Competition and Performance in Uganda´s Banking System

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Abstract

This paper focuses on sharpening the debate on the financial sector by analysing the competitive behaviour and the structure–performance correlation. In line with the literature on the measurement of competition, it follows the two mainstreams — non-structural and the structural approaches — in analysing the nature of competition and market structure of Uganda's financial system.

By using the non-structural models of competitive behaviour—the Panzar-Rosse model—the study measures competition and emphasizes the competitive conduct of banks without using explicit information about the structure of the market. Estimations indicate monopolistic competition, competition being weaker in 1995–1999 compared with 2000–2005. Moreover, the relationship between competition, measuring conduct, and concentration measuring the market structure, is negative and statistically significant; which could suggest that a few large banks can restrict competition. Overall, the results suggest that while competition in the Ugandan banking sector falls within a range of estimates for comparator markets, it tends to be on the weaker side.

The structural approach to model competition includes the structure-conduct-performance (SCP) paradigm and the efficiency hypothesis. Using the SCP framework, we investigate whether a highly concentrated market causes collusive behaviour among larger banks resulting in superior market performance; whereas under the efficiency hypothesis we test whether it is the efficiency of larger banks that makes for enhanced performance. Using Granger causation test, we establish that the efficiency Granger causes concentration and using instrumental variable approach, the study establishes that market power and concentration as measured by market share and Herfindahl index, respectively, positively affect bank profitability. In addition, bank efficiency also affects bank profitability. Other factors that affect bank profitability include operational costs, taxation and core capital requirement.

A major policy implication derived from this analysis is that the Ugandan banking system has been subject to deep structural transformation since the early 1990s. Advances in information technology, liberalization of international capital movement, consolidation and privatization have permitted economies of scale in the production and distribution of services and increased risk diversification. These forces have led to lower costs and, undoubtedly, higher efficiency. However, to ensure that lower costs are passed through to households and firms, greater efficiency must be accompanied by a similar strengthening in the competitive environment in the banking sector.

Acknowledgements

1. Introduction

A high degree of efficiency in the banking system can contribute to greater financial stability, product innovation, and access by households and firms to financial services, which in turn can improve the prospects for economic growth. In addition, efficiency in the banking sector is a precondition for macroeconomic stability and important for effective monetary policy execution. Thus, research on banking system efficiency has important policy implications. While there has been a rapidly growing literature on banking efficiency issues in developed countries, little attention has been paid to the efficiency of banks in developing countries, yet there is an increasing recognition that financial sector development is a top priority to sustain economic growth in developing countries, particularly among the more successful reformers, such as Uganda.

Moreover, whereas the Ugandan banking industry experienced a profound transformation subsequent to financial liberalization, the consolidation in Uganda's banking industry in recent years has created a genuine concern about the possible effects that this phenomenon could have on the level of competition in the industry. Related to this has been the continuing increase in the banking sector's profitability. According to the literature, there are two possible explanations. One explains increase in profit by efficiency improvements that increase the total surplus, and the other explains increase in profits by the increase in market shares and market power. It is crucial to determine which of these two theories better – and more accurately – describes the behaviour of increasing bank profits, since the economic policy implications derived from these theories are radically diverse. If the market power paradigm (MP) uncovers more substantial empirical support, authorities should put major emphasis on promoting competition, regulating prices in the industry and discouraging mergers. Should the efficient paradigm (ES) prove more accurate, however, some of these management measures could be detrimental to banking service users by inhibiting industry development and service quality improvement. This paper aims to contribute to the existing literature by analysing the banks efficiency and the profit–structure relationship of Uganda's banks.

Statement of the research problem

Financial markets and institutions are central to economic development and growth. In a perfect world characterized by an Arrow-Debreu economy, there is no role for the financial services sector and intermediation, in general. In this perfect world there is a complete set of state contingent claims, and transaction costs are absent, making the role of financial intermediation irrelevant. The Modigliani and Miller (1958) argument further underpins the perfect economy world where financing decisions of firms are irrelevant to the value of the firm. In this case the financial intermediation process does exist, but the way it is utilized is irrelevant to the value of the firm. In reality, though, the economy is imperfect and exhibits transaction and information acquisition costs. In this respect the existence of financial intermediaries such as banks becomes necessary because they assist in the acquisition of information about firms and households and will alter the allocation of credit in the economy. Indeed, any contractual arrangement that ensures the repayment of loans will encourage savers and lenders to lend and this influences the savings pattern. The existence of capital markets allows households and firms to insure against consumption shocks and allocate consumption across time and space via the trading of security instruments.

Financial systems tend to evolve around a banking sector seeking to achieve economies of scale in order to offset the costs of collecting and processing information designed to reduce uncertainty thereby facilitating a more efficient allocation of financial resources. The importance of a strong banking sector to a country's economic growth and development is well-established in the literature (Beck, Levine and Loayza, 2000; Levine, 1997). Efficient financial systems help countries to grow, partly by widening access to external finance and channelling resources to the sectors that need them most. A well-developed financial system can also help an economy cope better with exogenous shocks such as terms of trade volatility and move them away from natural resource-based development. In a well-functioning economy, banks tend to act as quality controllers for capital seeking successful projects, ensuring higher returns and accelerating output growth. It is necessary for the banking system to be competitive, however, in order to ensure that banks are effective forces for financial intermediation channelling savings into investment fostering higher economic growth.

Banks are the predominant financial institutions in most developing countries and in Uganda comprise over 80% of the financial system. Banks are the primary mechanisms for the transmission of monetary policy and they play an important role in determining the supply of money in the economy. They also form the backbone of the payments system. Therefore, changes in the structure and performance of banks can have far-reaching implications for the whole economy. Uganda's banking industry is highly concentrated and many studies in the banking literature elsewhere and in the more general industrial organization literature find a positive statistical relationship between performance and measures of market structure – either concentration or market share. This could therefore suggest that the recent wave of buyouts and mergers in Uganda's banking industry is motivated by the prospective benefits from greater market power created by increasing the concentration or market shares of the merging banks. The

traditional structure-conduct-performance hypothesis asserts that this finding reflects the setting of prices that are less favourable to consumers (lower deposit rates, higher loan rates) in more concentrated markets as a result of competitive imperfections in these markets. This study is therefore intended to enrich the debate on the nature of competition and the market structure and performance of Uganda's banking sector. Moreover, since Uganda's financial sector has gone through reforms, it is important to understand their impact on the structure of the industry and therefore perhaps deduce how they are likely to affect the growth potential of the economy. A previous study by Nannyonjo (2002) on the impact of the structure of Uganda's banking sector and its effect on profitability indicated no significant impact. This could have resulted from misspecification as efficiency could cause concentration and market share would therefore bias the results if all of these variables are assumed to be weakly exogenous in the profits reduced form equation. Here we extend this concept by testing for causation and adopting appropriate specification and estimation methods.

Literature suggests a relationship between competition and efficiency and between market structure and performance. These relationships have generated competing hypotheses. On one hand, the traditional collusion hypothesis, also called the structure-conduct-performance hypothesis (Bain, 1951), proposes that market concentration lowers the cost of collusion between firms and results in higher than normal profits. On the other hand, the efficient structure hypothesis (Demsetz, 1973) postulates an alternative explanation for the existence of a positive correlation between concentration and profitability, affirming that the most efficient firms obtain greater profitability and market share and, consequently, the market becomes more concentrated. In this case, the positive observed relationship between concentration and profits is spurious and simply proxies for the relationship among superior efficiency, market share and concentration.

This study is particularly relevant for Uganda's economy given the high degree of concentration in its banking market. It is important to determine the level of competition and how this is linked to concentration, and whether the structure of the banking system does affect profitability. For instance, if the current trends in market structure and performance reflect collusive or other forms of non-competitive behaviour of Ugandan banks, the policy that has permitted some banks that are perceived as more efficient to acquire the branches of closed banks or to buy out other less efficient banks is likely to lead to a reduction in market competition, raise costs and may lead to welfare losses as a result of unfavourable interest rates.

Broadly, the knowledge about bank behaviour, pricing and efficiency in Uganda is limited. There is a gap in empirical work on whether market concentration and/or efficiency of the banking system have increased in the era of financial liberalization. This study analyses the relationship between banks performance in terms of returns on assets and market structure (concentration and market share) applying stochastic frontier approach to estimate a direct measure of efficiency of Ugandan banks. The study particularly contributes to the scanty empirical evidence on the behaviour of structure-performance of banks under a liberalized financial system in Uganda.

Objectives of the study

A financial system's contribution to the economy depends on the quantity and quality of its services and the efficiency with which it provides them. As mentioned above, by the late 1980s a repressive government, interest rate controls and non-price rationing mechanisms severely undermined Uganda's financial sector and significantly retarded its development (Kasekende and Atingi-Ego, 2003). Ambitious reforms were initiated later aimed at redefining the structure and operation of the system and the subsequent easing of entry, removing financial taxation by eliminating mandatory investments and reducing the reserve requirement ratio, phasing out direct monetary policy, privatizing the state-owned financial institutions, and strengthening prudential norms. The impact and experience of the reforms offer no simple solution to the pre-reform glaring deficiencies particularly in terms of the dominance of the industry by few institutions, limited credit extension, and high and rising intermediation margins. In particular, a weak financial market limits the efficient aggregation and allocation of resources and subsequently causes waste in those sectors and enterprises that are less well linked into the financial pipelines. Moreover, the recent reforms, particularly the privatization of the dominant Uganda Commercial Bank (UCB) and consolidation within the banking system, may have resulted in a sound but uncompetitive and thus inefficient system that could have failed to deliver on greater access and financial deepening although they could have increased the sector's profitability.

Uganda's banking industry is undergoing unprecedented changes, caused by the deregulation of financial services, strengthening of regulatory and supervision frameworks, and developments in information technology. An integral part of the process has been the liberalization of international capital movements. Many of these changes could have had vast implications for competition and concentration in the banking and financial sectors. The combination of improvements and unfulfilled potential warrants a new look at Ugandan banking sector. One of the consequences has been mergers and buyouts which has increased concentration.[i] This process of concentration may affect competition, in particular on local markets for retail banking services. Questions may arise such as: Should concentration be slowed down? Or are additional measures needed to ensure sufficient competition in Uganda's banking industry? Besides, increased concentration and the size of the global players may cause concerns about financial stability. In order to judge the implications of these developments, one has to examine the banking industry's current market structure so as to determine the degree of competition and to investigate the impact the concentration is likely to have on the market structure and the behaviour of banks.

A high degree of competition and efficiency in the banking system can contribute to greater financial stability, product innovation, and access by households and firms to financial services, which can in turn improve the prospects for economic growth. In this respect, there is a concern that a monopolistic or oligopolistic, inefficient, and fragile banking sector in Uganda is a major hindrance to economic development. Identifying the kind of reforms and environments that may help to promote competition

and efficiency in Uganda's banking system is therefore important.

The literature on the measurement of competition may be divided into two mainstreams, the structural approach and the non-structural approach. The structural approach to modelling competition includes the structure–conduct–performance (SCP) paradigm and the efficiency structure hypothesis (ESH), as well as a number of formal approaches with roots in industrial organization theory. The SCP paradigm investigates whether a highly concentrated market causes collusive behaviour among larger banks, resulting in superior market performance; whereas the efficiency hypothesis tests whether it is the efficiency of larger banks that makes for enhanced performance. Neither the SCP nor the ESH resolves the debate of the bank profitability (Berger, 1995; Berger and Humphrey, 1997). It is argued that both theories centre on profitability rather than the deviation of output price and marginal cost, which is the basis for analysing competition conditions.

In reaction to the theoretical and empirical deficiencies of the SCP and ESH, the industrial organization models show that the competitiveness of an industry cannot be measured by market structure indicators alone such as Herfindahl-Hischman index and other concentration indexes. The threat of entry can be a more important determinant of the behaviour of market participants. This theory also suggests that performance measures, such as the size of the banking margins or profitability, do not necessarily indicate the competitiveness of a banking system. Such measures are influenced by a number of factors, including a country's macro performance and stability, the form and degree of taxation of financial intermediation, the quality of country's information and judicial systems, and bank specific factors like scale of operations and risk preferences. As such, these measures can be poor indicators of the degree of competition.

Banks are the predominant financial institutions in Uganda and structural consolidations within the sector, reflecting both mergers and failures, have prompted concerns over the potential for monopoly power in the system. In assessing the likely impact of these changes on the industry conduct, it is useful to explore the degree of competition in the banking system and how the structure of the system affects performance. This study therefore measures the degree of competition in Uganda's banking industry and investigates the impact of concentration on competition. It also examines how banks' profitability is linked to the industry's market structure. By providing an analysis of the interrelationship between banks' performance and the market structure, the study contributes to a better understanding of the factors that spur bank performance, and thereby deduces the financial sector factors likely to have an impact on the growth of the economy.

Specific objectives are:
* To examine the competitiveness of Uganda's banking industry.
* To examine Uganda's banking industry market structure and its impact on banks' profitability.
* To examine bank efficiency and its possible impact on the market structure (concentration and market share).

- To empirically ascertain the relative strength of market power and efficiency in explaining the banks' profitability.

The study tests the following hypotheses:

a) Uganda's banking sector is uncompetitive.
b) Competition is negatively correlated with concentration.
c) Efficiency has a positive impact on market concentration and market share.
d) The banking industry market structure and efficiency positively affect the banks' profitability.

The remainder of the paper is organized as follows. Section 2 summarizes the trends in Uganda's banking system. Section 3 surveys contributions relating to bank competition, efficiency and performance. Section 4 presents the theoretical framework, derives empirical equations and estimates the models. It also summarizes the estimation results and while Section 5 concludes.

2. Cursory sketch of Uganda's financial system

Financial markets and institutions are central to economic develop ment and growth. Increasingly, scholars acknowledge that supportive policy for financial sector development is a key component of national development policy. A comparative analysis of the growth rates of different countries has produced convincing evidence that having a deeper financial system contributes to growth – and is not merely a reflection of prosperity (Honohan and Beck, 2007). Moreover, the development of the financial sector is fundamental to the conduct of monetary policy. Countries with deep financial systems also seem to have a lower incidence of poverty than others at the same level of national income. At the firm level, firm growth responds to access to credit and to the conditions that favour such access.

The economies of East Asia have shown how putting national savings to work in productivity—increasing investment can sustain rapid growth. In Asia and Latin America, micro finance innovations have helped low-income households manage risks through savings (Beck, Demirgüç-Kunt, and Levine, 2004; Beck, et al., 2000; Honohan , 2004). Such innovations have empowered energetic micro-entrepreneurs, giving them the first step up the ladder of prosperity and lifting living standards in the areas where they operate. Innovations in the technology for remittances and novel techniques in insurance have also played an important role in improving welfare. By bridging the gap between savers and entrepreneurs, financial systems not only reduce the risks on both sides but also open up opportunities to both sides. They can reduce the barriers to entry for entrepreneurs, thereby allowing the economy at large to benefit in terms of increasing employment, improving the price and quality of services, and reducing the stifling influence of established monopolies. Given access to the necessary finance, farmers can move to a higher level of productivity and output. Savers, too, can share in the returns on an expanded flow of investment. Housing, insurance and pension arrangements can be lifted to a new plane.

