOR = 1 for foreign bank and 0 otherwise. GOV = 1 for government bank and 0 otherwise. CR4 = annual average of total loan market shares and total deposit market shares for the largest 4 banks. GDPC = GDP per capita. REF96 = 1 for period between 1996 and 2001 and 0 otherwise. REF02 = 1 for period from 2002 and 0 otherwise. Reported standard errors are adjusted for white heteroscedasticity.

	Dep. Var. = DEAEFF				Dep. Var. = SFAPROF				Dep. Var. = DFAPROF			
Variable	Estimate	Std.Err.	t-value	p-value	Estimate	Std.Err.	t-value	p-value	Estimate	Std.Err.	t-value	p-value
CONST	-3.440	1.040	-3.310	0.001	9.994	1.722	5.800	<.0001	7.333	1.891	3.880	0.000
ROA	1.852	0.232	7.970	<.0001	2.993	1.010	2.960	0.003	3.094	1.154	2.680	0.008
RSK	0.100	0.029	3.390	0.001	0.046	0.073	0.630	0.531	0.058	0.084	0.680	0.494
EQA	0.000	0.000	0.480	0.632	-0.001	0.001	-1.950	0.052	-0.001	0.001	-1.460	0.145
LIQ	0.034	0.022	1.560	0.120	-0.035	0.026	-1.330	0.183	-0.035	0.034	-1.020	0.307
RHHI	0.002	0.056	0.040	0.967	-0.005	0.091	-0.050	0.959	-0.041	0.097	-0.430	0.670
lnTA	-0.019	0.005	-4.130	<.0001	0.013	0.011	1.110	0.268	0.015	0.012	1.230	0.218
FOR	-0.012	0.015	-0.850	0.398	-0.029	0.017	-1.660	0.097	-0.031	0.019	-1.640	0.103
GOV	0.048	0.019	2.550	0.011	-0.171	0.043	-3.960	<.0001	-0.187	0.044	-4.230	<.0001
CR4	1.361	0.146	9.350	<.0001	-0.696	0.203	-3.430	0.001	-0.344	0.218	-1.580	0.115
lnGDPC	0.432	0.124	3.470	0.001	-1.140	0.207	-5.520	<.0001	-0.823	0.226	-3.640	0.000
REF96	0.084	0.029	2.910	0.004	0.120	0.033	3.660	0.000	0.075	0.036	2.090	0.038
REF02	0.078	0.035	2.190	0.029	0.169	0.043	3.920	0.000	0.126	0.047	2.680	0.008
Adj.R-sq.	0.325				0.321				0.264			
F-stat.	17.490				15.130				11.720			
Prob>F	<0.0001				<0.0001				<0.0001			

Table 17 Unit root tests for stationarity of variables in economic growth function

This table reports the results of unit root tests for stationarity of variables in economic growth function. Economic growth function is $GDPR = f(trade\_openess, bank\_efficiency)$ for linking bank efficiency to economic growth, and is $GDPR = f(trade\_openess, bank\_competition)$ for linking bank competition to economic growth. Variable definitions are as follows. GDPR = GDP growth rate. EXPORT is value of exports to nominal GDP. Bank efficiency measure refers to the industry average score of productive efficiency measure, including DEAEFF, SFAPROF, DFAPROF, SFACOST, and DFACOST. DEAEFF = productive efficiency measure with data envelopment analysis approach. SFAPROF = profit efficiency measure with stochastic frontier approach. DFAPROF = profit efficiency measure with distribution free approach. SFACOST = cost efficiency measure with stochastic frontier approach. DFACOST = cost efficiency measure with distribution free approach. Theta = the industry average degree of competition for Egyptian banking sector. Lerner = theta / industry demand elasticity. [a], [b], [c] indicates the significance level at 1%, 5% and 10%, respectively.

