**UNIVERSITY OF CAPE TOWN**

# FIRM GROWTH, SURVIVAL AND PRODUCTIVITY IN SOUTH AFRICA

**By**

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# Abstract


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In developing economies, the existence of a healthy industrial structure is vital to the pursuit of long term policy objectives of employment and sustainable economic growth. This makes it important to understand the dynamics of firm survival and growth. While there is a growing empirical literature on the topic, there is limited coverage of developing economies because of data limitations. This thesis studies the relationship between firm growth, survival and productivity using South Africa as the case study and fills the gap in industrial organisation literature by providing new empirical evidence on developing countries. The thesis uses data from the Johannesburg Stock Exchange (JSE) listed companies during the period 2000-2010 collected by DataStream. This is done in three independent but related papers that constitute the main chapters of this thesis.

The first paper analyses the changing size distribution, concentration rates and reasons for non-survival. Using the Law of Proportionate Effects (LPE) framework, commonly known as Gibrat's law, it evaluates the relative growth rates of large and small companies in South Africa at general, sectoral and industrial levels. The results indicate that smaller firms are growing faster than larger ones, and more interestingly it is the smallest of the small and medium firms that are growing the fastest indicating that the industrial structure in South Africa is quite healthy. This finding is robust to correction of potential econometric problems of sample selection bias, growth persistence and heteroscedasticity. The results also reveal that non-survival is more pronounced among the smaller size categories of firms and that takeovers are the main cause of death of firms. This leads to the second paper on the key drivers of firm survival.

The second paper begins by considering the patterns of growth and survival of firms over the period 2000-10 and specifies a simple logit binary survival model that allows for firm size, age financial and sectoral characteristics to determine the main drivers of survival among the

listed companies in South Africa. The study improves on these models by using the non-parametric Kaplan-Meier product limit method and estimating Cox proportional hazard model. This is because these models are able to account for the evolution of exit risk. The results show that about fifty per cent of the companies listed in the JSE survived for the whole period and that the decline in the overall survival can be explained by firm size, leverage, profitability and economic sectors. The results on the determinants of survival indicate that large firms, high leverage and profitability operating in the primary sector have higher probability of survival in South Africa. This indicates that large firms are able to resist negative shocks for a longer time. Also access to financial resources through debt and profits seems to improve survival chances. The results seem to be robust even after taking into account the global financial crisis of 2008-2009 on firm survival. The strong influence of financial indicators through leverage and profitability on firm survival raises the issues about the validity of the finance-productivity link which has been largely ignored in the empirical literature in developing countries.

The last paper considers the link between firm finance and firm productivity. It specifically assesses the extent to which firm finance determines productivity level. Using total factor productivity as a measure of productivity, and leverage and liquidity as indicators of finance, the model of the determinants of total factor productivity augmented with financial sector indicators is specified. The results from panel data estimation methods reveal that low leverage firms are more productive compared to the high leverage. This is because high leveraged firms focus more on repaying their debts rather than investing on productivity enhancing activities. It is also found that the low liquid firms are less productive compared to high liquid firms because availability of cash within the firm allows for undertaking critical projects that improve productivity. The finance-productivity link seems to have not been affected by the global financial crisis of 2008-2009. The results were subjected to a number of robustness tests to address potential econometric issues that may invalidate the findings.

Overall, this thesis argues that as developing countries strive to pursue the long term objectives of sustainable growth and employment creation, more effort should be directed towards ensuring that there is a healthy industrial structure and a well-developed financial sector to support it.

## Declaration

I declare that this thesis is my own work, except where acknowledged in the text. I further declare that this thesis has not been submitted for a degree at any other university.

Candidate . . . . . . . . . . . . . . . . . . . . . . . . . . . . . …..

Date . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ……..

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Last but not least, I wish to thank my family members and friends who in different ways supported me during this challenging journey. My heartfelt gratitude goes to my wife Mabahlakoana, my daughters Reabetsoe and Reitumetse and their brothers Atang and Thapelo.

# Dedication

To my late father Rodwell Makalo Masenyetse.

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# Chapter One : Introduction

Firm size distribution is critical in the shaping of a healthy industrial structure by ensuring competitiveness, innovation and employment creation. Small, medium and large enterprises contribute in different ways to a dynamic industrial sector. A common perception is that small enterprises are critical for innovation, growth, competiveness and creating private jobs (Audretsch, 1995). This view has influenced policy formulation in many countries. Large firms are stable and contribute significantly to economic growth, while medium firms represents the next generation of large firms. The neoclassical theory of the firm suggests that, in a dynamic industrial sector over time less efficient producers find it difficult to keep up with the competition and exit the market, leaving the relatively more efficient producers. A large number of papers in industrial organisation have focused on the analysis of the changing distribution of firms over time[1]. This is because firm size distribution has an important effect on industrial structure. However, most of the empirical evidence on firm size distribution has been done on developed countries with little attention given to the developing countries due of data limitations, This is because the analysis of firm size distribution requires a firm level panel data which are generally unavailable in most developing countries except for few countries with established stock exchanges such as South Africa. This study fills that gap using data from South Africa.

This thesis investigates the relationship between firm growth, survival and total factor productivity in South Africa. It uses the unique firm level panel data collected on companies listed in the Johannesburg Stock Exchange (JSE) in South Africa for the period 2000 –2010. The main objectives of this thesis are threefold: (1) to explore the relationship between firm growth and size, (2) to empirically investigate the patterns of survival and model the main drivers of a firm's survival among the listed firms in South Africa and (3) to investigate the effect of finance on economic growth through firm total factor productivity. These objectives are addressed in three independent but related studies constituting the main chapters of this thesis. The chapters are related by the common theme of linking firm performance indicators, such as firm growth, survival and total factor productivity to the overall economic perfomance. They relate the industrial structure to financial sector developments in order to

[1] for survey articles see Sutton, 1997; Caves, 1998; Santarelli et al., 2006

understand the overall economic performance. The findings from this thesis imply that for a country to achieve sustainable economic growth, a healthy industrial structure and a well-functioning financial sector are pre-requisites.