The Ugandan banking system has been subject to deep structural transformation since the early 1990s. At that time, the banking sector mainly comprised of four international banks (Standard Chartered, Standard Bank, Barclays and Bank of Baroda), and the two large indigenous banks (Uganda Commercial Bank and Cooperative Bank) that controlled 70% of the banking assets and liabilities but were insolvent. By the end of 2007, the system had grown substantially and was made up of a formal and an informal sector. The formal sector encompassed the central bank, 16 commercial banks (Tier 1), 4 credit institutions (Tier 2), 4 microfinance deposit-taking institutions (Tier 3), the National Social Security Fund (NSSF), 19 insurance companies, 84 foreign exchange bureaux, 3 development institutions, and a stock exchange. The informal sector consists of a wide range of moneylenders, savings and credit cooperative societies (SACCOs), rotating savings and credit association (ROSCAs), and microfinance institutions (MFIs).

There has been considerable progress in expanding the outreach of the informal financial institutions and improving the access to financial services especially by the rural population. Despite the proliferation, however, several commercial banks were closed; in fact, the commercial bank branch network of about 187 in 2008 compared with 290 in 1972 appears to depict a contrary picture of the industry. This resulted in a rapid deterioration in the ratio of customers per bank branch from 34,000 in 1972 to 80,000 and 100,000 in the 1980s and 1990s, respectively, and to about 190,000 in 2005. A higher number of customers per branch is often associated with congestion and poor services, and Uganda levels compare very poorly with the average of 7,000 customers per bank branch for the Common Market for Eastern and Southern Africa (COMESA) region (Meyer et al., 2004). However, this could also be a reflection of a switch from investment in branches to investment in communication networks and information technology.

While Uganda has a well-developed and diversified microfinance industry, it nonetheless suffers low capitalization and legal restrictions. These handicaps limit the industry's ability to meet the development finance needs of the rural and micro enterprise sectors that form the bulk of Uganda's productive enterprises and account for more than 50% of its GDP. Thus, microfinance cannot overcome the chronic shortage of larger and longer-term loans to small-scale enterprises, especially in the commercial farming sector. On the other hand, Uganda's capital market is not developed enough to play any significant role in furnishing long-term funds to the economy and the pension system is very weak where mobilizing long-term funding is concerned. Moreover, the expansion of unregulated SACCOs, ROSCAs and MFIs causes concern about the safety of small-balance deposits, which they illegally hold. Some of these institutions use subsidized funds from the government supported Microfinance Support Centre, which might introduce distortions by weakening the credit culture and thus undermine the viability of these institutions.

Since the reforms aforementioned, the banking industry has been strengthened in many important aspects and is now stronger and more vibrant but still underdeveloped compared with other developing countries. Financial deepening has shown a positive

trend, in part achieved through effective supervision and enforcement of prudential regulations in the banking system, along with increased frequency of on-site inspections and surveillance. In addition, improvements in supervision methodology and the prudent management of monetary and exchange rate policy by the Bank of Uganda have contributed to strengthening the financial sector. This indeed has contributed to minimizing the non-performing assets (NPA) as well as enhancing the profitability of the sector. NPA fell from 29% of the portfolio in 1999 to 12% in 2000 and further to 3.9% in 2007. The cleanup of the portfolio of the erstwhile Uganda Commercial Bank, and its subsequent resolution, and the closure of troubled banks are key factors in explaining this improvement.

Overall, although financial depth remains shallow, signs of recovery are unmistakable and encouraging. Financial intermediation is low, playing a limited role in the provision of funds for development finance, and is dominated by commercial banks. Basic indicators of financial development, such as the broad-money/GDP and currency-broad money ratios, suggest that the financial sector is still underdeveloped (Figure 1). As shown in Table 1, which compares some East African Community countries, while the levels of liquid liabilities to GDP, bank deposits to GDP and private credit to GDP are similar to those in Tanzania, they are below those of Kenya and the overall average for sub-Saharan Africa and the low-income group. The banking system also intermediates a smaller share of deposits into credit to the private sector, as indicated by the lower loan-deposit ratio than in comparator countries. Interest margin and overhead costs are higher than in comparator countries, suggesting inefficiencies in the system, which may arise out of its small size, higher operating costs, and/or low levels of competition. A significant proportion of deposits consists of foreign exchange typically held at international banks; a large part of these deposits is not invested onshore but placed in the international money markets.

Table 1: Financial intermediation across countries, 2004

	Private credit / GDP	Liquid liabilities / GDP	Loan deposit ratio	Over-head costs	Interest margin	Over-head costs	Gov. and other securities/ Assets	Forex deposits/ total deposits
Uganda	5.8%	14.9%	38.9%	7.9%	13.4%	9.1%	35.0%	32.0%
Kenya	22.6%	34.9%	60.1%	6.1%	6.7%	5.1%	24.0%	16.0%
Tanzania	6.8%	16.7%	40.9%	7.0%	7.7%	6.4%	20.0%	37.0%
SSA	19.1%	23.6%	74.2%	6.1%	8.3%	6.7%		
Low-income	15.0%	22.1%	70.0%	5.9%	7.5%	6.2%		

Source: Hauner and Peiris, 2005.

In addition, the system is dominated by the commercial banking sector, which by 2007 accounted for almost 80% of total sector assets. Other financial intermediaries are limited in number, small in size and relatively ineffective. Consequently, only a limited number of financial instruments are available for savings mobilization, liquidity management and portfolio diversification.

Figure 1: Financial sector indicators(%): 1966–2007
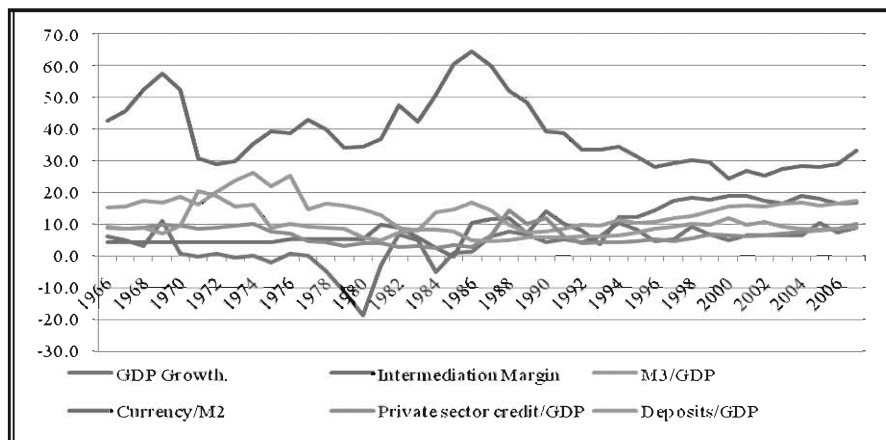
Source: World Bank, World Development Indicators, 2008.

Another key feature of the Ugandan banking sector is the degree of concentration on both asset and liability portions of the balance sheet. Loans to the top five borrowers for each bank on the aggregate represent about 24% of total loans of the system. On the deposit side, the top five depositors for each bank on the aggregate account for about 21% of total deposits in the system. Measured by the three-bank asset concentration index, market concentration averaged 55.5% between 1993 and 1998 and increased to 64.6% between 1999 and 2005. The share of deposits increased from 54.3% to 72.2% in the same periods, but the share of loans remained at the same level. Furthermore, treasury bills have become the most popular forms of investment for the commercial banks. Moreover, high interest rates paid on treasury bills mean that banks can be assured of high and safe returns simply by devoting a large proportion of their assets to them. Thus, although total bank deposits have increased almost tenfold since the late 1980s, they have not been translated into more affordable credit for private investment. Given that commercial banks are the predominant source of external financing, the shift in their asset portfolio away from credit to the private sector is likely to have significant implications for firm performance. Firms that are riskier or that have lower profitability are likely to be crowded out of the market for external financing. It follows that small and medium firms could be the most affected by this development. The banking system still offers a limited array of products and is limited mostly to the short end of the maturity curve: Only 17% of total deposits are time deposits and less than 0.4% of time deposits have a maturity of more than 12 months. Only 12% of all loans and 35% of loan volume have an outstanding maturity of more than one year. Long-term lending is almost nonexistent. Leasing and mortgage finance alike suffer the lack of medium to long-term funding sources.

3. Literature review

Banking efficiency is instrumental to economic development (Fry, 1995; Barajas, et al., 2000; Chirwa, 2001; Randell, 1998). Inefficiencies in the financial sys tems of most developing countries have persisted even though many of these countries have undertaken financial liberalization over the past two decades or so. Gelbard and Leite (1999) observe that in many Sub-Saharan Africa (SSA) countries the range of financial products remains extremely limited, interest rate spreads are wide, capital adequacy ratios are often insufficient, loan recovery is a problem and the share of non-performing loans is large. The expectation is that removing government controls on interest rates and lifting barriers to entry into the financial system would lead to greater competition and improve performance of the financial institutions. A number of studies have argued that unless bank behaviour changes, financial liberalization cannot be expected to lead to a significant improvement in the efficiency of the financial system.

There are several explanations for limited changes in the financial system efficiency following financial liberalization. First, following Bain's (1951) market structure, conduct and performance hypothesis in the industrial organization literature, poor performance may persist if financial sector reforms do not significantly alter the structure within which banks operate. Gibson and Tsakalotos (1994) point out that competitive pressures resulting from conditions of free entry and competitive pricing will raise the functional efficiency of intermediation by decreasing the spread between deposits and lending rates. Although the empirical evidence of a positive and significant relationship between market structure and banks' performance yields non-robust results, there is compelling evidence to suggest that market structure plays an important role in altering the performance of banks (Gilbert, 1984; Berger and Hannan, 1989; Molyneux and Forbes, 1995; Demirguc-Kunt and Huizinga, 1999). The most recent literature (Barajas et al., 1999, 2000) supports the hypothesis that banks performance indicators are positively related to market power.

Second, the removal of credit controls during financial liberalization may worsen the quality of loans, which may in turn lead to increased risks of systemic crises.

Brownbridge and Kirkpatrick (2000) note that liberalization of interest rates and removal of credit controls may allow those that are not constrained by prudential regulations to invest in risky assets in order to maintain larger market shares. This may reduce the quality of assets and may result in a higher proportion of non-performing loans and provisions for doubtful debts. Banks tend to offset the cost of screening and monitoring attributable to bad loans or the cost of forgone interest revenue by charging higher lending rates (Barajas et al., 1999). These responses are likely to affect the banking sector's performance. Randell (1998) finds support for the positive and significant association between poor bank performance and provisions for doubtful debts in the Caribbean countries. Barajas et al., (1999, 2000) further confirm that the cost of poor quality assets is shifted to bank customers through higher spreads in the Colombian financial system. Brock and Rojas-Suarez (2000), however, find a significant negative relationship in the cases of Argentina and Peru.

Third, there is overwhelming empirical evidence that high non-financial costs are also a source of persistent inefficiency in the banking sector in developing countries. Non-financial costs reflect variations in physical capital costs, employment and wage levels. High non-financial costs may result from inefficiency in bank operations that may also be shifted to bank customers, particularly in imperfect markets. Dermirguc-Kunt and Huizinga (1999) find evidence of a negative relationship between bank performance and overhead costs. Barajas et al. (1999, 2000) and Brock and Rojas-Suarez (2000) also find significant evidence of the positive relationship between bank inefficiency and non-financial costs.

Fourth, macroeconomic instability and the policy environment may also affect the pricing behaviour of commercial banks and therefore their performance. In order to capture the effects of the macroeconomic and policy environment, the bank performance equations include inflation, growth of output and money market real interest rates as control variables. For example, Claessens et al. (2001), Dermirguc-Kunt and Huizinga (1999), and Brock and Rojas-Suarez (2000) note that banking industry performance and inflation are negatively associated.

In summary, whilst financial liberalization should generally lead to improved banking sector performance, whether actual improvement occurs will depend on a number of factors. Generally, banks' efficiency can increase or remain low depending on the competitiveness of the banking system, the cost structure of the market, the sophistication of the banking system and the macroeconomic environment.

According to the literature on industrial organization, there are two main explanations for the likely impact of market structure on the conduct and performance of firms: market power and efficiency. The market power explanation has two hypotheses: the Structure-Conduct–Performance (SCP) hypothesis and the Relative Market Power (RMP) hypothesis. The traditional structure-conduct-performance hypothesis is based on the proposition that the persistence of economic profits is indicative of allocative distortions, and is due to some features of market structure that foster collusion and retard competition among firms in the industry (Bain, 1951). Since concentration facilitates collusive or monopolistic practices, firms in concentrated markets will earn higher profits than firms operating in less concentrated markets irrespective of their efficiency. This hypothesis suggests that banks in concentrated markets would be able

to extract monopolistic rents by their ability to offer low deposit rates and high loan rates. For its part, the relative market power hypothesis states that only firms with large market shares and well-differentiated products are able to exercise market power in pricing these products and earning supernormal profits (Shepherd, 1986).

In contrast to these two market power theories, there are two efficiency explanations of the positive relationship between profits and either concentration or market share, that is, of the positive profit-structure relationship. The *X-efficiency* version of the efficient-structure hypothesis posited by Demsetz (1973) asserts that efficient firms increase in size and market share because of their superiority in producing and marketing products. Here, the positive profit-structure relationship is spurious, rather than of direct origin, with efficiency driving both profits and market structure. It is due to such expansion that the degree of concentration of a market increases, while at the same time the firms increase their profits.

Under the *Scale-efficiency* version of the efficient-structure (ES) hypothesis, firms have essentially equally good management and technology, but some firms simply produce at more efficient scales than others, and therefore have lower unit costs and higher unit profits. These firms are assumed to have large market shares that may result in high levels of concentration, again yielding a positive profit-structure relationship as a spurious outcome (Lambson, 1987). The two market power hypotheses have radically contrasting implications from the two efficient-structure hypotheses.