Variable	Augmented Dickey-Fuller (ADF) Test Statistic		Phillips-Peron (PP) Test Statistic		Conclusions
	Level	1st Diff.	Level	1st Diff.	
GDPR	0.69	-2.24[b]	0.27	-4.28[a]	I(1)
EXPORT	0.31	-1.92[c]	0.03	-1.83[c]	I(1)
DEAEFF	-0.36	-2.45[b]	-0.47	-5.59[a]	I(1)
SFAPROF	-0.94	-2.07[b]	-0.85	-2.59[b]	I(1)
DFAPROF	-0.92	-2.08[b]	-0.79	-3.76[a]	I(1)
SFACOST	0.10	-5.19[a]	-0.08	-4.89[a]	I(1)
DFACOST	-1.44	-7.38[a]	-0.94	-6.29[a]	I(1)
Theta	-0.49	-2.31[b]	0.20	-2.55[b]	I(1)
Lerner	-0.39	-2.23[b]	0.34	-2.45[b]	I(1)

Table 18 Johansen cointegration trace tests for economic growth function

This table reports the results of cointegration trace tests for economic growth function with different productive efficiency measures of Egyptian banking sector. Economic growth function is $GDPR = f(trade\_openess, bank\_efficiency)$ for linking bank efficiency to economic growth, and is $GDPR = f(trade\_openess, bank\_competition)$ for linking bank competition to economic growth. Variable definitions are as follows. GDPR = GDP growth rate. Trade openness is measured by exports to nominal GDP (EXPORT). Bank efficiency measures include DEAEFF, SFAPROF, DFAPROF, SFACOST, and DFACOST. DEAEFF = productive efficiency measure with data envelopment analysis approach. SFAPROF = profit efficiency measure with stochastic frontier approach. DFAPROF = profit efficiency measure with distribution free approach. SFACOST = cost efficiency measure with stochastic frontier approach. DFACOST = cost efficiency measure with distribution free approach. Theta = the industry average degree of competition for Egyptian banking sector. Lerner = theta / industry demand elasticity. * indicates the trace statistic is significant at the 5% level.

H_0	DEAEFF	SFAPROF	DFAPROF	SFACOST	DFACOST	Theta	Lerner
Rank = 0	44.495*	34.936*	37.565*	34.841*	49.831*	35.785*	36.157*
Rank = 1	11.437	8.730	11.566	13.198	14.401	19.260*	17.842*
Rank = 2	1.851	0.466	0.025	0.5546	0.025	3.605	2.545

Table 19 Granger causality tests for economic growth function

This table reports the results of Granger causality tests for economic growth function with different productive efficiency (competition) measures of Egyptian banking sector. Economic growth function is $GDPR = f(trade\_openess, bank\_efficiency)$ for linking bank efficiency to economic growth, and is $GDPR = f(trade\_openess, bank\_competition)$ for linking bank competition to economic growth. Variable definitions are as follows. GDPR = GDP growth rate. Trade openness is measured by exports to nominal GDP. Bank efficiency measures include DEAEFF, SFAPROF, DFAPROF, SFACOST, and DFACOST. DEAEFF = productive efficiency measure with data envelopment analysis approach. SFAPROF = profit efficiency measure with stochastic frontier approach. DFAPROF = profit efficiency measure with distribution free approach. SFACOST = cost efficiency measure with stochastic frontier approach. DFACOST = cost efficiency measure with distribution free approach. Bank competition measure Theta = the industry average degree of competition for Egyptian banking sector. Lerner = theta / industry demand elasticity. The short-run and long-run causality tests are ECM test (F statistic) with Johansen cointegrating vectors between bank efficiency and bank competition measures. [a], [b], [c] indicates the significance level at 1%, 5% and 10%, respectively.

Panel A: Testing null hypothesis H_0 = Bank efficiency change does not cause economic growth					
Causality	DEAEFF	SFAPROF	DFAPROF	SFACOST	DFACOST
Short-run	9.18[c]	8.72[c]	12.18[b]	15.90[a]	20.31[a]
Long-run	1.01	1.01	-0.75	-0.28	-1.11
Panel B: Testing null hypothesis H_0 = Economic growth does not cause bank efficiency change					
Causality	DEAEFF	SFAPROF	DFAPROF	SFACOST	DFACOST
Short-run	37.12[a]	13.76[a]	6.97	5.44	8.01[c]
Long-run	-4.55[a]	-0.13	0.81	-2.51[b]	2.85[b]
Panel C: Testing null hypothesis H_0 = Bank competition change does not cause economic growth					
Causality	Theta	Lerner			
Short-run	10.08[b]	8.96[c]			
Long-run	-1.30	0.18			
Panel D: Testing null hypothesis H_0 = Economic growth does not cause bank competition change					
Causality	Theta	Lerner			
Short-run	22.70[b]	20.45[a]			
Long-run	-0.27	-0.95			