The thesis makes three distinct contributions to the economic literature. Firstly, it adds to the industrial organisation literature by using the firm level panel data in an emerging economy hence contributes to scanty literature in developing countries While there are studies in the advanced countries using firm level data, the unavailability of comprehensive firm level panel data have made such studies very scarce in developing countries. Most of the studies in developing countries using firm level data have been based on adhoc survey data which rarely undertake the follow ups to facilitate the construction of the panel. A few studies done for developing countries include those by McPherson (1996), Zhang et al (2009), Shanmugan and Bhadura (2002), Ribeiro (2007) and Alvarez and Vergara (2006). This study uses a unique panel dataset constructed on companies listed in the stock exchange in South Africa to explore firm dynamics and survival in developing countries. Such an exploration has received very little attention despite its importance for policy formulation. Secondly, it extends the literature on the finance-productivity nexus by investigating the link in the case of South Africa. South Africa is chosen because it has relatively sophisticated financial systems, but it has not achieved the robust economic growth that would create jobs over the past dacade. As such, this thesis brings to the fore new evidence on the effects of financial sector development on total factor productivity at the firm level. Thirdly, the thesis contributes to the industrial organisation literature by employing micro econometrics methods such as survival analysis and panel estimators on the firm level data. These methods have not been used extensively in developing countries, particularly, Africa. This is despite the overwhelming evidence that the methods are more robust.

The rest of the thesis is divided into six chapters including introduction and conclusions. The next chapter (chapter two) locates the thesis within the body of literature and presents the background to the South African industrial structure during the period 2000–2010. Specifically, it traces the evolution of the theory of the firm and relates to the macroeconomic and industrial policy setting in South Africa. Thereafter, it introduces the unique firm level panel data used for empirical analysis in the main chapters. Although the data has been used by Fosu (2013), Fielding (2000) and Fedekke (2013), it has not been used for similar studies on South Africa. The following three chapters constitute the main papers of the thesis.

Chapter three investigates the evolution of firm size distribution in South Africa during the period 2000–2010. A major concern as an economy develops is the evolution of its industrial structure, with a mixture of firms of different sizes important for innovation and sustainable growth. As a result, the study analyses the changing size distribution, concentration rates and reasons for non-survival. Using the popular Law of Proportionate Effects (LPE) framework, commonly known as Gibrat's law, it evaluates the relative growth rates of large and small companies in general and at sectoral and industrial levels. The approach is adopted because it is easy to implement. The study makes a number of contributions to economics literature. First there is little research on the evolution of the company sector in South Africa and in developing countries in general. The only available evidence in South Africa is McPherson (1996). Most of the results on the relationship between firm growth and size are derived using data from the developed countries whose industrial structures are significantly different from that of developing countries (Santarelli et al., 2006; Wagner, 1994; Hart and Oulton, 1996; Hart and Oulton, 1998; Dunne and Hughes, 1994; Geroski, 1998; Evans, 1987a, 1987b; Hall, 1987). Second, the data on listed companies have not been used extensively to analyse industrial structures in South Africa.

Chapter four explores the evolution and determinants of firm survival during the period 2000–2010. The industrial organisation literature and previous empirical studies suggest firm specific and external factors as the main drivers of firm survival (Manjon-Antolin and Arauzo-Carod, 2008). Firm specific factors includes firm size, age, foreign ownership and financial position, while external factors comprise industry specific factors such as industry competition, barriers to entry and capital requirement, and other factors like firm location and business cycle factors. However, empirical literature on firm survival has been concerned with testing stylized facts on firm survival established in developed countries with little attension given to emerging and developing countries in general. This study provides evidence from a developing country, South Africa. To the best of our knowledge, no other study has investigated the patterns and the determinants of firm survival in South Africa among the JSE listed companies. Following Nkurinzuza (2012), the study estimates a simple logistic binary survival model that allows for firm size, age, leverage, profitability, firm origin and sector characteristics as drivers of firm survival among JSE listed firms. *The empirical analysis also takes into account the global financial crisis episode that might have affected firm survival. The study improves upon* the binary models by using the non-parametric Kaplan-Meier product limit method and estimating Cox proportional hazard model in order to control the evolution of exit risk.

Chapter five introduces finance as one of the determinants of total factor productivity of firms and assesses the link between firm finance and total factor productivity. The economic growth models assert that total factor productivity is an important channel through which financial sector development influences real economic progress (Papaioannou, 2007) yet this link is not automatic. There has been significant empirical evidence on the finance-growth nexus with less attention on testing finance–productivity link (Gehringer, 2014). Most of the studies on developing countries are based on aggregate macro level data with little use of firm level data, despite it being more appropriate for unpacking the relationship between finance and productivity. This study, thus analyses the relationship between finance and productivity using firm level data. The empirical strategy followed involves specifying the model for firm's total factor productivity that allow for firm and industry characteristics augmented with financial sector variables. The intensively used leverage and liquidity are selected as the appropriate measures for financial sector development indicators at the firm level, while total factor productivity is used as the measure of productivity. The panel data methods of pooled ordinary least squares and fixed effects models are employed because they take into account the unobserved firm heterogeneity that may be correlated with the explanatory variable and bias the estimates.