The traditional concerns about concentration in product markets focuses on the social loss associated with the exercise of market power at high levels of concentration. The higher prices in concentrated markets bring about a restriction of output relative to the competitive level and thereby misallocate resources. The social cost of this misallocation has been approximated by the difference between loss in consumer surplus and gain in producer surplus occasioned by non-competitive pricing. Another possible social loss associated with the exercise of market power focuses on lessened effort by managers to maximize operating efficiency because competitive pressure is reduced. Thus, in addition to the traditionally reorganized higher prices and reduced output from market power, there may also be higher cost per unit of output in concentrated markets because of slack management (Berger and Hannan, 1989; Caves and Barton, 1990). This could also result in managers pursuing objectives other than bank profits or managerial leisure, e.g., the expansion of staff or other utility-enhancing inputs beyond levels justified by profit maximization (expense preference behaviour) or the reduction of risk below levels justified by maximization of shareholder value (Hannan and Mavinga, 1980). Another cost related argument is that managers may expend resources to obtain and maintain market power. For example, banks might spend resources on lobbying efforts to limit the number of banks or to preserve geographic restrictions on branching in order to maintain barriers to entry and impediments to competition. Such expenditures would raise costs and reduce measured cost efficiency, although profits may be higher as a result. In addition, the price cushion provided by market power may simply allow inefficient managers or practices to persist without any intention to pursue goals other than maximizing bank value. The lack of market discipline in concentrated markets may simply blunt the economic signals that would normally force changes in management to keep costs low, leaving managers in positions for which they do not have competitive

advantages. Thus, market power may allow managerial incompetence to persist without any wilful shirking of work effort, pursuit of other goals, or efforts to defend or obtain market power (Berger and Hannan, 1989). One conclusion is that banks in concentrated markets may take advantage of market power, but much of the benefit of this power may be manifested as higher costs rather than as higher profits.

A number of studies, most of them in developed countries, have been carried out to test these hypotheses but there is no conclusive evidence in relation to either (Shepherd, 1986; Smirlock et al., 1984; Smirlock, 1985; Evanoff and Fortier, 1988; Berger and Hannan, 1989; Berger, 1995; Goldberg and Rai, 1996).

The most recent refinements to the tests of the two hypotheses are done by Berger (1995), who uses direct measures of both X-efficiency and scale-efficiency in the empirical analysis in order to explain whether the structure-profit relationship reflects superior management or greater market power of firms with large market shares. His results provide no conclusive evidence to support fully either of the two hypotheses.

As a first-order effect, one would expect increased competition in the financial sector to lead to lower costs and enhanced efficiency, even allowing for the fact that financial products are heterogeneous. Recent research has highlighted, however, that the relationships between competition and banking system performance, access to financing, stability and growth are more complex (Vives, 2001). Market power in banking, for example, may up to a degree be beneficial for access to financing.

Using bank level data for 77 countries, Demirguc-Kunt, Leaven, and Levine (2004) investigate the impact of bank concentration and regulations on bank efficiency. They find that concentration has a negative and significant effect on the efficiency of the banking system except in rich countries with well-developed financial systems and more economic freedoms.

Overall, the evidence on the structure-performance relationship in banking is mixed, and this is one area that has remained inconclusive in both methodology of testing the relationship and the results. Whereas Berger (1995) and Goldberg and Rai (1996) make a significant contribution to the methodology of testing the two hypotheses by including measures of efficiency directly into the profit function, the derived efficiency measure may be biased since it does not isolate shifts in the efficiency frontier due to technical change from changes in the average efficiency of banks. Rapid technical progress that leads to the production of more output with the given level of inputs could, for instance, result in lower average bank efficiency even if banks became increasingly productive over time.

These new empirical industrial organization approaches measure competition and emphasize the analysis of the competitive conduct of banks without using explicit information about the structure of the market. They determine the impact of monopoly and oligopoly power by estimating the deviation between marginal cost and competitive pricing without explicitly using the market structure indicator. The reduced-form revenue model from Rosse and Panzar (1977) and the Bresnahan (1982) and Lau (1982) mark-up model are two of the important methods in this strand of literature. Both approaches are derived from profit-maximizing equilibrium conditions. The model of Bresnahan (1982) and Lau (1982), uses the condition of general market equilibrium. 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 Rosse-Panzar (R–P) model works well with firm-specific data on revenues and factor prices, allows for bank-specific differences in production function, and does not require information about equilibrium output prices and quantities for the firm or/and industry. In addition, the Rosse-Panzar model is robust even in small empirical samples, while the Bresnahan-Lau mark-up model tends to exhibit an anticompetitive bias in small samples (Shaffer, 2001).

A number of studies have applied either the Bresnahan or the Panzar and Rosse methodology to the issue of competition in the financial sector, although mostly to the banking system specifically. For example, Shaffer (1989) studies a sample of US banks and finds results that strongly reject collusive conduct, but are consistent with perfect competition. Using the same model, Shaffer (1993) finds that the Canadian banking system was competitive over the period 1965–1989, although being relatively concentrated. Shaffer (2001) uses the Bresnahan model for 15 countries in North America, Europe, and Asia during 1979–91. He finds significant market power in five markets and excess capacity in one market. Estimates were consistent with either contestability or Cournot type oligopoly in most of these countries. Shaffer (1982) applies the P–R model to a sample of New York banks using data for 1979 and found monopolistic competition. Nathan and Neave (1989) studies Canadian banks using the PR methodology and found results consistent with the results of Shaffer (1989) using the Bresnahan methodology, i.e., rejection of monopoly power. Several papers have applied the PR methodology to European banking system (Molyneux et al., 1994; De Bandt and Davis, 2000). Generally, these studies reject both perfect collusion and perfect competition, and find mostly evidence of monopolistic competition. Tests on the competitiveness of banking systems for developing countries and transition economies using these models are few to date.

4. Methodology: Baseline theoretical model

Rosse and Panzar (1977) and Panzar and Rosse (1987) formulated simple models for oligopolistic, competitive and monopolistic markets and developed a test to discriminate among these models. The model[ii] assumes that firms can enter or leave rapidly any market without losing their capital, and that potential competitors posses the same cost functions as firms that already serve in the market. The key argument is that if the market is contestable, the threat of market entry with price-cutting by potential competitors enforces marginal cost pricing by incumbents, so that in equilibrium they will not earn excess profits and no entry is observed to occur. The test of the model is based on properties of a reduced-form revenue equation at the firm or bank level and uses a test statistic, H, which under certain assumptions can serve as a measure of the competitive behaviour of banks. The test is derived from a general banking market model, which determines equilibrium output and the equilibrium number of banks, by maximizing profits at both the bank level and the industry level. This implies, first, that bank i maximizes its profits, where marginal revenue equals marginal cost:

$$R'_{it}\left(y_{it}, n_t, k_{it}\right) - C'_{it}\left(y_{it}, p_{it}, q_{it}\right) = 0 \tag{1}$$

where R_{it} refers to revenues and C_{it} to costs of bank i, prime denotes marginal, y_{it} is the output of bank i, n is the number of banks, P_{it} is a vector of m factor input prices of bank i, k_{it} is a vector of exogenous variables that shift the bank's revenue function, and q_i is a vector of exogenous variables that shift the bank's cost function. Second, at the market level, it means that, in equilibrium, the zero profit constraint holds:

$$R^*_i\left(y^*, n^*, k^*\right) - C^*_i\left(y^*, p, q\right) = 0 \tag{2}$$

Variables marked with an asterisk (*) represent equilibrium values. Market power is measured by the extent to which a change in factor input prices is reflected in the equilibrium revenues earned by bank i. Panzar and Rosse define a measure of competition H as the sum of the elasticities of the reduced-form revenues with respect to factor prices:

$$H = \sum_{i=1}^{m} \frac{\partial R_i^*}{\partial p_i} \frac{p_i}{R_i^*} \tag{3}$$

The first market model Panzar and Rosse investigated describes monopoly. The monopoly analysis includes the case of price-taking competitive firms, as long as the prices they face are truly exogenous, that is, as long as their equilibrium values are unaffected by changes in the other exogenous variables in the model. An empirical refutation of "monopoly" constitutes a rejection of the assumption that the revenues of the banks in question are independent of the decisions made by their actual or potential rivals. Panzar and Rosse proved that under monopoly, an increase in input prices will increase marginal costs, reduce equilibrium output and subsequently reduce revenues; hence H will be zero or negative. This is a very generalized result, requiring little beyond the profit maximization hypothesis itself. Along similar lines, Vesala (1995) proves that the same result holds for monopolistic competition without the threat of entry, i.e., with a fixed number of banks. Thus, this case also falls under monopoly. In the case where the monopolist faces a demand curve of constant price elasticity $e>1$ and where a constant returns to scale, Cobb–Douglas technology is employed, Panzar and Rosse proved that H is equal to $e–1$. Hence apart from the sign, the magnitude of H may also be of importance, as H yields an estimate of the Lerner index of monopoly power, $L = [(e–1)/e] = H/(H–1)$.

Three other commonly employed models for an industrial market investigated by Panzar and Rosse are monopolistic competition, perfect competition and conjectural variation oligopoly, all of which happen to be consistent with positive values for H. In these models, the revenue function of an individual bank depends on the decisions made by its actual or potential rivals. For monopolistic and perfect competition, the analysis is based on the comparative statics properties of the Chamberlinian equilibrium model. This model introduces interdependence into banks' structural revenue equations via the hypothesis that, in equilibrium, free entry and exit results in zero profits. Under a set of general assumptions, it can be proved that under monopolistic competition, $0<H<1$. Positive values of H indicate that the data are consistent with monopolistic competition but not with individual profit maximization as under monopoly conditions. In other words, banks produce more and the price is less than would be optimal in each individual case. A priori, monopolistic competition is most plausible for characterizing the interaction between banks, as it recognizes the existence of product differentiation and is consistent with the observation that banks tend to differ with respect to product quality variables and advertising, although their core business is fairly homogeneous.

In the limited case of the monopolistic competition model, where banks' products are regarded as perfect substitutes of one another, the Chamberlinian model produces

the perfectly competitive solution, as demand elasticity approaches infinity. In this perfect competition case, $H=1$. An increase in input prices raises both marginal and average costs without – under certain conditions – altering the optimal output of any individual firm. Exit of some firms increases the demand faced by each of the remaining firms, leading to an increase in prices and revenues equivalent to the rise in costs.

Finally, analysing the conjectural variation oligopoly case, Panzar and Rosse show that strategic interactions among a fixed number of banks may also be consistent with positive values of H. In general, the value of H is not restricted. In the special case of *perfect* collusion oligopoly or a perfect cartel, the value of H is non-positive, similar to the monopoly model. Table 2 summarizes the discriminatory power of H.

Table 2: Discriminatory power of H

Value of H	Competitive environment
$H \leq 0$	Monopoly equilibrium; each bank operates independently as under monopoly profit maximization condition (H is a decreasing function of the perceived demand elasticity) or perfect cartel.
$0 < H < 1$	Monopolistic competition; free entry equilibrium (H is an increasing function of the perceived demand elasticity)
$H = 1$	Perfect competition; free entry equilibrium with full efficient capacity utilization.

The Chamberlinian equilibrium model described above provides a simple link between H and the number of banks, between market behaviour and market structure. The model is based on free entry of banks and determines not only the output level but also the equilibrium number of banks. Vesala (1995) proves that H is an increasing function of the demand elasticity e, that is, the less market power is exercised on the part of banks, the higher H becomes. This implies that H is not used solely to reject certain types of market behaviour, but that its magnitude serves as a measure of competition. One of the general assumptions underlying the Chamberlinian equilibrium model is that the elasticity of perceived demand facing the individual firm, $e(x,n,w)$, is a non-decreasing function of the number of rival banks. Panzar and Rosse call this a standard assumption, eminently plausible and almost a truism. Vesala's result and this assumption together provide a positive (theoretical) relationship between H and the number of banks, or – in a loose interpretation – an inverse relationship between H and banking concentration.

De Bandt and Davis (2000) show that the P–R approach requires a number of working assumptions. First, banks must be treated as single product firms. Consistent with the intermediation approach to banking, banks are viewed as producing intermediation services using labour, physical capital and financial capital as inputs. Second, higher input prices must not be correlated with higher quality services that generate higher revenues, because such a correlation would bias the computed H statistic. This means, however, that if one rejects the hypothesis of a contestable competitive market, the bias cannot be too large (Molyneux et al., 1996). Third, banks must be in long-run equilibrium.

The empirical P–R model

The empirical application of the P–R approach assumes a log-linear marginal cost function (dropping subscripts referring to bank i)

$$\ln MC = \beta_0 + \beta_1 \ln y + \sum_{i=1}^{m} \delta_i \ln p_i + \sum_{j=1}^{g} \gamma_j \ln q_j \tag{4}$$

where y is output of the bank, p_i are the factor input prices (regarding, e.g., funding, personnel expenses and other non-interest expenses) and q are other variables, exogenous to the cost function as in Equation 1. Equally, the underlying marginal revenue function has been assumed to be log-linear of the form

$$\ln MR = \alpha_0 + \alpha_1 + \ln y + \sum_{i=1}^{h} \varphi_i \ln k_i \tag{5}$$

where k_i are variables related to the bank-specific demand function. For a profit-maximizing bank, marginal costs equal marginal revenues in equilibrium, yielding the equilibrium value for output (denoted by an asterisk):

$$\ln y^* = \left[\left(\beta_0 - \alpha_0 + \sum_{i=1}^{m} \delta_i \ln p_i + \sum_{j=1}^{g} \gamma_j \ln q_j - \sum_{i=1}^{h} \varphi_i \ln k_i \right) \Big/ \left(\alpha_1 - \beta_1 \right) \right] \tag{6}$$

The reduced-form equation for revenues of bank i is the product of the equilibrium values of output of bank i and the common price level, determined by the inverse-demand equation, in logarithms, of the form

$$\ln P = \varpi + \eta \ln \sum_i y_i^*$$

In the empirical analysis, the reduced-form revenue equation yields:

$$\ln R_{it} = \phi_0 + \phi_1 \ln IF_{it} + \phi_2 \ln PE_{it} + \phi_3 \ln KE_{it} + \sum_{k=1}^{K} \lambda_k \Pi_{kit} + \sum_{n=1}^{N} \gamma_g Z_{nt} + \phi_4 D + \varepsilon_{it} \tag{7}$$

where R represents the ratio of revenue to total assets of the bank i at time t; IF is the ratio of annual interest expenses to total funds, or the average funding rate; PE is the ratio of personnel expenses to the total balance sheet, or the (approximated) price of personnel expenses, KE is the ratio of physical capital expenditure and other expenses to fixed assets, or the (approximated) price of capital expenditure, π is a vector of bank specific exogenous factors (without explicit reference to their origin from the cost or revenue function). Bank-specific factors π reflect differences in risks, costs,

size and structures of banks and should, at least theoretically, stem from the marginal revenue and cost functions underlying the empirical P–R. Specifically, for total assets *TA* to control for potential size effects, the risk component can be proxied by the ratio of non-performing loans to total assets (NPA). *Z* is a vector of macro variables that affect banking market as a whole, specifically the nominal treasury bill rate (TBR) and inflation *(Inf)*. We allow for the privatization of UCB to Stanbic Bank with a zero-one dummy (2002–2005=1; and zero otherwise). In addition, we include a dummy variable *(D)* for large banks. ε is a stochastic error term. To allow for heterogeneity across the sample of banks, we use the error-component method, specifically a one-way error component described by: $E_{it} = \eta + \psi_{it}$, where η_i denotes the unobservable bank specific effect and ψ_{it} denotes a random term that is assumed to be white noise.