Table 20 Johansen cointegration trace tests for bank competition and efficiency

This table reports the results of cointegration trace tests for competition and productive efficiency measures of Egyptian banking sector. Variable definitions are as follows. Bank efficiency measures include DEAEFF, SFAPROF, DFAPROF, SFACOST, and DFACOST. DEAEFF = productive efficiency measure with data envelopment analysis approach. SFAPROF = profit efficiency measure with stochastic frontier approach. DFAPROF = profit efficiency measure with distribution free approach. SFACOST = cost efficiency measure with stochastic frontier approach. DFACOST = cost efficiency measure with distribution free approach. Bank competition measures include Theta and Lerner. Theta = the industry average degree of competition for Egyptian banking sector. Lerner = theta / industry demand elasticity. * indicates the trace statistic is significant at the 5% level.

H_0	DEAEFF	SFAPROF	DFAPROF	SFACOST	DFACOST
Panel A : bank competition measure is Theta					
Rank = 0	15.577*	12.854	11.017	29.231*	28.031*
Rank = 1	5.325	0.112	1.298	7.497*	3.721
Panel B: bank competition measure is Lerner					
Rank = 0	14.957	11.339	10.472	29.230*	30.307*
Rank = 1	5.529	0.242	1.121	6.276*	5.004

Table 21 Granger causality tests for bank competition and efficiency

This table reports the results of Granger causality tests for competition status and productive efficiency measures of Egyptian banking sector. Variable definitions are as follows. Bank efficiency measures include DEAEFF, SFAPROF, DFAPROF, SFACOST, and DFACOST. DEAEFF = productive efficiency measure with data envelopment analysis approach. SFAPROF = profit efficiency measure with stochastic frontier approach. DFAPROF = profit efficiency measure with distribution free approach. SFACOST = cost efficiency measure with stochastic frontier approach. DFACOST = cost efficiency measure with distribution free approach. Bank competition measures include Theta and Lerner index. Theta = the industry average degree of competition for Egyptian banking sector. Lerner = theta / industry demand elasticity. The short-run and long-run causality tests are ECM test (F statistic) with Johansen cointegrating vectors between bank efficiency and bank competition measures. [a], [b], [c] indicates the significance level at 1%, 5% and 10%, respectively.

Panel A: Testing null hypothesis H_0 = Theta change does not cause efficiency change					
Causality	DEAEFF	SFAPROF	DFAPROF	SFACOST	DFACOST
Short-run	6.17[b]	N.A.	N.A.	N.A.	8.60[b]
Long-run	-0.37	N.A.	N.A.	N.A.	-2.11[c]
Panel B: Testing null hypothesis H_0 = Efficiency change does not cause theta change					
Causality	DEAEFF	SFAPROF	DFAPROF	SFACOST	DFACOST
Short-run	**5.31[c]**	**N.A.**	**N.A.**	**N.A.**	**14.96[a]**
Long-run	0.47	N.A.	N.A.	N.A.	4.30[a]
Panel C: Testing null hypothesis H_0 = Lerner change does not cause efficiency change					
Causality	DEAEFF	SFAPROF	DFAPROF	SFACOST	DFACOST
Short-run	N.A.	N.A.	N.A.	N.A.	7.91[b]
Long-run	N.A.	N.A.	N.A.	N.A.	-1.91[c]
Panel D: Testing null hypothesis H_0 = Efficiency change does not cause Lerner change					
Causality	DEAEFF	SFAPROF	DFAPROF	SFACOST	DFACOST
Short-run	N.A.	N.A.	N.A.	N.A.	20.48[a]
Long-run	N.A.	N.A.	N.A.	N.A.	4.72[b]