# Chapter Two : The Theory of the Firm and Industrial Structure in South Africa

## 2.1 Introduction

Analysis of the changing industrial structure over time requires comprehensive firm level panel data. This is mostly unavailable in developing countries, particularly, Africa. The only widely available firm level data in developing countries are survey data which rarely collect the follow-up data. Fortunately, South Africa has publicly available data on companies listed on the JSE. Because the JSE is among the mature stock exchanges in Africa, the coverage of its listed firms provides sufficient data points to allow for econometric analysis. Some stock exchanges have small number of listed firms. In 2010, the JSE had 450 listed companies followed by Nigerian Stock Exchange with 217 and Egyptian Stock Exchange with 213 companies. [2]

The purpose of this chapter is to set the stage for the rest of the thesis. First, it presents the theoretical framework by discussing the theory of the firm. Second, it provides some background to the economic and industrial structure in South Africa during the 11 years leading up to 2010. Third, it presents the data collection of firm level panel data to be used for the empirical analysis in Chapters 3, 4 and 5 and provides some descriptive analysis of the main characteristics of the data. This chapter provides insight to whether the assembled data can represent the evolution of the economic and industrial structure in South Africa during the period.

## 2.2 Theory of the Firm

The theory of the firm has evolved significantly from when business was carried out by farmers and merchants to today where there are large multinational companies (Hart, 2011). As a result, different theories have attempted to understand the nature of a firm. These are reviewed in the enormous literature the theory of the firm (Hart, 2000, Hart, 2011, Trau, 1996, Kantarelis, 2007). In tracing the evolution of the theory of the firm, the natural starting

[2] African Securities Exchanges Association (ASEA)

point is the neoclassical view of the firm which has dominated economics textbooks for a considerable period.

The neoclassical model views a firm as a single product and profit maximizing entity based on the production function. The firm is expected to operate under perfect competitive markets and complete information. At the core of the neoclassical theory of the firm is the assumption of optimal allocation of productive inputs, such as physical and human capital for profit maximization. As a result, these set of theories are sometimes called 'technological theories' in the literature. As firms grew in complexity the assumption of profit maximization became the centre of criticism of the neoclassical theory of the firm. The argument was that rather than maximizing profits, firms largely satisfy the ambitions of the managers (Hardt, 2009). In this model, the growth of the firm is guided by the existence of the U-shaped average cost curve such that firms only grows until they reach the minimum average cost. In this way, growth of firms is a mechanism towards reaching optimal size (Coad, 2009).

Some of the assumptions of the neoclassical theory of the firm have been relaxed (Hart, 2000). For instance, in analyzing the strategic interaction of firms, the perfect competition assumption is relaxed. Hart (1989) argues that this capability is one of the strong points of the neoclassical theory. The constant returns to scale assumptions can also be relaxed to allow for increasing returns to scale. Despite these, the neoclassical model still remains inadequate to deal with the internal organisation of large firms, firm financing decisions and optimal compensation of managers. Obviously, companies listed on the stock exchange are large and possess more complex organizational structures than those envisioned in the neoclassical world. This is because their growth may be influenced by mergers. As such, the application of neoclassical theory may not be relevant.

A major development of the neoclassical theory of the firm was the principal agent theory of the firm. It introduced the conflict of interest between different economic actors through information asymmetry. Conceptually, the firm is still the neoclassical black box, but recognizes that production decisions are made by professional managers on behalf of the owners. As such, the interest of the owners and those of the managers are not necessarily aligned. The managers have their own interests which include their salaries and empire building. With this modification, the goal of profit maximization may be difficult to attain. The agency theory of the firm builds upon the information asymmetry between the economic agents to handle moral hazard and adverse selection. Interestingly, agency theory is the basis for corporate finance theories which deals with the financing of the firm. These theories are more applicable to publicly listed companies.

The transaction cost theory of the firm presented a different approach to addressing the weaknesses in the neoclassical theory of the firm. The theory can be traced back to the seminal paper by Coase (1937), which was later extended by Williamson (1975, 1985). According to Coase (1937), the firm is conceptualized as minimizing transaction costs. The theory recognises that transaction costs play an important role in the firm. Coase (1937) focused on the comparative transaction costs of alternative organizational structures, such as firms and markets. Transactions costs are costs incurred when making an economic exchange. They include the costs of organizing business activity over time, planning the future as well as limiting and allocating risks which may arise in the future. According to Coase, the market cannot be relied upon for certain transactions. This is because the market tends to make them costly. As such, this requires managers to sign contracts that can be monitored.

Williamson (1975, 1985) provided the major improvement to transaction cost theory. The theory views the firm as a governance mechanism and, as such, it has been used to explain mergers and acquisition and competition law. In particular, the theory rests upon two behavioral assumptions; 1) that human beings operate on limited information and; 2) they are opportunistically self-seeking. He asserts that transaction costs are important in situations where economic agents make relation specific investments. In this situation, it is difficult to anticipate the future as the contract is incomplete. Alchian and Demsetz (1972) also built on the work of Coase (1937) and recognized the importance of costs associated with measuring and monitoring outputs. Their view was that a firm was a nexus of contracts. They argued that in transactions that involved team production it was necessary to have proper monitoring of the contribution of each agent.

The relevance of the review of the evolution of the theory of the firm to this thesis is to locate which of the theories best captures the prevailing conditions in the developing countries. This is important because most of the theories are best suited for conditions in developed countries. They have also been mostly applied to the developed countries. As such, most theories of the firm have some limitations when applied to the developing country context.