IF, PE, KE are the unit prices of the inputs of the banks: funds, labour and capital, or proxies of these prices. In the notation of (7), the *H* statistic is given by $\phi_1 + \phi_2 + \phi_3$.

The dependent variable is the ratio of total *interest* revenue to the total balance sheet, as in Molyneux et al. (1994). The decision to consider only the interest part of the total revenue of banks is consistent with the underlying notion inherent in the P–R model, that financial intermediation is the core business of most banks. Shaffer (1982) and Nathan and Neave (1989), however, took total revenue as their dependent variable.

An important feature of the *H*-statistic is that the tests must be undertaken on observations that are in long-run equilibrium. This suggests that competitive capital markets will equalize risk-adjusted rates of return across banks such that in equilibrium, rates of returns should be uncorrelated with input prices. Thus, in the context of the theory of competitiveness and contestability set out in the model above, we specify a model for obtaining measures of the competitive banking environment by including a specification for equilibrium condition:

$$\ln \pi_{it} = \phi_0 + \sum_{j=1}^{3} \phi_j' \ln P_{jit} + \sum_{k=1}^{K} \lambda_k' \Pi_{kit} + \sum_{n=1}^{N} \gamma_g' Z_{nt} + \phi_4 D + v_{it} \qquad (8)$$

where, π_i are net profits to total assets, v is a stochastic term, P_i are the inputs IF , PE and KE , and the remaining variables are as in (7). A condition for long-run equilibrium is that $\Omega = \sum_{j=1}^{3} \phi_j = 0$. Hence, to test for equilibrium, the Rosse-Panzar statistic is calculated with the return on assets replacing bank revenue as the left-hand variable in the regression equation. If we find that $\Omega < 0$, we infer market disequilibrium; whereas $\Omega = 0$ would indicate equilibrium.

Empirical analysis: P–R approach

As shown in Tables 3 and 4, the correlations show a significant and positive correlation between margins and spreads. Overhead costs and loan loss provisions are positively correlated and market share in deposits and loans are negatively correlated with spreads. Overhead costs and ROA are positively correlated with margins.

Table 3: Summary statistics and correlations

Variable	Mean	Median	Std. Dev.	Minimum	Maximum
Margin	0.097	0.090	0.045	-0.252	0.291
Spread	0.181	0.190	0.044	0.010	0.31
Overhead	0.097	0.069	0.041	0.016	0.195
ROA(Pre-tax return on assets)	0.019	0.033	0.103	-1.005	0.210
NPA	0.192	0.041	0.43	0.000	0.295
Liquidity ratio	0.863	0.798	0.359	0.138	2.652
Market share deposits	0.057	0.026	0.076	0.001	0.323
Market share loans	0.062	0.019	0.085	0.000	0.403
EFF (X-efficiency)	0.132	0.276	0.145	0.102	0.345
HERF(Herfindahl asset concentration ratio)	1821.6	1799.8	183.0_1	1432.9	2257.1
CAS (Ratio of core capital to net assets)	0.24	0.12	0.044	0.10	0.310
GASS (Growth of bank's assets)	10.2	1.18	11.7	0.00	13.9
TR (Ratio of taxes to revenue)	15.1	14.6	6.5	12.4	15.4

Table 4: Correlations

	Spread	Margin	Overhead	ROA	NPA	LR	MSD	MSL
Spread	1	0.342***	0.358***	0.121**	0.281***	-0.04	- 0.262***	-0.139***
Margin		1	0.61***	0.222**	0.034	-0.03	-0.093*	0.014
Overhead			1	-0.18***	0.343***	-0.192***	-0.32***	-0.218***
ROA				1	- 0.542***	0.143***	0.133***	0.136***
NPA					1	-0.154***	-0.288***	-0.264***
LR						1	-0.115**	-0.194***
MSD							1	0.876***
MSL								1

*significant at 10%; ** significant at 5%; *** significant at 1%
MSD denotes market share in deposits, and MSL denotes market share in loans.

The estimation is based on Equation 7. We use unscaled total revenue, revenue-assets ratio and interest revenue-assets ratio as dependent variables. Using bank-level quarterly data for the period 1995–2005 and applying an adapted version of the Panzar and Rosse (1987) methodology, we estimate the degree of competition in Uganda's banking system. We estimated the model for the entire period, 1995–2005, and for two subperiods, 1995–1999 and 2000–2005, because the 1995–1999 period was characterized by bank failures and this could have had an impact on the overall performance of the industry. The second period, 1999–2005, was characterized by regulatory reforms and a more strengthened but also more concentrated financial sector after mergers and closure of some banks. The panel can be estimated by fixed effects estimator or random effects estimator depending on the nature of the individual effects, h_i. We use the Hausman test to determine the appropriate estimation method and hence report the results based on the appropriate estimation technique.

Table 6 reports the results of our econometric analysis. The estimates reveal that the estimated value of H is always non-negative and therefore that the Ugandan banking sector is characterized by monopolistic competition according to the Panzar and Rosse classification. Irrespective of model specification, estimation method and the sample period, the H-statistic consistently lies between 0 and 1, with a value of 0.28 on average for the entire period, 0.40 for the 2000–2005 period and 0.31 for the 1995-1999 period. The H-statistic also differs significantly from 1. We interpret H between 0 and 1 as a continuous measure of the level of competition, in the sense that higher values of H indicate stronger competition than lower values. Thus, it seems that competition has increased in recent years.

The model seems to be relatively precisely estimated with a number of statistically significant variables. The results suggest that there has been an increase in competition after the cleaning up of the sector in the 2000-2005 period. The positive value of the H statistic indicates that the industry is characterized by monopolistic competition, hence recognizing the existence of product differentiation and the fact that banks tend to differ with respect to product quality and advertising, although their core business is fairly homogeneous.

The unit cost of funds has a positive sign and is statistically significant at the 1% level. Also the unit cost of labour is statistically significant. The results indicate that for the period 1995–2005, the price of funds provides the highest contribution to the explanation of interest revenues and therefore to the H-statistic, followed by the price of labour. The unit price of labour is significant in all specifications and with similar positive coefficients. This result suggests that personnel costs could be an important driver of overhead costs, which are quite high in Uganda as noted earlier.

Bank size measured by assets is positively related to revenues, hinting at the beneficial effects of size. Other things being equal, the larger the bank, the higher the revenues. This demonstrates strong economies of scale, which not only indicates that the profitability structure of the banking sector is skewed towards the larger banks, but also implies that there could be scope for greater consolidation in the sector in the future.

The estimates based on these two subperiods highlight two salient features. First, the H-statistic increased during the second subperiod compared with the first, although

it was significantly different from both 0 and 1 during both subperiods. Second, while the coefficient for capital was uniform across both subperiods, the coefficient on unit cost of labour increased significantly in the second period and so did the coefficient on the cost of funds.

The non-performing assets have a statistically significant negative effect, but only in the period 1995–1999 confirming that regulatory reforms have strengthened the banking sector particularly as a result of cleaning up the banking system. The treasury bill rate has had a significant and positive effect on interest revenue in both periods, which indeed supports the inclination of banks holding significant proportion of their portfolio in treasury bill. The dummy for large banks is also statistically significant, suggesting that small banks could be vulnerable in the event that their main earning assets, treasury bills, dry up.

For robustness, we estimate an alternative reduced revenue equation in which we include the ratio of total revenue to total assets as the dependent variable. Also, the non-interest revenues of banks have been increasing significantly over the sample period. To take account of the increasing share of non-interest revenues in total revenue, we also estimate the alternative specification of the revenue function, where we replace the dependent variable, interest revenue, with the ratio of total revenue to total assets. The results obtained broadly mirror the earlier findings. Specifically, the value of the H-statistic for the entire period is positive although slightly lower than earlier, confirming the existence of a monopolistic free-entry equilibrium.

In sum, the results reject the monopoly and perfect competition hypothesis and lend credence to the proposition that Ugandan banks earn their revenues as if under monopolistic competition. These results seem to be compatible with the contestable markets theory, if it is assumed that the incumbents set their prices close to the competitive level because of potential competition.

Comparing these results with those obtained elsewhere in Africa using a similar methodology, we find that the H statistic obtained for Uganda is much lower than those for Ghana (0.56), Kenya (0.58), Nigeria (0.67) and South Africa (0.85), which indicates a much lower level of competition in the sense that higher values of H indicate stronger competition than lower values. Overall, it is fair to conclude that the little competition in Uganda's banking system is effectively limited to large international banks. As a result, the international banks are basically insulated from vigorous competition by their size, reputation for deposit safety and international links. Competition between these large banks is largely limited to the top tier corporate clients. The entry restriction that was imposed in 1996 (but lifted in 2002) could also have reduced competition.

A critical feature of the H statistic is that the P–R approach must be based on observations that are in long-run equilibrium. An equilibrium test exploits the fact that in competitive capital markets, risk-adjusted rates of return will be equalized across banks. In such a case, the return rates will not be correlated with input prices. An equilibrium test is provided by Equation 7, after replacement of the dependent variables by the rate of return on total assets (ROA). $H=0$ would then indicate equilibrium, whereas $H < 0$ would point to disequilibrium. We find that the hypothesis of equilibrium

(H=0) cannot be rejected at the 5% significance level (refer to Table 5). With the possible exception of the input price of interest expenses, input prices are not statistically different from zero at the 5% level of significance and have not affected returns to assets in the period 1995-2005. However, the definition of equilibrium is not very clear in the P–R model. Given the internal logic of the model, it is best to think of equilibrium as a steady-state, reflecting adjustments to shocks.

Table 5: Test of equilibrium

	LogROA		
	1995–2005	1995–1999	2000–2005
	Fixed effects	Fixed effects	Fixed effects
Constant	0.018*	0.12	0.19
LogIF	0.081	0.064	0.102*
LogPE	-0.059	-0.045	-0.068*
LogKE	-0.0058	-0.0087*	0.0009
LogTA	0.523**	0.96**	0.65**
LogNPA	-0.078*	-0.14**	-0.043*
LogTBR	0.125***	0.09***	0.167***
LogINFI	-0.009	-0.05***	-0.001
Dummy	0.076**	0.045	0.079**
UCB - dummy	0.08**	0.009	0.10***
Adj. R-squared	0.682	0.615	0.636
F-test	317.3	299.5	325.9
Prob > F	0.000	0.000	0.000
H-statistic	0.016	0.0103	0.035
HO: H=0	F=0.18 accept	F=0.194 accept	F=0.188 accept
SE	0.052	0.056	0.063
Observations	660	300	360

*significant at 10%; ** significant at 5%; *** significant at 1%

Given the dynamic changes within the Ugandan banking scene since financial liberalization, it would be no surprise to find that market equilibrium may not have held over the sample period. One way to deal with this is by using a recursive or rolling estimation approach (Matthews et al., 2007). We test for market equilibrium by running a rolling regression with the aim of identifying periods when the banking market was not in equilibrium. The approach is to fit the model to the first K observations, in our case the starting point is 1995 quarter 1 and next is to use the first *K+1* data points and

compute the coefficient vector again. The same procedure is repeated, adding one sample point at a time, until the final coefficient vector is obtained, based on all n sample points. A summary of the results is reported in Table 6.

Table 6: Test of equilibrium(Rolling sample) dependent variable LogROA

Period (quarters)	LogIF	LogPE	LogKE	H	$H_0 : H = 0$, F-statistic
1995.1–1997.4	0.0006	-0.0096	0.0117	0.0027	0.17
1995.2–1998.1	0.0059	-0.0009	-0.0013	0.0037	0.21
1995.3–1998.2	0.0001	0.0006	0.0018	0.0025	0.51
1995.4–1998.3	0.0047	0.0007	0.0014	0.0068	0.80
1996.1–1998.4	0.0071	0.0002	-0.0071	0.0002	0.12
1996.2–1999.1	0.0091	0.0003	-0.0101	-0.0007	0.27
1996.3–1999.2	0.0085	0.0007	-0.0101	-0.0009	0.29
1996.4–1999.3	0.0019	-0.0005	-0.0026	-0.0012	0.32
1997.1–1999.4	0.0051	0.0001	-0.0045	0.0007	0.47
1997.2–2000.1	0.0012	0.0007	-0.0016	0.0003	0.57
1997.3–2000.2	0.0002	0.0001	0.0002	0.0005	0.95
1997.4–2000.3	0.0036	0.0059	-0.0069	0.0026	0.68
1998.1–2000.4	0.0097	0.0007	-0.0102	0.0002	0.92
1998.2–2001.1	0.0102	-0.0008	-0.0107	-0.0013	0.79
1998.3–2001.2	0.0107	-0.001	-0.0106	-0.0009	1.29
1998.4–2001.3	0.0098	-0.0012	-0.0091	-0.0005	2.48*
1999.1–2001.4	0.0083	-0.0089	0.0005	-0.0001	4.23**
1999.2–2002.1	0.012	-0.0019	-0.0109	-0.0008	3.18**
1999.3–2002.2	0.0135	-0.0015	-0.0249	-0.0129	4.98**
1999.4–2002.3	0.0099	-0.0105	-0.0082	-0.0088	3.58**
2000.1–2002.4	0.0079	0.0006	-0.008	0.0005	0.89
2000.4-2003.3	0.0097	0.0021	-0.0107	0.0011	1.17
2001.1-2003.4	0.0104	0.0021	-0.0047	0.0069	1.06
2001.2-2004.1	0.0107	0.0007	-0.0039	0.0075	2.08
2001.3-2004.2	0.0119	0.0002	-0.0112	0.0009	0.77
2001.4-2004.3	0.0105	0.0001	-0.0102	0.0004	0.90
2002.1-2004.4	0.0112	0.0007	-0.0074	0.0045	0.94
2002.2-2005.1	0.0105	0.0006	-0.0105	0.0006	1.85
2002.3-2005.2	0.0101	0.0004	-0.0098	0.0007	1.32
2002.4-2005.3	0.0117	0.015	-0.0115	0.0012	1.87
2003.1-2005.4	0.0101	0.0018	-0.0104	0.015	0.69
1995-2005.4	*0.0810*	*-0.0590*	*-0.0058*	*0.016*	*0.18*

*Significant at, 10%, ** significant at 5%

The rolling sample results indicate that the market equilibrium over the entire sample period was in equilibrium. For the 1998–2002 period, however, the elasticities reject that banking market was in equilibrium. This was a period of banking crisis that culminated in bank runs and closure of some bank and also bank consolidation. Thus while the banking industry was not in equilibrium for some of the sample period, we cannot reject that it was in equilibrium for the most part of the sample period or for the entire sample period.

Overall, our results suggest that while competition in the Ugandan banking sector falls within a range of estimates for comparator markets, it tends to be on the weaker side. On the basis of the computed market power coefficients, we conclude that Uganda's banks seem to earn their revenues as if operating under conditions of monopolistic competition. In banking services such conditions are, of course, expected a priori from the results of previous empirical studies and from economic theory, since banks (a) are licensed, regulated and supervised, and (b) engage in product (service) differentiation.