For instance, the neoclassical theory of the firm is based on strict assumptions of a well-functioning markets and complete information. These assumptions may not hold in the developing country particularly in Africa. Furthermore, while the transaction cost theory has addressed the concerns about the neoclassical theory, its assumptions are still short of capturing the prevailing conditions in developing countries. Transactions costs are high and enforcement of contracts remains the main obstacles to firms. This thesis contributes to the empirical literature by extending the application of the theory of the firm to the developing country context. To characterise the nature of the firm and the conditions in the case of South Africa, the next section discusses the South African policy context by tracing the economic and industrial performance.

## 2.3 Overview of Economic and Industrial Performance

The South African economy during the post-apartheid period has been characterized by significant changes in macroeconomic, trade and industrial policies. These changes have shaped the evolution of firm size distribution, survival of firms and their productivity. This section traces some of the key economic developments in South Africa during the period.

Economic performance in South Africa during the post-apartheid period 2000–2010 has been low (Lewis, 2001; Faulkner et al., 2013; Eyraund, 2009; Clarke et al., 2012). Economic growth measured by the changes in real gross domestic product (GDP) shows that the economy registered an annual average of 3.6 per cent in the period, reaching a peak of 5.6 per cent in 2006 at the height of the commodity boom as shown in Table 2.1. This is because South Africa is highly endowed with several mineral deposits: it is the world largest producer of platinum and the second largest exporter of gold, and, over the years its overall performance have tended to correlate with commodity price movements. The best years seems to have been 2004-06 with the growth rate averaging in excess of 5 per cent. Subsequently, the economy contracted by 1.5 per cent in 2009 for the first time after ten years, reflecting in part the effects of the 2007–08 global financial crisis. The International Monetary Fund (IMF) has suggested at the time that the impact of the crisis on the South African economy was more pronounced than in other large emerging markets largely because it is highly integrated to the developed countries where the crisis was more severe (IMF, 2010). Several studies have provided evidence on the effects of the crisis in South Africa, Marenza and Ikhide (2013) provide evidence on the effect of the crisis on productivity of the banking system while Mathee et al. (2016) look at the impact on exporters. The integration of the South African economy with the rest of the world coupled with the overall evolution of GDP is likely to have a bearing on the firm dynamics. To get the full picture on the relative performance of the South African economy, it is compared with similar economies such as BRICS.

Comparing the economic performance of South Africa with fellow BRICS member countries shows that it is similar to Brazil but lags behind China and India.[3] The economies of China and India are commonly used for benchmarking economic performance following their star performance of the last decade (Hseih and Klenow, 2009). During the period under consideration, China and India registered average real GDP growth of 10.3 per cent and 7.7 per cent respectively. This far outstrips the performance in South Africa and Brazil, which registered real GDP growth of around 3.6 per cent and 3.7 per cent during the same period respectively. A slightly different pattern is observable when the comparison is done using the unemployment rates. In sharp contrast to single digit unemployment rate reported for Brazil, China and India that of South Africa stayed consistently at double digits. In 2010, China had the lowest unemployment rate of 3.0 per cent compared with 4.3 per cent and 9.3 per cent for India and Brazil respectively, while in South Africa it was recorded at 26.7 per cent in 2000 to 24.7 per cent in 2010. Overall, the statistics divulge that the South African economy has been performing dismally. However, to visibly see the influence on firm dynamics, GDP is disaggregated into expenditure components.

Different expenditure components of GDP have varying implications for the industrial structure and firm dynamics. A consumption driven economy will have more firms in consumer goods and services, while a public investment driven economy will be dominated by infrastructural support companies. In South Africa, there has been a steady increase in investment as a share of GDP rising from 15.1 per cent in the 2000 to 19.3 per cent in 2010. The available data does not allow for identification of whether the increase comes from private or public but, for our analysis, it is sufficient to note that investment levels have been increasing. A modest increase is also observed in exports of goods and services. The ratio exports of goods and services to GDP reached a peak of 35.8 per cent in 2008. Exports are believed to be critical for driving economic growth, as South Africa is pursuing export led

[3] BRICS countries are Brazil, Russia, India, China and South Africa.

growth strategy. Imports of goods and services averaged 29.2 per cent during the period. Lastly, total consumption, which, accounts for the largest share of GDP seems to have remained stable at around 81 per cent of GDP. Overall, there have not been major shifts in the expenditure components in South Africa during the period except a marked increase in total investment. The next factor to investigate is whether the same stability can be observed in the sectoral distribution.

**Table 2.1 South Africa Macroeconomic Indicators 2000–10**

| **Indicator** | **2000** | **2006** | **2007** | **2008** | **2009** | **2010** | **Average 2000-10** | **Average 2005-10** |
|---|---|---|---|---|---|---|---|---|
| **Overall Output** | | | | | | | | |
| GDP growth | 4.15 | 5.60 | 5.55 | 3.62 | -1.53 | 3.09 | 3.61 | 3.60 |
| GDP per capita growth | 1.61 | 4.43 | 4.40 | 2.48 | -2.58 | 1.70 | 2.18 | 2.42 |
| **Expenditure Categories** | | | | | | | | |
| Final consumption expenditure, etc. (% of GDP) | 81.13 | 82.76 | 81.50 | 80.36 | 81.33 | 80.97 | 81.34 | 81.57 |
| Gross fixed capital formation (% of GDP) | 15.14 | 18.34 | 20.15 | 23.08 | 21.56 | 19.33 | 17.78 | 19.87 |
| Exports of goods and services (% of GDP) | 27.87 | 30.01 | 31.48 | 35.88 | 27.31 | 27.36 | 29.51 | 29.90 |
| Imports of goods and services (% of GDP) | 24.92 | 32.45 | 34.21 | 38.94 | 28.19 | 27.56 | 29.23 | 31.53 |
| **Sectors** | | | | | | | | |
| Services, etc., value added (% of GDP) | 64.94 | 65.96 | 65.74 | 64.70 | 66.08 | 67.58 | 65.37 | 66.04 |
| Industry, value added (% of GDP) | 31.78 | 31.16 | 31.25 | 32.32 | 30.99 | 29.84 | 31.49 | 31.12 |
| Manufacturing, value added (% of GDP) | 18.98 | 17.46 | 16.99 | 16.80 | 15.23 | 14.20 | 17.72 | 16.53 |
| Agriculture, value added (% of GDP) | 3.27 | 2.88 | 3.00 | 2.99 | 2.92 | 2.58 | 3.14 | 2.84 |
| **Unemployment and Inflation** | | | | | | | | |
| Unemployment, total (% of total labor force) | 26.70 | 22.60 | 22.30 | 22.70 | 23.70 | 24.70 | 24.63 | 23.30 |
| Inflation, consumer prices (annual %) | 5.34 | 4.64 | 7.10 | 11.54 | 7.13 | 4.26 | 5.96 | 6.34 |

Source: World Development Indicators

The sectoral distribution of output in an economy also has direct implications on the firm dynamics (McPherson, 1996). Certain sectors are characterised by barriers to entry, while others are highly regulated. The economic structure of the South African economy is closer to that of developed countries as most of its output is produced in the services sector (Fedderke, 2013). The services sector contributes 67 per cent of GDP mainly driven by the finance, real estate and business services sub-sector. The financial sector was developed at the back of the mining boom in the late 1800s which required a well-functioning financial system for it to prosper (Gondo, 2009). As such, South Africa has one of the most sophisticated financial sectors among the developing countries.

The industrial sector is the second largest sector, with the average contribution of 31 per cent of GDP, and comprises value added in manufacturing, mining, construction, electricity, water, and gas. The manufacturing sub-sector, which is pivotal for industrial policy, accounts for an average of 16.1 per cent of GDP, and has been on a downward trend since the 1970s, from 19.3 per cent in 1994 to 11.3 per cent in 2012. This long term decline in manufacturing sector has resulted in the net loss in employment, particularly in low and medium skill industries (Edwards, 2005). Moreover, growth in the manufacturing sector has been slightly lower compared with real GDP growth during the period, growing by an average of 3.0 per cent during the period 2000-2010. What is of importance to firm dynamics is that the manufacturing sector in South Africa is relatively diversified, covering automotive, textiles and clothing, carbon and stainless steel, and chemicals. The number of products accounting for 75 per cent of exports is 94 which is high compared to Southern African Development Community (SADC) countries.[4]

Finally, the primary sector, which is dominated by the mining and quarrying sub-sector, is the smallest. Nevertheless, the mining and quarrying sub-sector is the traditional bedrock of the South African economy, contributing an average of 7.5 per cent of GDP. As indicated, it continues to influence economic performance in South Africa. It is expected that the firm distribution of the South African economy will reflect the historical dominance of mining in the economy through mining firms and supporting companies. Agriculture sub-sector seems to have been shrinking, falling from 3.27 per cent in 2000 to a mere 2.5 per cent of GDP in 2010. The foregoing analysis has established that services sector driven by the finance, real

[4] Diversification indicators for Southern African Development Community (SADC) countries are presented in Appendix A2.

estate and business services sub-sector dominates the economic structure of the South African economy. Then, the next section examines the data collection and sample construction

## 2.4 Data and Sample Construction

A major constraint in analysing changing industrial structure in developing countries is data availability. The data used in this thesis was collected from a number of unique and relevant databases on companies listed on the Johannesburg Stock Exchange (JSE). The primary source is the Datastream system which provides a full set of company financial accounts for companies listed in the stock exchanges around the world. In South Africa, by law, among other requirements listed companies are required to file their annual financial statements with the stock exchange together with any changes in the company structure such as mergers, acquisitions and takeovers. The study uses data covering the period 2000–2010. All effort was made to collect information for all listed companies. The non-financial data were collected from various sources including the Profiles Stock Exchange Handbooks, Macgregor Handbooks and online database, Financial Times Top Companies and Who Owns Whom. The following paragraphs describe in detail each data source and the process to incorporate this information into the main dataset.

Data from Datastream comprise of three types of financial accounts normally prepared as part of the financial statements of the company, namely income statements, profit and loss account and balance sheet. The income statement records the company's sources of income. The profit and loss account records the company income and expenditures while the balance sheet captures the assets and liabilities of the company. Datastream stores assets and liabilities separately. The variable definitions are standardised across the firms and across the countries which make it easier to compare across countries.

Companies are classified using the Industry Classification Benchmark (ICB). The ICB classification has ten industries and twenty nine sectors[5]. While the data is downloaded in sectors, it is aggregated to the industry level according to the ICB classification. The industries are oil and gas, basic materials, industrials, consumer goods, health care, consumer services, telecommunications, utilities, technology and finance.

[5] See Appendix A1

The format in which the data is downloaded is not analytically plausible so some work has been done to ensure that the data is analytically presentable. This involved merging from sector level to industry level in line with the ICB classification. Also, the income statement, profit and loss and the balance sheet for each company were merged through unique identifiers. A high level of care was required to ensure that companies that were replicated in the downloaded data were removed. Some companies that that did not have values for the entire sample period, were also deleted. This arises due to companies that exited from the stock exchange before the start of the sample period but were not removed from the database.

This data was complemented by information from other sources. The quarterly JSE handbooks, Profiles Stock Exchange Handbooks and Macgregor Handbooks were also used. The handbooks document information on the JSE listed companies, such as nature of business, sector, directors, capital structure and dividend distributions. These handbooks provided data on the year that the companies were established. Macgregor also has the online database which has the depository for the Stock Exchange News Service (SENS). SENS is a service that provides market participants with access to company announcements such as mergers, take-overs, rights offers, capital issues and cautionaries. This information was used in documenting the reasons for exit from the database.