Table 7: Results of the Panzar and Rosse model for Uganda: Sub-period 2000–2005

	Total revenue			Total revenue-Asset ratio			Interest revenue-Asset ratio		
	1995–2005	1995–1999	2000–2005	1995–2005	1995–1999	2000–2005	1995–2005	1995–1999	2000–2005
Constant	0.238**	-3.123**	-0.424	0.483	0.172	0.161	0.014	0.12	0.136
LogIF	0.119**	0.109*	0.182**	0.105**	0.127**	0.169**	0.126**	0.132**	0.153*
LogPE	0.155**	0.148**	0.21*	0.102**	0.118**	0.178*	0.116**	0.181**	0.198*
LogKE	0.041**	0.021**	0.045**	0.042**	0.039**	0.020**	0.022*	0.043*	0.053*
LogTA	1.026**	0.979**	0.957**						
LogNPA	-0.022*	0.940**	-0.011	-0.023*	-0.053**	-0.010	-0.102**	-0.073**	0.017
LogTBR	0.007**	0.023	0.004	0.007**	0.009**	0.003	0.091**	0.073**	0.086*
LogINFl	-0.001	0.009**	-.019*	-0.001	0.005	-0.016*	-0.09	0.002	0.031
Dummy	0.100**	0.100**	0.553**	0.551**	0.108**	0.111**	0.115**	0.117**	0.100*
UCB-dummy	0.005***	-0.08**	0.09*	0.0065***	-0.092**	0.104*	0.07***	-0.008	0.003
Adj. R-squared	0.98	0.97	0.98	0.691	0.698	0.634	0.627	0.64	0.67
F-test	486.9	444.9	317.9	17.7	15.657	14.115	12.126	10.277	16.42
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
Hausman test	6.458	33.42	7.34	58.61	21.8	6.92	1.04	1.14	6.77
Prob > chi2	0.259	0.003	0.24	0.00	0.00	0.567	0.998	0.992	0.453
H-Statistic	0.315	0.278	0.437	0.249	0.284	0.367	0.264	0.356	0.404
HO: H=0	F=228 Reject	F=198 Reject	F=187.6 Reject	F=89.7 Reject	F=97.3 Reject	F=89.6 Reject	F=54.2 Reject	F=49.8 Reject	F=46.8 Reject
HO:H=1	F=122 Reject	F=111.7 Reject	F=125.6 Reject	F=69.8 Reject	F=57.2 Reject	F=45.9 Reject	F=42.8 Reject	F=27.2 Reject	F=28.7 Reject
SE	0.047	0.053	0.051	0.043	0.04	0.048	0.046	0.052	0.055
Observations	660	300	360	660	300	360	660	300	360

*significant at 10%; ** significant at 5%; *** significant at 1%.

Market concentration and competition in Uganda's banking sector

Uganda's banking system is highly concentrated. This is not surprising, given the small size of the national market. Concentrated banking systems are not necessarily uncompetitive – for example, in open systems, the threat of entry can restrain incumbents from overcharging (Claessens and Laeven, 2004; Demirgüç-Kunt, Laeven and Levine, 2004). But concentration does often go hand in hand with market power, especially when contestability is weak. Indeed, economic theory provides conflicting predictions about the relationship between the concentration and the competitiveness of the banking industry and the fragility of the banking system. Some theoretical arguments and country comparisons suggest that a less concentrated banking sector with many banks is more prone to financial crises than a concentrated banking sector with a few banks (Allen and Gale, 2004). First, concentrated banking systems may enhance market power and boost bank profits. High profits provide a "buffer" against adverse shocks and increase the charter or franchise value of the bank, reducing incentives for bank owners and managers to take excessive risk and thus reducing the probability of systemic banking distress (Hellman et al., 2000; Matutes and Vives, 2000). Second, some hold that it is substantially easier to monitor a few banks in a concentrated banking system than it is to monitor many banks in a diffuse banking system. From this perspective, supervision of banks will be more effective and the risks of contagion and thus systemic crisis less pronounced in a concentrated banking system.

Some proponents of the "concentration–stability" view argue that holding other things constant, banks in concentrated systems will be larger than banks in more diffuse systems, and larger banks tend to be better diversified than smaller banks. These assumptions suggest that concentrated banking systems with a few large banks will be less fragile than banking systems with many small banks. Models by Diamond (1984), Boyd and Prescott (1986), Allen (1990), and others predict economies of scale in intermediation.

An opposing view is that a more concentrated banking structure enhances bank fragility. First, proponents of this view argue that the standard argument that market power in banking boosts profits and hence bank stability ignores the potential impact of banks' market power on firm behaviour. Concentrated banking systems could enhance market power, which allows banks to boost the interest rate they charge to firms. These higher interest rates may induce firms to assume greater risk. Thus, there could be a positive relationship between concentration and bank fragility and therefore the probability of systemic distress (Caminal and Matutes, 2002). They also note that less competition can lead to less credit rationing, larger loans and higher probability of failure if loans are subject to multiplicative uncertainty. Second, advocates of the "concentration–fragility" view argue that relative to diffuse banking systems, concentrated banking systems generally have fewer banks and that policy makers are more concerned about bank failures when there are only a few banks. Banks in concentrated systems can then be assumed to tend to receive larger subsidies through

implicit "too important to fail" policies that intensify risk-taking incentives and hence increase banking system fragility (Mishkin, 1999).

Proponents of the concentration–fragility view would also disagree with the proposition that a concentrated banking system characterized by a few banks is easier to monitor than a less concentrated banking system with many banks. The countervailing argument is as follows. Bank size is positively correlated with complexity, so that large banks are harder to monitor than small banks. Holding all other features of the economy constant, concentrated banking systems tend to have larger banks. Thus, this argument predicts a positive relationship between concentration and fragility. In the following section, we investigate the link between concentration and competitiveness.

As already noted, a key feature of the Ugandan banking sector is the degree of concentration on both the loan and deposit sides, reflecting the structure of the economy as well as the size of the banking system. Loans to the top five borrowers for each bank on the aggregate represent about 24% of total loans of the system and on the deposit side, the top five depositors for each bank on the aggregate account for about 21% of total deposit in the system. In addition, concentration increased after the 1998/99 bank crises because of reputational bias against small banks. Compared with small banks, however, large banks lend more as measured by loan-to-deposits ratio. They have lower spreads, lower overhead costs and fewer non-performing assets, and higher profit margins (Table 8). They also hold many foreign exchange deposits. This in part could be attributed to the type of clients they deal with, relatively less risky clients, the corporate clients.

Table 8: Characteristics of Ugandan banks

	Large banks	Small banks
Lending rate	18.5	23.5
Deposit rate	0.7	3.5
Spread	17.8	19.9
Overhead costs	5.7	13.3
Return on assets (ROA)	8.5	5.5
Non performing assets (NPA)	3.0	5.6
Loan/deposits	38	36
Forex deposits/total deposits	40	29

Source: Uganda commercial bank data, 1995–2005

Traditionally, research and public policy concerns about concentration in product markets have focused on the social loss associated with the exercise of market power at high levels of concentration. The higher prices in concentrated markets bring about restriction of output relative to the competitive level and thereby misallocated resources (Berger and Hannan, 1998). In addition to the traditionally recognized higher prices and reduced output from market power, there may also be higher cost per unit of output in concentrated markets because of slack management. The P–R approach, although providing a measure of competition, ignores the size distribution of banks or inequality in a given market. As concentration indexes – weighted averages of banks' market

shares — take both the size — distribution and the number of banks into account, they are often used as a simple proxy of the market structure.

There are two frequently used indexes of market concentration. The first is the k-bank concentration ratio, which takes the market shares of the k largest banks in the market. This index is based on the idea that the behaviour of a market is dominated by a small number of large banks. We use $k = 3$; that is, we measure the three-bank asset concentration index, in which market concentration averaged 55.5% between 1993 and 1998 and increased to 64.6% between 1999 and 2005. The share of deposits increased from 54.3% to 72.2% in the same periods, but the share of loans remained at the same level (see Table 9). This could be attributed to the financial crisis of the period 1998/99, which led to the closure of several banks. Uganda's banking sector is heavily concentrated and as noted earlier, this could have an impact on efficiency.

Table 9: Structure of banking industry

Year	No. of banks	No. of branches	Market share of 3 largest			Total assets (Ush billions)
			Deposits	Loans	Assets	
1993	14	229	66	71	64	473
1994	15	146	64	74	65	588
1995	15	144	58	63	62	706
1996	20	152	48	54	51	806
1997	20	147	47	38	48	1,052
1998	20	144	43	37	43	1,279
1999	17	136	61	54	61	1,352
2000	17	132	69	55	63	1,845
2001	16	128	74	57	65	2,038
2002	15	126	78	58	66	2,456
2003	15	126	80	60	68	2,947
2004	15	132	89	62	75	3,315
2005	15	142	88	64	80	3,689

Source: Bank of Uganda, various annual reports and bank returns.

The second measure is the Herfindahl index *(HERF)*, the sum of squared market shares of all banks operating in the market.

In order to investigate the relationship between competition and market structure in the banking industry, we relate the H statistic for all banks, a measure of competition, to the concentration index as a measure of market structure, that is, $H = \delta_0 + \delta_1 C + \delta_2 D + \delta_3 (D \times C) + v$, where D represents a dummy for the

period after 1999 (See Table 10). For both regressions, the coefficient of the concentration index shows the expected negative sign indicating that competition is

Table 10: Competition and concentration relationship

	Dependent variable - H		
	k=3 (Assets)	k=3 (Deposits)	HERF
Constant	1.2	1.08	1.32
	(5.4)	(2.9)	(3.5)
Concentration	-0.85	-0.74	-0.56
	(3.6)	(4.2)	(6.6)
Dummy × concentration	*0.08*	*0.12*	*0.04*
	(1.9)	*(2.6)*	*(2.4)*
Dummy	0.17	0.08	0.13
	(2.5)	(2.64)	(4.0)
Adj. R-square	0.45	0.51	0.50

t -values in parentheses

decreasing with increasing market concentration. There is no one-to-one relationship between concentration and competition, however. The dummy variable is also statistically significant indicating the change in concentration and competition after 1999.

Efficiency and market structure

As a first order effect, one would expect increased competition to lead to lower costs and enhanced efficiency. As Vives (2001) highlights, however, the relationship between competition and banking system performance is more complex. Market power in banking, for example, may up to a degree be beneficial for access to financing and the view that competition is unambiguously good for financial sector performance could be more naïve than in other industries as vigorous rivalry may not be the best for financial sector performance. Further, in a dynamic world, bank and borrower establish relationships to overcome information problems. The higher its market power, the more likely the bank invests in information gathering about firms, especially for informationally opaque banks, and the more likely it provides credit (Vives, 2001). More competition can then undermine the incentives of banks to invest in a relationship. But the relationship involves sunk costs and leads to a hold-up problem: the incumbent bank has more information about the borrower than its competitors. This increases the switching costs for the borrower, especially for better quality borrowers since they will face adverse conditions when trying to look for financing from another bank, as they will be perceived as a poor credit risk. Borrowers will be less willing to enter a relationship with a bank if they are less likely to be subjected to a hold-up problem, for example, when the market for external financing is more competitive. The net effect of these problems can vary with the overall competitive environment. Boot and Thakor (2000), for example,

show that increased inter-bank competition may induce banks to make not less, but more relationship loans. There can also be effects from the type of information problem on the scope for potential competition.

The existence of a relationship between market structure and banks' behaviour is indicated by, among others, the P–R model described in the preceding section. However, the P–R model puts at the backstage the relevance of market structure for banks' conduct and performance and, as a description of the market structure, it is rather limited. For instance, it fully ignores the size distribution of banks (or inequality) in a market. Moreover, DeYoung (1998) suggests that bank management quality is positively related to cost efficiency, which is in turn related to asset quality. Thus, robust evidence is essential, on one hand, to corroborate the monopolistic market structure evidence obtained under the P–R framework and, on the other hand, to examine how the market structure affects the performance of the banks. To achieve this, we analyse bank efficiency and how it relates to bank returns in the following section. Here, the aim is to measure the degree of X-inefficiency in Uganda's commercial banks and how it relates to the bank profitability using a stochastic frontier approach. We also analyse the relationship between profitability and market structure (concentration and/or market share).

Theoretical work in the area of productive efficiency has yielded the concept of X-efficiency. In the context of a production function, X-efficiency is defined as any deviation from the fully efficient amount of output as represented by the efficient production frontier. The empirical estimation of X-efficiency has resulted in an extensive literature addressing both the econometric theory of efficiency estimation and the empirical application of the concepts in different situations. Of the approaches used to estimate frontiers and the inefficiency component, the two most popular are stochastic frontier analysis (SFA) and data envelopment analysis (DEA). SFA is a regression approach that typically includes a normally distributed error and an inefficiency component assumed to follow a one-sided distribution (e.g., exponential, gamma). The data envelopment approach assumes that there are random fluctuations, so that all deviations from the estimated frontier represent inefficiency. If there is any luck or measurement error in an observation not on the estimated frontier, it will be mistakenly included in that firm's measured efficiency. If there is a random error in an observation on the frontier, it will be mistakenly reflected in the measured efficiency of all firms that are measured relative to that part of the frontier. The choice of any specific approach depends upon the research objectives and available data, but the non-parametric approach is highly sensitive to outliers and parametric models are considered relatively more robust. Both methods have their strengths and weaknesses. SFA is stochastic, but requires the choice of a functional form and an ad hoc assumption about the distribution of the inefficiency component. DEA does not require distributional assumptions or a specific functional form, but it is non-stochastic. Because of this limitation, we lean towards SFA.

One way to test for the competition hypotheses of market share and concentration is to take both market share and concentration into account at the same time by estimating a performance equation that includes both market share and concentration as independent variables and to examine the significance of their coefficients (Smirlock,

1985). The baseline model for this approach could be expressed as:

$$\pi_{it} = f\left(M_{it}, C_{it}, MC_{it}, Z_{it}\right) \tag{9}$$

where sub index i refers to banks, and sub index t represents observations over time, represents a bank profit measure, Z represents a vector of variables that prior studies have found to affect bank profitability, M represents the market share, C represents a market concentration measure, and MC is an interaction term defined as market share multiplied by concentration.