Lastly, information was sourced from the Financial Times top companies online and Who Owns Whom online database. They provided lists of new issues, delisting, suspensions and mergers and acquisitions. Some work had to be done to assemble the data into a consistent panel suitable for analysing the changing industrial structure. This included following up on each of the companies to record their current status and documenting the reasons for their exit from the JSE. The multiple source verification of the reasons for exit ensured that the correct status for exit was recorded. For instance, the data on mergers and acquisitions is contained in the records of the Competition Commission. According to the Competition Act of 1998, companies are required to file with the Commission before the merger can take place. The Commission database starts from 2002, hence could not be relied on exclusively. Bloomberg database also has information on mergers and acquisitions. In addition, company websites were used to find the historical events and past annual reports. In general, the non-financial data on the reasons for exits were verified by checking multiple sources.

The data collected is used to construct the panel dataset for companies listed in the JSE for the period 2000-2010. The database is rich in both financial and non-financial characteristics of the listed firms. Datastream provides financial data such as total sales, total assets, total liabilities, equity, debt financing, liquid assets and tangible assets. Data on the country of origin for each company is also available. This is used as the proxy for ownership in the thesis. Other sources provide non-financial information, such as the age of the companies and reasons for exit from the database. Due to the unavailability of industry/sector level deflators, the average annual consumer price index (CPI) published by Statistics South Africa is used to deflate the variables where necessary.

It is argued that the dataset can be used to fill the existing gap in the availability of firm level panel data in South Africa. Although there are some available firm data in South Africa, most of them are survey- based and cannot allow for annual panel data construction. To the best of our knowledge, we are not aware of any publicly available dataset in South Africa with a high enough frequency that can allow for annual panel data construction. For instance, the World Bank enterprise surveys undertaken in South Africa have two waves only. Naughtin and Rankin (2014) use the Large Sample Survey of Manufacturing from Statistics South Africa to construct a panel for 2005 and 2008. The data for constructing a firm database with the same characteristics can also be found from the South African Revenue Services (SARS) and Statistics South Africa (StatsSA) based on companies tax and statistical returns, but these data are not available publicly (Kerr et al., 2013). Data from SARS is used in Matthee et al. (2016) and Edwards et al. (2016). Another advantage is that by tracking firm's overtime, such that the births and deaths are correctly identified. It is possible to address a number of econometric problems associated with sample selection. This is because firms that exit the sample are accounted for by use of additional information.

However, the dataset is not immune to some shortcomings. Firstly, it does not include the location or geographical dimensions. It is not possible to disaggregate the location by provinces. This is important in South Africa. Furthermore, capturing whether the firm is located in an urban, rural or coastal has implications on firm dynamics. This is because some regions may be more preferred than others. Secondly, large firms may be overrepresented in the sample as small companies do not generally list in the stock exchange. Also the informal sector is excluded from the sample. It is possible that South Africa, like most developing countries, has a relatively large informal sector. This is evidenced by comparing with the data from South African Revenue Services. The data shows that in the period 2003-2006 listed companies represented about 0.1 per cent of the total companies with taxable income (SARS, 2008). A similar observation is made in the nationally representative World Bank enterprise survey conducted for South Africa in 2007 whereby, the percent of firms with legal status of being listed represented just 0.4 per cent of the total sample of 937 firms.

The next issue is the sample characteristics and the type of problems that are likely to arise. The resulting sample comprises of about 860 companies, making 4635 observations covering the 11 years (see Table 2.4). While publicly listed companies generally represent a small proportion in African countries, in South Africa, they play an important role. As Table 2.4 indicates, the stock market capitalization of the JSE averaged 200 per cent of GDP during the period under review. This suggests considerable financial depth in the economy. The evolution of the number of companies to a large extent reflects some changes in the JSE over the period. The panel is unbalanced and comprises of an average of 421 companies per year. The number of companies has been declining from 524 in 2000 to 386 in 2010. The largest decline was experienced in the period 2000–05, while the last five years was somehow stable, especially following the observed spike in 2007. This includes allowing offshore listing due to the gradual liberalisation of exchange controls. Walters and Prinsloo (2002) point out that by 2000 about five companies had been granted permission to move their primary listing to the London Stock Exchange. Burke (2005) also notes that the population of the listed companies declined significantly despite the doubling of market capitalisation. The reason for this seems to have been a tranche of unsuited companies listing on the JSE because of a listing boom. This led to a lot of fund money going into small capitalisations companies for expected large returns. This, in turn, encouraged listings which drive up prices, until the bottom fell out of the market. As a result, the JSE tightened up listing requirements (Burke, 2005).

The sample of JSE listed companies resembles the corporate sector in South Africa (Jenson, 2004). It should be noted that the JSE listed companies excludes important private companies. Following Gomis and Khatiwada (2016), in order to assess the size of the companies listed in the stock market, gross domestic product in current prices and total sales are compared. Table 2.2 below shows the South African Gross Domestic Product in current prices and the total sales figure for all companies in the JSE for the period 2000-2010. Noting that aggregate sales do not correspond to GDP as it is not based on value added, it can be seen that total sales comprise of a significant share of GDP. To check the consistency, another indicator of market capitalization of listed companies is considered. In South Africa, the ratio of stock market capitalization to GDP in 2010 stood at 179 per cent. This suggests a significant size of the JSE and supporting the higher share of sales to GDP. With regards to the structure, there are more companies in the services sector accounting for 49 per cent of the total population. This is followed by the secondary sector with 31.7 per cent and the primary sector with 19.3 per cent. However, it should be pointed out that listing a company in the stock exchange is subject to some strict criteria and these may raise issues of sample selection in the empirical analysis.[6] The JSE listing requirements states that to list in the stock exchange, a company should have the prescribed capital of R50 million, not less than R20 million equity shares and three years profit history with at least R15 million in the last year. These requirements exclude some companies that would want to list and proper modeling for sample selection will have to be done to deal with the potential bias. Furthermore, as will be seen in section 3.3, in disaggregating the companies by size, our definition of a small firm in the stock exchange is inconsistent with the legal definition of a small firm. As a result, it should be stressed that our results can only be relevant to the sample.