The usefulness of (9) in discriminating between the two hypotheses is straightforward. Ignoring the interaction term, a significant and positive coefficient on M and insignificant coefficient on C would imply that firms with market share are more efficient than their rivals and earn rents because of this efficiency, while also indicating that increased market concentration does not result in banks earning any monopoly rents – which would support the efficient structure hypothesis. Conversely, a combination of a significant and positive coefficient on concentration with insignificant coefficient on market share implies that market share does not affect firm rents and that rents reflected in higher performance indicators are monopoly rents that result from market concentration. If the coefficients on M and C are both positive, this could be interpreted as a demonstration that all banks in concentrated markets earn monopoly rents from collusion and that these benefits are distributed unevenly, with the larger firms in the market capturing the lion's share of monopoly rents. However, this could also suggest that the leading banks are more efficient than their rivals and that market concentration fosters collusion that results in monopoly rents being earned. An indirect test of the cause of the market share effect involves employing the interaction of market share and concentration, MC. If high concentration is associated with collusive behaviour that is characterized by disproportionate rent-sharing in favour of the larger firms, then a positive coefficient on MC should be observed (Smirlock, 1985).

The theoretical structural model that tests the efficient-structure (ES) and market power (MP) hypotheses pioneered by Berger (1995) can be summarized as follows:

$$\pi_{it} = f_1\left(\Psi_{it}, Z_{it}\right) + \varepsilon_{1it} \tag{10}$$

$$M_{it} = f_2\left(\Psi_{it}, Z_{it}\right) + \varepsilon_{2it} \tag{11}$$

$$C = f_3\left(M_{it}\right), \forall_i \tag{12}$$

where ψ represents efficiency and $\varepsilon_j, j = 1,2$, are random errors. Equation 10 represents the ES hypothesis. Under this setting, higher performance reflects efficiency, depending on which of the two versions of the hypothesis is used.

Equation 11 implies that under the ES hypothesis, more efficient banks gain dominant

market shares. This could occur in a number of different ways:

a) If the products of banks within a local market are homogeneous, each market may be in a competitive equilibrium with a common price equal to every bank's marginal cost. More efficient firms are larger and have greater shares if they have lower marginal cost at every scale.

b) If the products of banks are differentiated by location under spatial competition, more efficient banks could set more favourable prices to consumers and attract customers from further distances.

c) More efficient banks could have larger shares in equilibrium, because of past out-of-equilibrium behaviour in which more efficient banks gained shares through price competition or through acquisition of less efficient banks.

Equation 12 implies that on average banks with higher market shares have higher concentration *(C)*. The concentration variable in this function applies to all banks and could be the Herfindahl index or the *k*-firm concentration ratio, e.g., the market share of the three largest banks.

Following Berger (1995), the two versions of the market-power (MP) hypothesis, SCP and RMP can be represented by the following model:

$$\pi_{it} = g_1\left(P_{it}, Z_{it}\right) + \varepsilon_{3it} \tag{13}$$

$$P_{it} = g_2\left(S, Z_{it}\right) + \varepsilon_{4it} \tag{14}$$

where P is a vector of output prices and S is a measure of market structure, either concentration *(C)* or market shares *(M)*, depending on whether the SCP or RMP hypothesis is being tested.

Equation 13 implies that higher profitability is due to banks charging consumers unfavourable prices. For instance, a bank may offer low deposit rates or charge high lending rates to its customers. This does not rule out efficiency as affecting performance under the market power hypothesis; the effects of efficiency are just viewed as less important than the exogenous effects of market power acting through prices.

In Equation 14, prices are primarily determined by the market structure. Under the SCP relationship, concentration is the key exogenous variable represented by S, implying that all firms in concentrated markets charge prices that are relatively unfavourable to consumers. On the other hand, if the RMP hypothesis applies, then S is the key exogenous variable in (14), implying that firms with large market shares have well-differentiated products because of advantages such as advertising and location. Firms are therefore able to exercise market power in pricing these products. This does not rule out the possible effects of the efficiency variable on P; these possible effects are just viewed as relatively unimportant. Under the SCP hypothesis, the positive profit–concentration relationship comes about because C affects P in (14) and P affects p in (13). Under either of these hypotheses, performance measures and the other market structure variables are spuriously positively correlated in (12).

The estimatable model, which is a reduced form of all the four hypotheses (SCP,

RMP, efficiency and scale-efficiency), is of the form:

$$\pi_{it} = f\left(C, M_{it}, EFF_{it}, Z_{it}\right) + \varepsilon_{it}. \tag{15}$$

Under the ES hypothesis, the coefficient of the appropriate efficiency variable is positive and the coefficients of all the other key variables are either relatively small or zero. Similarly, under the MP hypothesis the appropriate market structure variable C, or M, has a positive coefficient and the remaining variables are irrelevant. The disturbance term is assumed to follow a one-way error component process: $e_{it} = m_i + u_{it}$. Where m_i represents any unobservable bank specific effects that are not included in the regression, e.g., unobservable managerial skills of the managers of banks. They are fixed parameters and can be estimated by introducing a dummy variable for each bank. u_{it} varies by bank and by time and represents all other market imperfections and regulatory restrictions that affect the return on assets (ROA) of banks randomly.

A second condition for the ES hypothesis is that the market structure variables *(M and C)* be positively related to efficiency. In order to test for this additional condition, the following reduced-form equations can be estimated:

$$M_{it} = f\left(EFF_{it}, Z_{it}\right) + \varepsilon_{5it} \tag{16}$$

$$C = f\left(EFF_{it}, Z_{it}\right) + \varepsilon_{6it} \tag{17}$$

Measurement of efficiency

To measure the X-inefficiency, Stochastic Frontier Analysis (SFA) has been applied widely to banking and other industries. SFA starts with a standard cost or profit function and estimates the minimum cost or maximum profit frontier for the entire sample from balance sheet data. The efficiency measure for a specific bank observation is its distance from the frontier. A standard multi-product translog cost function is specified and deviations from the cost frontier are estimated based on it.

The analysis of inefficiency in this modelling framework consists of two (or three) steps. At the first, we will obtain estimates of the technology parameters. This estimation step also produces estimates of the parameters of the distributions of the error terms in the model (s_w and s_u). In the analysis of inefficiency, these structural parameters may or may not hold any intrinsic interest for the analyst. With the parameter estimates in hand, it is possible to estimate the composed deviation, $j_{it} = u_{it} - w_{it} = y_{it} - b\not{c}x_{it}$, by plugging in the observed data for banks in year t and the estimated parameters. But, the objective is estimation of w_{it} not u_{it}, which contains the bank-specific heterogeneity. Note that the estimator is the expected value of the inefficiency term given an observation on the sum of inefficiency and the firm specific heterogeneity. The estimated w_{it} is then used in regression analysis of profitability on w_{it} (the estimates) and other interesting covariates in order to explain how profitability is affected by efficiency.

Existing studies show that X-inefficiency can be measured in a number of ways.

The first is cost inefficiency. The cost concept assumes that the primary objective of the bank is to minimize cost (Berger, 1995). We illustrate the methodology using cost efficiency as follows. Suppose that total costs for the *i-th* bank in year *t*, C_{it}, are given by Equation 18 in which y_{it} represents the various products or services produced by the bank and P_{it} represents the prices of inputs. The random disturbance term has two components; V_{it} represents measurement error and other uncontrollable factors, while w_{it} represents technical and allocative inefficiency aspects that can be influenced by management.

Hence, we have:

$$C_{it} = f\left(y_{it}, P_{it}\right) + \left(V_{it} + \omega_{it}\right) \tag{18}$$

As is common in the efficiency literature, we use a translog specification for the cost function in (18) with the standard symmetry and homogeneity assumptions.

The second way of measuring X-inefficiency is by analysing profit inefficiency (Berger, 1995; Goldberg and Rai, 1996). The analysis is based on a standard profit function. The standard profit function seeks to maximize profits at a given level of input and output prices. It therefore takes into account input prices as well as revenues generated from output. Output prices are taken as exogenous, however, which implies that maximizing profit is determined by the input inefficiencies. The standard profit function is given by: $\pi_{it} = f(y_{it}, P_{it}) + (V_{it} + w_{it})$, where π is profit.

The SFA approach maintains that managerial or controllable inefficiencies, i.e., ω_{it}, increase costs only above, or profits only below, the frontier or best practice levels. Random fluctuations, i.e., V_{it}, may either increase or decrease costs or profits from these benchmarks. Hence, the frontier itself is stochastic and the term ω_{it} represents inefficiency or the distance from best practice.

Furthermore, the V_{it} terms are assumed to be identically distributed as normal variates with zero mean and variance equal to σ_V^2. The w_{it} terms are non negative random variables distributed normally but truncated below zero. We assume that the w_{it} terms are distributed independently but not identically. Hence, for the *i-th* bank in year *t*, technical inefficiency, w_{it}, is assumed to follow a half normal distribution, i.e., $N\left(\mu_{it}, \sigma_{\omega_{it}}^2\right)$, in which both the mean m_{it} and variance $\sigma_{\omega_{it}}^2$ may vary. Because structural conditions in banking and general macroeconomic conditions may generate differences in banking efficiency we include time effects in the estimation of the frontier. Specifically, in addition to the half normal specification with constant mean and variance, we estimate frontiers that allow for a mean shift or for a heteroscedastic variance.

The stochastic frontier approach assumes that the output of a firm will vary from its frontier as a result of two economically distinguishable random disturbances, w_{it} and u_i. The disturbance w_{it} reflects the fact that the output of each firm must lie on or below its frontier. Any such deviation is the result of factors under the control of the firm, e.g., technical and economic inefficiency and the will and effort of the producer and the employees. The frontier itself is stochastic because of unpredictable factors

that are beyond the control of the firm; a random disturbance $v_i \le 0 / \ge 0$ accounts for such factors – e.g., luck, labour market conflicts and machine performance – as well as measurement errors in the dependent variable and left-out explanatory variables (Battese and Coelli, 1992). Here, too, the analysis of inefficiency consists of two (or three) steps. At the first, we will obtain estimates of the technology parameters. This estimation step also produces estimates of the parameters of the distributions of the error terms, s_u and σ_ω. In the analysis of inefficiency, these structural parameters do not necessarily hold any intrinsic interest. Having determined parameter estimates, we can now estimate the composed deviation, $\varphi_{it} = v_{it} + \omega_{it} = C_{it} - \beta' x_{it}$ using the observed data for a given bank in year t and the estimated parameters. In this framework the objective is usually estimation of ω_{it} not φ_{it}, which contains the bank-specific heterogeneity.

The technical inefficiency effects are defined by:

$$\omega_{it} = \omega_i \left\{ \exp\left[-\eta(t - T) \right] \right\}$$

where η is an unknown parameter to be estimated, whilst ω_i can be considered as the technical inefficiency effects for the *i-th* firm in the last period of the panel. Battese and Coelli (1992) have shown that an appropriate predictor for the technical efficiency of the *i-th* firm at the *t-th* time period, involves the conditional expectation of $\exp(-\omega_{it})$ given the vector of random variables $\varphi_{it} = v_{it} - \omega_{it}$. That is, the technical efficiency predictor may be derived using: $TE_{it} = E\left[\exp(\omega_{it}) / \varphi_{it} \right]$.

Battese and Coelli also show that the conditional expectation of $\exp(\omega_{it})$, given the vector of random variables φ_{it}, is:

$$E\left[\exp(-\omega_{it}) / \varphi_{it} \right] = \left\{ \exp\left[-\eta_{it} \tilde{\mu}_i + \frac{1}{2} \eta_{it}^2 \tilde{\sigma}_i^2 \right] \right\} \times \left\{ \frac{1 - \Phi\left[\eta_{it} \tilde{\sigma}_i - (\tilde{\mu}/\tilde{\sigma}_i) \right]}{1 - \Phi(-\tilde{\mu}_i/\tilde{\sigma}_i)} \right\} \quad (19)$$

where $\tilde{\mu}_i = \dfrac{\mu \sigma_v^2 - \eta_i' \varphi_i \sigma^2}{\sigma_v^2 + \eta_i' \eta_i \sigma^2}$, $\tilde{\sigma}_i^2 = \dfrac{\sigma_v^2 \sigma^2}{\sigma_v^2 + \eta_i' \eta_i \sigma^2}$, $\Phi(\bullet)$ denotes the distribution function of the standard normal random variable.

Another disentangling approach is by Jondrow, Lovell, Materov and Schmidt (1982). Their estimator of ω_{it} is $E\left(\omega_{it} | \varphi_{it}\right) =$

$$\frac{\sigma\lambda}{1+\lambda^2}\left[\frac{\phi(a_{it})}{1-\Phi(a_{it})}-a_{it}\right]$$

where $\sigma=\left[\sigma_\omega^2+\sigma_\nu^2\right]^{1/2}$, $\lambda=\sigma_\omega/\sigma_\nu$

$a_{it}=\pm\varphi_{it}\,\lambda/\sigma$

$f(a_{it})$ = the standard normal density evaluated at a_{it}

$F(a_{it})$ = the standard normal CDF (integral from -∞ to a_{it}) evaluated at a_{it}.

In order to estimate the cost frontier, a translog functional form assumed to be homogenous in inputs of the form below can be used:

$$\ln C_{it}=\gamma_0+\sum_j\lambda_j\ln x_{jit}+\frac{1}{2}\left\{\sum_j\sum_k\gamma_{jk}\ln x_{jit}\ln x_{kit}\right\}+\nu_{it}+\omega_{it}. \qquad (20)$$

Inputs are defined as loanable funds plus implicit resource costs involved in producing services to depositors, plus explicit interest payments to the depositors. Inputs include: total deposits; other liabilities including financial capital (these provide an alternative to deposits as a source of funding the earning assets of a bank); interest expenses; labour costs; other expenses including those on physical capital and depreciation; and a time trend that accounts for the fact that output is not only influenced by inputs but also by technical progress.

Data sources

The data used are a quarterly panel spanning the post financial liberalization era, 1995–2005, as obtained from the commercial banks' returns submitted to the BOU. The period could not be extended to 1993 because of missing data.

We use several bank-specific variables computed from balance sheet and income statements to explain the banks' performance. Tables 4 and 5 provided summary statistics and correlations for some of the variables. Overhead costs are the costs for salaries, motor vehicles, fixed assets, etc., over total assets and average 9.7% across banks over the sample period, 1995–2005. Overhead costs for the sector have shown an increasing trend over the period. Banks' recent investments in physical infrastructure such as increased outreach efforts and very high costs for power might explain the recent increase in operating costs. ROA defined as profits over total assets averaged 1.9% across banks over the sample period. While banks' profitability hit a bottom after the banking crisis in 1998 owing to the failed privatization of the Uganda Commercial Bank and closure of several banks, it has recovered and has shown signs of increasing since then. Loan losses given by provisions for bad debts over total assets have been falling over the last decade; they averaged 4.6% across the sample. The liquidity ratio is a function of liquid assets relative to short-term liabilities and has been relatively stable over the past decade, with an average of 86.3%. The market share of deposits and loans proxies both for market power of individual banks and for bank size. The

average market share is 6%, but it ranges from 1% to 32% for deposits and 40% for
loans.