**Table 2.2 South African GDP in current prices vs. Aggregate Sales**

| Period | South Africa GDP in current prices (Millions) | Total Sales for listed companies (Millions) | Number of listed companies in the JSE | Market Capitalisation for listed companies (Per cent of GDP) |
|---|---|---|---|---|
| 2000 | 922,146 | 1,060,306 | 524 | 154.2 |
| 2001 | 1,020,007 | 1,087,969 | 471 | 118 |
| 2002 | 1,171,085 | 1,267,954 | 426 | 166.2 |
| 2003 | 1,272,536 | 1,392,475 | 398 | 159.2 |
| 2004 | 1,415,272 | 1,467,218 | 402 | 207.9 |
| 2005 | 1,571,081 | 1,597,527 | 402 | 228.9 |
| 2006 | 1,767,422 | 1,865,749 | 408 | 273.9 |
| 2007 | 2,016,184 | 2,244,864 | 417 | 291.3 |
| 2008 | 2,256,484 | 2,597,331 | 405 | 179.9 |
| 2009 | 2,406,401 | 2,664,287 | 396 | 248.2 |
| 2010 | 2,659,365 | 2,707,624 | 386 | 174.9 |

Source:Statssa, World Development Indicators and own calculations,

[6] For a detailed definition of small firm in South Africa see the National Small Business Act of 1996.

The next step shows how the main variables used in the study are derived. The main variables include firm sales, assets age, productivity, leverage, liquidity, capital stock, labour and value added. Table 2.3 below shows the list of the main variables used in the thesis, description, derivation and the source. In the derivation the name of the variable and the Datastream code are included. The code ensures comparable across the firms and countries. The column on source identifies the financial statement (Balance sheet, profit and loss or income statement) where the variable can be located.

**Table 2.3 Variable Construction**

| **Variable** | **Description** | **Derivation (DataStream code in brackets)** | **Source** |
|---|---|---|---|
| Sales | Logarithm of sales | Net Sales or revenue (wc01001) | Income Statement |
| Assets | Logarithm of assets | Total assets (wc02999) | Balance Sheet |
| Profitability | Logarithm of profitability | Earnings before interest and taxes(wc18191)/ total assets(wc02999) | Income Statement |
| Leverage | Logarithm of leverage | Short term debt(wc03051) + long term debt(wc03251) / total assets(wc02999) | Balance Sheet |
| Leverage-long | Logarithm of long term based leverage | Long term debt(wc03251) / total assets(wc02999) | Balance Sheet |
| Liquidity | Logarithm of liquidity | Cash and short term investment (wc02001) | Balance Sheet |
| Tangibility | Logarithms of tangibility | Fixed assets(wc02501) / Total Assets (wc02999) | Balance Sheet |
| Value Added | Logarithm of value added | net income before extra items (Wc01551) +Income tax(wc01451) + interest expense paid on debt (wc01251_num) + salaries and benefits(wc01084) + depreciation (wc01151) | Income statement |
| Capital Stock | Logarithm of capital | Total Assets (wc02999) – Total Intangible Assets (wc02649) | Balance sheet |
| Labour | Logarithm of labour | Salaries and benefits expenses (wc01084) | Profit and Loss |
| Intermediate Input | Logarithm of intermediate inputs | Operating expenses(wc01250) | Profit and loss |
| Origin | Origin | Nation(wc06026) | Profit and Loss |
| Age | Logarithm of age | Current year - year the firm was founded | |

## 2.5 Conclusion

South Africa provides a valuable case study for analyzing the changing industrial structure. The assembled firm level data on companies listed in the JSE has sufficient data points for undertaking the econometric analysis and, to a large extent, represents the key features of the South Africa economy. The following chapters will use the data for detailed empirical analysis.

**Table 2.4 Frequency Distribution**

| **Category** | | **Observations** | **Percent** |
|---|---|---|---|
| **Panel 1** | | | |
| By Industry | Basic Materials | 867 | 18.71 |
| | Industrials | 1,043 | 22.50 |
| | Consumer Goods | 411 | 8.87 |
| | Health Care | 94 | 2.03 |
| | Consumer Services | 645 | 13.92 |
| | Telecommunications | 63 | 1.36 |
| | Utilities | 16 | 0.35 |
| | Technology | 378 | 8.16 |
| | Oil and Gas | 27 | 0.58 |
| | Financials | 1,091 | 23.54 |
| **Panel 2** | | | |
| By Sectors | Primary | 894 | 19.3 |
| | Secondary | 1,470 | 31.7 |
| | Tertiary | 2,271 | 49.0 |
| **Panel 3** | | | |
| By Size | Small | 1,413 | 30.66 |
| | Medium | 2,413 | 52.37 |
| | Large | 782 | 16.97 |
| **Panel 4** | | | |
| By Age | Young (>5Yrs) | 771 | 16.83 |
| | Middle(5-10Yrs) | 719 | 15.70 |
| | Mature(<10Yrs) | 3090 | 67.87 |
| **Panel 5** | | | |
| By Origin | Domestic | 3237 | 91.34 |
| | Foreign | 307 | 8.66 |