Econometric analysis

In this study, we measure efficiency as the ability of a bank to produce a given set of
outputs with minimal cost of inputs, under the assumption of variable returns to
scale. To calculate the efficiency, an empirical frontier is estimated. Estimating cost
efficiency is based on the observed cost values of any firm relative to the best practising
firm. The best practising firm is, by assumption, operating at 100% efficiency level.
Therefore, the relative cost efficiency will exist within the range of 0% to 100%.

A bank is technically efficient if it lies on the frontier and to establish the frontier we
use a stochastic frontier framework. Modelling a bank's production process poses a
challenge, however. The most obvious problem is that it is not clear whether services
to customers are an input to the production of assets or an output. There are two major
approaches to this in the literature: The production approach and the intermediation
approach. The production approach says that banks use capital and labour as inputs to
produce individual accounts of various sizes and incur operating cost in the process.
Operating costs are incurred in the course of processing deposits and loans. Therefore,
the number of deposits and loan accounts is, according to this approach, a measure of
bank's output, while average account size is used as proxy for the characteristics of
this output. Consequently, total bank cost in this approach includes only operating costs
by excluding interest costs. According to "the intermediation approach", which we
adopt, banks collect deposits and purchase funds from outer sources, and use them as
a source of generating earning assets like loans, bonds and shares, etc. Earning assets
are thus proxy for a bank's outputs, while deposits, capital and labour are its inputs.

Total costs are the sum of interest and non-interest costs. The input prices are the
price of capital measured by the ratio of non-interest expenses to total fixed assets,
and the price of funds measured by the ratio of interest expenses to total deposits. The
output variables and costs are normalized by total loans and the input variable is the
ratio of the price of capital to the price of funds. Thus, the specification assumes
homogeneity with respect to prices and constant returns to scale. In addition, we test
for robustness with respect to the normalization and specification of the cost and profit
functions by reporting results that include only three outputs – liquid assets, deposits
and loans – and normalize costs and outputs by equity rather than loans. For these
cases, the assumption of constant returns to scale is not imposed. Our estimates are
summarized in Table 11.

Table 11: Stochastic frontier estimates

	Cost frontier		Cost frontier	
		Heteroscedastic		Heteroscedastic
		case		case
Log likelihood	-229.8	-239.8	-324.87	-362.9
$\left(\sigma_\omega/\sigma_V\right)$	1.97	2.12	2.08	2.47
		(0.55)		*(0.29)*
σ	0.38	0.48	0.43	0.90
		(0.09)		*(0.02)*
λ	0.768	0.824	0.794	0.867
Mean efficiency	0.661	0.6549	0.686	0.676

Standard errors are in parentless for the estimated parameters. In the heteroscedastic case, the statistics are based on the estimated variance averages over the observations.

The value of the log likelihood function is shown in the first row of Table 11. The next two rows report some parameters of the estimated frontiers, namely the ratio of the standard deviation of the inefficiency component of the disturbance to the random component $\left(\sigma_\omega/\sigma_V\right)$ and the standard deviation of the composite disturbance $\left(\sigma\right)$. The fourth row contains the proportion of the variance in disturbance that is due to inefficiency,

$$\lambda = \sigma_\omega^2\big/\sigma^2 \ .$$

Since the cost and profit frontiers are translog functions, efficiency is defined as $e^{-\omega}$, where ω is the estimated inefficiency. Hence, efficiency is always positive and it is equal to one for the best practice or zero for an inefficient bank. The last row reports the mean efficiency from each frontier estimate.

As evident in Table 11, allowing for heteroscedasticity in the specification for both the cost and output specifications has the highest log likelihood values. Hence, we take the efficiency scores obtained by collecting for heteroscedasticity as measures of efficiency in banks' performance regressions to investigate the effect of efficiency on bank performance. Average efficiency scores are contained in Appendix Table A1.

Given the translog function and share equations, we use the cost as well as the profit measure of X-inefficiency and attempt to establish whether the two measures generate significantly different results when applied to the same data set. The results show that the mean value for cost X-inefficiency is 34. This result suggests that on average banks are 66% cost efficient. The mean value of profit X-inefficiency is 32, which is slightly lower than cost X-inefficiency. This suggests that banks are on average 68% profit efficient. Overall, these estimates are consistent with results reported by Berger and Humphrey (1997) in their comprehensive survey of bank efficiency estimates internationally. The average cost efficiency scores for the entire sample period range from 46% to 94%, with overall mean of about 66%, implying that efficiency varies substantially between banks and that the banks are non-homogeneous.

Bank efficiency and performance

The econometric analysis is based on Equations 15, 16, and 17 using return of assets (ROA) as a proxy for gross profits (performance). We use this measure because it represents the benefits obtained by the banks before taxes, provision for insolvency and extraordinary items, and reflects the difference between earnings and costs derived from lending and from bank services. We have used gross profits rather than net profits after taxes because net profits would capture the effects of random factors that are sometimes beyond the firm's control. This closely follows the Berger (1995) methodology, which incorporates efficiency measures directly into the bank performance function summarized in Equation 8, in order to distinguish between the effects of efficiency from the effects of market power on the structure-profitability relationship. We use efficiency score derived from the cost efficiency stochastic frontier as a measure of efficiency since profit as a measure of performance erodes the impact of scores derived from the profit frontier. The Berger (1995) analysis does not control for possible endogeneity that might bias the estimated effects. We do control for this by instrumenting measures of concentration and market share. Another major difference regards control variables included in the models. Berger (1995) uses population of the market in which each bank operates concentration of stocks, state dummies and size dummies as control variables. These are of no significance in the Ugandan case and as such the Berger (1995) model cannot be duplicated in Uganda.

In addition, we control for the effects of asset quality and risk on the level of bank efficiency by deducting non-performing loans from earning assets, defined as output of banks. In so doing, we avoid overstating the level of efficiency of banks. For instance, banks scrimping on credit evaluations or producing excessively risky loans might be labelled as efficient when compared with banks spending resources to ensure that their loans are of higher quality.

Granger causality tests

A major methodological concern is the endogeneity problem, as bank efficiency could affect market share and concentration; hence estimating the equations as specified in Equations 7, 8, and 9 would bias the estimated effects.

To investigate whether there is an endogeneity problem, we use the Granger causality test. Causality is said to exist if a variable X_t, in this case EFF, helps to improve the forecasts of another variable(s) Y_t, in this case concentration and market share. Denoting by $Y_{t+h}|\Omega$ the optimal $h-$step forecast of Y_t at origin t based on the set of all the relevant information in the universe Ω_t, we may define X_t to be Granger-non causal for Y_t if and only if

$$Y_{t+h}|\Omega = Y_{t+h}|\Omega \setminus \left\{X_{t,s|s\leq t}\right\}3, \ h = 1,2,\ldots\ldots\ldots \tag{21}$$

Thus, X_t is not causal for Y_t if removing the past of X_t from the information set does not change the optimal forecast horizon. In turn, X_t is Granger-causal for Y_t if (21) does

not hold for at least one h, and thus a better forecast of Y_t is obtained for some forecast horizon by including the past of X_t in the information set. If W_t contains past values of Y_t and X_t only, i.e., $W_t = \{(Y_{t,s}, X_{t,s}) \notin \frac{1}{2}s \pounds t\}$ and $(Y_t, X_t) \notin$ is generated by a bivariate $VAR(r)$ process of the form

$$\begin{bmatrix} Y_t \\ X_t \end{bmatrix} = \sum_{i=1}^{p} \begin{bmatrix} \alpha_i & \beta_i \\ \gamma_i & \delta_i \end{bmatrix} \begin{bmatrix} Y_{t-i} \\ X_{t-i} \end{bmatrix} + u_t \tag{22}$$

then (21) is equivalent to $b_i = 0, i=1,\ldots\ldots,p$. In other words, X_t is not Granger-causal for Y_t if its lags do not appear in the Y_t equation. Analogously, Y_t is not Granger-causal for X_t if the lags of the former variable do not enter the second equation.

The general causal model, suggested by Sargent (1976) can be written as:

$$C_t = \varpi_0 + \sum_{i=1}^{m} \alpha_i (EFF)_{t-i} + \sum_{j=1}^{n} \beta_j (C)_{t-j} + \varepsilon_t$$

$$EFF_t = \chi_0 + \sum_{i=1}^{n} \gamma_i (EFF)_{t-i} + \sum_{j=1}^{m} \delta_j (C)_{t-j} + v_t$$

$$MS_t = \varpi_0 + \sum_{i=1}^{m} \alpha_i (MS)_{t-i} + \sum_{j=1}^{p} \psi_j (EFF)_{t-j} + \varepsilon_t$$

$$EFF_t = \varpi_0 + \sum_{i=1}^{n} \varphi_i (EFF)_{t-i} + \sum_{j=1}^{p} \phi_j (MS)_{t-j} + \eta_t$$

The VAR is used to test the hypotheses that $\beta_j = 0, \delta_i = 0, \psi_j = 0, \phi_j = 0$, $\theta_i = 0, \alpha_i = 0, \gamma_i = 0$. The lag length is selected automatically on the basis of Schwarz information criteria. Using this approach, the summary results reported below seems to indicate Granger causality. In other words, the causality test seems to indicate that efficiency is Granger causal for market concentration and market share. Given this causation, any OLS regression including efficiency, market share and concentration would bias the estimated marginal effects:

Null hypothesis:	F-statistic	Probability
MS does not Granger cause EFF	0.20040	0.81995
EFF does not Granger cause MS	4.57451	0.02244
C does not Granger cause EFF	0.62848	0.3026
EFF does not Granger cause C	9.11088	0.00142

Therefore, to determine the nature of causation and the relations shown in the model specification, we use a two-stage least squares (2SLS) procedure by instrumenting C and MS by their predicted values, i.e., $\hat{C}, \hat{MS}$, respectively.

Empirical results

Empirical analysis is based on estimating reduced form-equations in which profitability measure is regressed on efficiency (EFF), concentration (C), market share (MS), and the control variables. The control variables include the ratio of non-performing loans to total loans (NPA). This was included to control for differences in costs resulting from default risk. The costs include forgone principal and interest payments and expenses on monitoring and administering the portion of a bank's existing loan portfolio that is currently performing. A high level of defaults is expected to have a negative effect on the profitability of banks.

The ratio of core capital to net assets (CAS) was included, first, to control for differences in costs owing to insolvency risk. Insolvency risk affects the costs and profits of a bank via the interest rates the bank has to pay for uninsured debt and through the intensity of risk management activities the bank undertakes. Second, the capital level of a bank directly affects costs since it may provide an alternative source of funding earning assets. Because raising equity typically involves higher costs than raising deposit capital, differences in profits of banks may to some extent reflect differences in the sources of funding. The sign is ambiguous a priori.

Central to the real or operating decisions of financial institutions are the costs of inputs, or the factors that are used in producing services, with labour and capital being the most important ones. The availability of technology such as computers, visual imaging and communications systems is essential for the most efficient management and combination of these inputs in order to produce financial outputs at the lowest possible cost. If banks were fully efficient, they would maximize profits at the lowest possible cost. However, there are a number of sources of cost inefficiency in banking. Important among these is operational inefficiency, such as excessive labour, as opposed to financial inefficiency that involves excessive interest rate payments (see Berger, 1995; Berger and Hannan, 1998). High operating costs widen the spread between deposit and loan rates and reduce the size of the financial system. To capture this argument, we include the ratio of operation cost to revenue (OP) and we expect that the higher the relative operational costs, the lower the profits.

The operating cost ratios of banks may also be raised through implicit and explicit taxation. Cash reserve requirements usually imposed on financial institutions, for instance, are often viewed by financial institutions as similar to a tax and a positive cost of undertaking intermediation. Moreover, inflation increases the reserve requirement tax; leading to a substantial drop in the real deposit rate and the real demand for money, thus further raising the operating resource cost ratios. Conventional taxes such as interest withholding taxes, stamp duties, transaction taxes, value added taxes, profit taxes and licence fees levied on the financial intermediation are yet another cause for a rise in operating cost ratios, and do widen the spread between deposit and loan rates of interest. They therefore reduce the real volume of financial intermediation and hence

saving and investment, as do higher operating costs. To capture the effect on performance we incorporate the ratio of total taxes to total bank revenue (*TR*).
Thus,

$$\pi_{it} = \beta_0 + \beta_1 \hat{C}_t + \beta_2 MS_{it} + \beta_3 \hat{EFF}_{it} + \beta_4 Z_{it} + \beta_5 D + \varepsilon_{it}$$

We first obtain predicted values for C and MS, which we use as instruments to control for bias resulting from endogeneity. $\hat{EFF}$ is obtained from the stochastic frontier model.

The regression results for concentration and market share are appended in Appendix Table A1 and corroborate Granger causation results, as efficiency significantly affects concentration and market share. This seems to suggest that efficient banks increase their market shares, which in turn increases market concentration.

On the profitability equation, the summary of the results reported later in this study shows that the signs on the variables are consistent with expectations, since efficiency, market power and concentration explain bank profitability. The results are generally consistent with the literature as discussed in Section 3. The results indicate that the coefficients on the efficiency measure (*EFF*) and the market structure (*MS* and *C*) are significantly different from zero. This provides partial support for efficient structure hypothesis since the explanatory power of efficiency variable far exceeds those of market structure (sum of explanatory power on concentration and market share). Each coefficient gives the marginal effect of one hypothesis on performance measured by return on assets.

The coefficient on concentration is positive, indicating support for *SCP*. An increase in concentration by 1% would result in the increase in profits by 1.4%. The coefficient on market share suggests that there is a significant influence on the profitability of banks by market share. This might suggest that the relative market power hypothesis (RMP) may explain part of the profit-structure relationship and therefore indicates that market share enables banks to reap benefits associated with market power. However, MS could represent market power of the larger banks in the market gained for example through international banking and failure of several small banks, etc., rather than efficiency. In addition, since the coefficients on the market share and concentration are all positive, this could be interpreted as demonstrating that all banks earn monopoly rents from collusion and that these benefits, as suggested by theories of oligopolistic behaviour, are distributed unevenly with the larger banks in the market capturing the lion's share of monopoly rents.

The coefficient on the efficiency measure is positive and statistically significant with a larger effect compared with the market share and concentration, which supports the efficiency hypothesis (see Table 12). This suggests that higher profitability of some banks may be explained by their superiority performance in producing and marketing banking services. A coefficient of 0.13 on the efficiency variable predicts a 13% increase in the return on assets of banks from a 1% improvement in efficiency, other

Table 12: Estimation results

Dependent variable: ROA (all variables deflated by CPI)
Estimation method: Fixed effects

Variable	Coefficient	Z-statistic
$\hat{C}$	0.014	4.62
	0.025	8.13
$\hat{MS}$	0.13	6.38
	-0.002	-1.32
$\hat{EFF}$	-0.056	-16.58
NPA	-0.005	-3.66
OP	-0.09	-2.98
CAS	0.017	1.89
TR	0.03	3.18
Dummy		
cons		

$F - stat = 19.85 \left(prob = 0.00 \right)$
$R - Sq = 0.53$

Dependent variable: ROA (all variables deflated by CPI)
Estimation method: fixed effects

Variable	Coefficient	Z-statistic
$\hat{C}$	0.010	3.34
	0.019	5.89
$\hat{MS}$	0.12	6.24
$\hat{EFF}$	-0.18	-2.69
MSC	-0.006	-0.89
	-0.063	-8.16
NPA	-0.003	-2.56
OP	-0.082	-2.73
CAS	0.013	1.74
TR	0.12	1.17
Dummy		
cons		

$F - stat = 22.51 \left(prob = 0.00 \right)$
$R - Sq = 0.56$

things being equal.

To interpret this finding appropriately requires determining whether the effect of market share on profitability is related primarily to efficiency or collusion. This is done by introducing an interactive term of market share and concentration $\left(MSC \right)$ as argued by Smirlock (1985). If high concentration is associated with collusive behaviour that is characterized by disproportionate rent-sharing in favour of the larger firms, then a positive coefficient on MSC should be observed. If collusion is not an extant, then the coefficient should be negative. In this case the estimated model is:

$$\pi_{it} = \beta_0 + \beta_1 \hat{C}_t + \beta_2 \hat{MS}_{it} + \beta_3 \hat{EFF}_{it} + \beta_4 Z_{it} + \beta_5 D + \beta_6 MSC + \varepsilon_{it}$$

The results obtained using this approach, as reported in Table 12, indicate that the

coefficient on MSC is negative, which is consistent with the interpretation above.

Uganda's banking sector has high operational costs in comparison with those of Tanzania and Kenya. The effect on the performance of banks is shown by a significant impact on profitability. A 1% increase in operational costs relative to revenue would reduce profits by 5.6%, all things equal. This in part explains the low ratio of advances to deposits and low branch network. Taxes paid and capital requirements also significantly affect profitability of banks. The coefficient on CAS is negative and significant. This suggests that capital requirements serve partly to strengthen banks, but also act as an insurance mechanism in case insolvency reduces bank profitability. CAS also captures the insolvency risk, i.e., the risk that a bank may not have enough capital to absorb portfolio losses from risks such as default and liquidity. Thus, the higher the insolvency risk, the lower the profits, although the magnitude is substantially small. In summary, while Uganda's banking system does not unambiguously support the efficiency-structure hypothesis, it is nevertheless fair to say that the efficiency in banks results in concentrated markets and high market shares, which in turn increase profitability. The non-competitive market structure in the Ugandan banking system may be hampering financial intermediation. The structure, as well as the other market characteristics, may constitute an indirect barrier to entry, thereby shielding the large profits in the Ugandan banking system. The monopolistic behaviour could also have contributed to higher intermediation costs and diseconomies of management than would have been the case under a competitive structure. In this sense, the non-competitive behaviour is consistent with the presence of wide interest rate margins and spreads, which tend to deter potential depositors, as well as potential borrowers, and result in low lending ratios.

5. Conclusion

In the banking literature and the more general industrial organization literature, there are two major empirical approaches for assessing market structure and competition: The structural approach to modelling competition embraces the structure–conduct–performance paradigm and the Efficient Structure Hypothesis (ESH). The SCP paradigm establishes a direct link from industry structure to bank conduct, and from bank conduct to industry performance. This view assumes that banks in a concentrated market can ignore potential competitors and stay inefficient because there are technological and regulatory barriers to entry; the implication is that concentration in the industry can generate market power, allowing banks to earn monopolistic profits by offering lower deposit rates and charging higher loan rates. Proponents of this view use the frequently observed positive relationship between market concentration and profitability to justify their arguments. The ESH interprets the positive relationship between profitability and market concentration in a different way by suggesting that the positive relationship is a consequence not of market power but of the greater efficiency of firms with larger market shares. In other words, the superior performance of the market leaders endogenously determines the market structure, implying that higher efficiency produces both higher concentration and greater profitability. According to ESH, highly efficient banks (owing to firm-specific factors such as technological or managerial skills, etc.) can maximize their profits by reducing prices and expanding bank size, thus gaining market share at the expense of other relatively inefficient firms. From these arguments, one could conclude that bank efficiency serves as the leading force to market concentration.

Alternatively, non-structural models do not infer the competitive conduct of banks through the analysis of market structure, but rather recognize that banks behave differently depending on the market structure in which they operate. The basic tenet of these models is that there is no clear evidence that the use of market power would be greater in more concentrated industries. Under this framework, the Contestable Markets Theory stresses that a concentrated industry can behave competitively if the barriers for new entrants to the market are low. This assumes that banks can enter or leave

rapidly any market without losing their capital. Therefore the incumbent banks are always vulnerable to hit-and-run entry when they try to exercise their potential market power.

This paper contributes to this debate by attempting to use the two approaches to measure bank competition and the degree of X-inefficiency in commercial banks in Uganda and then attempts to investigate how the degree of efficiency affects banks profitability in relation to efficient structure hypothesis. It also uses banking market share and concentration as measures of market structure to analyse how the market structure affects profitability in relation to structure–conduct–performance hypothesis. While some of these relationships between competition and banking system performance and stability have been analysed in the developed countries, empirical research in developing countries is at best still at infancy. In particular, this paper makes important contributions to the literature on bank efficiency and how it affects banks' performance, since most studies on the efficiency and market structure of banking systems have focused on non-African countries. First, we complement other studies on the nature of bank competition. Second, we investigate the interaction between competition and concentration and finally, we examine how bank profitability is affected by market structure and efficiency.

Using interest revenue and total revenue as ratios to total banks' assets and also unscaled total revenue as dependent variables, we found the resulting H statistic to provide strong evidence that Uganda's banking market is characterized by monopolistic competition and that the degree of competition among the banks is broadly in line with estimates reported in the literature for other countries. Overall, our results suggest that while competition in the Ugandan banking sector falls within a range of estimates for comparator markets, it tends to be on the weaker side. On the basis of the computed market power coefficients, we conclude that Uganda's banks seem to earn their revenues, as if operating under conditions of monopolistic competition and concentration in banking markets does lead to a lower level of competition.

In banking services such conditions are, of course, expected a priori from the results of previous empirical studies and from economic theory, since banks are licensed, regulated and supervised, and engage in product (service) differentiation. That is, the study finds the H-statistic to be between 0 and 1, with an average value of 0.28 for the entire period pointing to monopolistic behaviour of banks, which may impede financial intermediation. There is also evidence that competition has increased during the period 2000–2005 following the cleanup of the financial system, which could point to the potential benefits of strengthening the regulatory and supervisory frameworks in fostering a competitive banking system. This result is of no surprise as it confirms the findings of a number of researchers. One implication that can be deduced from this result is that since the banking system is heavily concentrated, small banks may come under pressure as competitive pressures build up, especially since the supply of treasury bills is declining and these have been a major source of revenue. On the other hand, a reduction in net treasury bill issuance may reduce the dependency of banks on government securities as a source of low-risk, high-yielding assets, which could lead to increased competition, as banks would have to identify new lending opportunities and expand their customer base in order to generate income.

A major policy implication derived from this analysis relates to the fact that the Ugandan banking system has been subject to deep structural transformation since the early 1990s. Consolidation and privatization have permitted economies of scale in the production and distribution of services and increased risk diversification. These forces have led to lower costs and, undoubtedly, higher efficiency. However, to ensure that lower costs are passed through to households and firms, greater efficiency must be accompanied by a similar strengthening of the competitive environment in the banking sector.

In order to investigate the relationship between the competition, measuring conduct and concentration measuring the market structure, we regress concentration indexes (k – bank concentration ratio and the Herfindahl index) on the H-statistic and we find both market structure measures significant, which could suggest that a few large banks can restrict competition.

However, the P–R framework does not reflect on the banking systems' functioning and performance. Although the measure of competition is crucial, it may not be the most important characteristic for their profitability. This consideration suggests some advantages of using a more structural approach to assessing the degree of competition in the financial sector. While one cannot expect to address all issues, a more formal test of the degree of competition will allow one to overcome some of these concerns. It will also allow a comparison of results. Moreover, persistently high operating profits, coupled with high revenues and/or high costs, are frequently associated with non-competitive behaviour. The contestability literature argues that competitive outcomes can occur in very concentrated markets, and that collusion can occur even when there is a large number of firms. To robustly conclude on the nature of Uganda's banking market we measure the degree of market efficiency and relate it to the profitability of the banks. One widely used method which we adopt is the X-efficiency approach; this attempts to capture the efficiency of a bank (given its inputs, outputs and prices) relative to other banks. An industry-wide "best practice" cost frontier is calculated and an individual bank's efficiency (or lack thereof) is based on its distance from the frontier. X-efficiency approach finds that there are large cost inefficiencies, on average, there are cost inefficiencies in the order of 34% and profit inefficiencies in the order of 32%.

Using the computed efficiency scores from the stochastic frontier, we analyse the relationship between market structure and profitability in Ugandan commercial banking by testing two hypotheses: the market power hypothesis and the efficient-structure hypothesis. The results are not conclusive. First, concentration and higher market share are positively related to higher bank returns, which provide some support for the market power theory. Second, higher efficiency is related to higher profits, and the relationship between higher efficiency and higher concentration is strong. This provides limited support for the ES hypothesis. Overall, there is some evidence favouring the effects of both market power and efficiency-structure on profitability.

In summary, the competitiveness of Uganda's banking industry has risen following regulatory reforms, closure of insolvent banks and advances in information technology. The system remains underdeveloped and inefficient, however, and performs only a limited intermediation role, despite recent reform efforts. This is due to the existence of various impediments to banking sector lending, competition and development in

general. Large international banks are effectively insulated from various competitions because of their size, reputation for deposit safety and international links. In addition, the recent steps undertaken to strengthen the system by closing weak banks and improving the regulatory, supervisory and legal framework have removed some impediments to financial intermediation but have also resulted in a highly concentrated system. Overall, this illustrates that simply opening the banking sector and privatizing state-owned banks does not solve the problems in banking efficiency, enhance the provision of banking services or transform the banking sector into an engine of economic growth.

It suffices also to point out that Uganda's market size may offer limited possibilities of exploiting economies of scale from overheads in administrative operations and information gathering, as well as economies of scope. Thus, it might be difficult to reduce spreads and increase efficiency and competition in the Ugandan banking industry without increasing the level of exploiting economies of scale and scope. It can be expected that the measures under way to strengthen the financial sector will increase the public's confidence in the sector and lead to a broader and better-structured deposit base, and to more efficient financial intermediation. Nonetheless, the effects of these measures may still be felt in the long-term. Given the low level of competition and the attractive options to invest in low-risk liquid assets, it is doubtful whether the banking structure and characteristics will change.

Notes

[i] This has included Stanbic Bank acquiring one of the largest and oldest banks, Uganda Commercial Bank, Orient bank acquiring of the Trust Bank, and recently Barclays acquiring the Nile Bank.

[ii] Note that the model is subject to several assumptions: banks are operating in long-run equilibrium; the performance of the banks is influenced by other participants' actions; the cost structure is homogenous and the production function is a standard Cobb–Douglas function with a constant returns to scale; and the price elasticity of demand is greater than unity.

[iii] The symbol $A \setminus B$ denotes the set of all elements of a set A not contained in the set B.

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Appendix: Supplementary tables

Table A1: Efficiency scores

Bank	Average cost efficiency score	Average profit efficiency score	Bank market share of assets	Period average NPA	Period average ROA
Standard Chartered	0.795	0.82	0.245	0.072	0.029
Barclays	0.765	0.795	0.15	0.125	0.021
Baroda	0.682	0.754	0.052	0.145	0.012
Stanbic	0.751	0.812	0.324	0.091	0.032
Tropical	0.554	0.569	0.006	0.342	0.004
Crane	0.678	0.694	0.032	0.069	0.016
Cairo	0.723	0.761	0.009	0.015	0.008
Centenary Rural Development	0.578	0.601	0.02	0.253	0.001
Nile	0.527	0.539	0.024	0.395	0.009
Allied	0.542	0.532	0.015	0.329	0.011
Orient	0.664	0.712	0.022	0.022	0.018
National Bank of Commerce Ltd	0.552	0.538	0.001	0.287	0.0004
Diamond Trust Bank (U) Ltd.	0.456	0.465	0.008	0.128	0.006
DFCU Bank Ltd.	0.718	0.735	0.027	0.174	0.0045
Citibank (U) Ltd.	0.935	0.958	0.065	0.031	0.025
Overall average	*0.661*	0.686			

Table A2: Regression results for market share and concentration

Dependent variable (fixed effects): Market share (MS)		
Variable	**Coefficient**	**z-statistic**
EFF	0.87	22.1
NPA	-0.07	-2.21
OP	-0.02	-0.89
gASS	0.001	0.05
cons	0.05	7.91

$F - sta = 41.56\left(prob = 0.00\right)$

$R - Sq = 0.435$

Dependent variable (fixed effects): Concentration (C)		
Variable	**Coefficient**	**z-statistic**
EFF	0.35	2.1
NPA	-0.045	-2.44
OP	-0.05	-3.61
gASS	0.003	4.51
cons	-0.01	-2.4

$F - sta = 28.1\left(prob = 0.00\right)$

$R - Sq = 0.36$

Table A3: Summary of the results (fixed effects)

Production frontier: Translog functional form. Wald chi2(6)= 39133.10
Log likelihood = -342.53858 Prob > chi2 = 0.0000

Variable	Coef.	Std. Err.	Z	P>|z|
Lgtd	0.6358907	0.0251796	25.25	0.000
Lgrwages	0.0422995	0.0095044	4.45	0.000
Lgdint	-0.0895473	0.0146479	-6.11	0.000
LgOrliab	0.8923581	0.091411	9.76	0.000
$0.5(\lg rtd .\lg rwages)$	0.1801718	0.0192669	9.35	0.000
$0.5(\lg rtd .\lg r\int)$	0.1273656	0.0192669	6.46	0.000
$0.5(\lg rtd .\lg orliab)$	-0.25522	0.0442361	-6.20	0.000
$0.5(\lg rwages.\lg r\int)$	-0.0151	0.0019453	-7.89	0.000
$0.5(\lg rwages.\lg orliab)$	-0.04210	0.0310864	-1.72	0.151
$0.5(\lg r\int .\lg orliab)$	0.060121	0.0180258	3.060	0.000
Lgtime	-0.0543436	0.0398231	-1.36	0.172
consant	1.050939	0.1500237	7.01	0.000
ω	0.2719085	0.0977315	2.784	0.005
lnsigma2	-1.089894	0.4081715	-2.67	0.008
ilgtgamma	-0.1081133	0.8592583	-0.13	0.900
σ^2	0.0062521	0.1372485	0.151	0.748
gamma	0.472998	0.2141881	0.1428	0.427
σ_ω^2	0.1590466	0.1365699		
σ_v^2	0.1772055	0.0106172		

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