Source: Datastream

# Chapter Three : The Relationship between Firm Size and Growth in South Africa[7]

## 3.1 Introduction

A major concern as an economy develops is the evolution of its industrial structure, with a mixture of firms of different sizes important for competition, innovation and sustainable growth. A tendency towards increased (or decreased) concentration within the industry can have implications for competitiveness, innovation, employment and trade in an industry and the economy. A small number of firms employ a large number of employees and have significant market power (Segarra and Teruel, 2012). However, little research has been done on the changes in the distribution of firm size in developing countries and, in particular, South Africa. This is despite the emphasis given to this in the industrial economics literature. Most of the empirical studies that investigate firm size distribution use data obtained from the developed economies. The only available published evidence on South Africa is McPherson (1996) who used limited survey data drawn from two townships. The current study fills this gap in the economic literature by considering the under investigated South African situation using data from companies listed in the Johannesburg Stock Exchange (JSE) during the period 2000–10.

This chapter investigates the changing distribution of companies in South Africa over the period 2000–10, using data collected from DataStream and other sources of companies listed on the JSE. It follows the work of Dunne and Hughes (1994), Hart and Oulton (1996, 1999) and others in using the Law of Proportionate Effects (LPE) framework and considers the implications for South Africa.

The rest of the chapter is structured as follows. Section 3.2 presents the theoretical background and related empirical research on firm growth and survival with special focus on emerging and developing countries. Section 3.3 presents data and some descriptive analysis. Section 3.4 presents the distribution of firms and their growth and survival over time. It analyses the relationship between the size of firms and their growth using the Law of

[7] Various versions of this paper were presented at University of Oxford Center for Studies for African Economies (CSAE) 2014 Conference "Conference on Economic Development in Africa", held in March 2014, TIPS "International Conference on Manufacturing led Growth for Employment and Equality", May 2014 and PRISM seminar series at UCT in October 2014.

Proportionate Effects approach. Section 3.5 discusses some specification tests, while section 6 presents the robustness tests. Section 3.6 concludes the chapter.

## 3.2 Theories of Firm Growth and Empirical Literature

The neoclassical theory of the firm provides the natural starting point towards understanding the growth process of firms. The theory rests on a number of assumptions including that firms are profit maximising, perfect competition and constant returns to scale. According to the neoclassical theory there exists some equilibrium size for the firm. It is the level at which the firm can achieve the profit maximising goals. As such, a firm grows through the competitive process in search of this equilibrium size. Beyond the equilibrium point, there is no incentive to grow or shrink. The equilibrium size is determined as the bottom of the U-shaped average cost curve. This model implies that there is relatively faster growing smaller firms moving towards the minimum efficient size (MES). Their maximum efficient size is where average variable costs are the lowest. The neoclassical view of firm growth has been seen as unsatisfactory as there is no evidence indicating such convergence towards the equilibrium size. As a result, the neoclassical theory has been extended to allow for imperfect competition under which firms are able to compete with an array of products which are differentiated as such the U-shaped average cost curve may be a myth. Another neoclassical theory assumption that contradicts the existence of MES when relaxed is that of constant returns to scale.

Subsequent theories have questioned the neoclassical view and provided alternative explanations for firm growth. Penrose (1959) rejects the neoclassical link of firm growth to size by arguing that growth is a result of internal process driven by learning-by-doing. The theory views a firm as a pool of resources that drive the growth process. It argues that overtime firm managers gather experience and become competent in the managerial tasks. Once they are experienced they can focus on value creating activities of the firm which drive growth. The more experienced managers are able to assist new ones to also graduate. In essence, there is a continuous process of producing managers in order to create value. While quite influential, Penrose’s theory of growth of the firm has had limited impact in economies (Coad, 2009).

Managerial theories recognise that the firm has other goals besides that of profit maximisation as advocated by the neoclassical theory. They argue that managers attach utility to the size of their firms (Marris, 1964). The manager's compensation and bonuses are related to firm size. As a result, firm size and growth are important factors in the manager's utility function. It is debatable whether the growth maximisation is aligned to profit maximisation.

Nelson and Winter (1982) proposed the evolutionary model of growth of firms, which emphasised the dynamic nature that characterises the modern economy. As such, it argues that firms that possess the best mechanism to deal with the changes are able to survive and grow. These mechanisms are referred to as routines and are specific to the firm in the form of knowledge by managers. Initially, competitive process ensures that the firm survive. This success, however, tends to influence future growth.

A popular approach towards analysing firm growth is the stochastic growth model. The approach suggests that the determinants of firm growth rates, including product demand, managerial talent, innovation and government policy, are complex and determined by a range of factors and behaviour that make treating growth as a random shock on initial firm size. The model implies that all firms grow at the same rate proportionate to their sizes. Thus, over time, the size distribution will begin to be characterised by few large firms and many small ones. The distribution will be positive skewed, indicating increased concentration. While the approach has been criticised as atheoretical, it has been widely used in empirical work analysing the growth of companies and the changing size distribution of firms. It uses the popular framework of testing Gibrat's law or the Law of Proportionate Effects (LPE) on company data in line with Dunne and Hughes (1994; 1993), Sutton (1997) and Caves (1998)[8]. The framework is outlined below and adopted in this study because of its tractability.

The Law of Proportionate Effects can be traced back to Robert Gibrat's 1931 thesis (Sutton, 1997). It states that the growth rate of a firm is independent of its size at the beginning of the period being examined. Three approaches have been identified in testing the Law of Proportionate Effects. The first assumes that it is valid for all firms including those that exit between the periods (Sutton, 1997, Lotti et al., 2003). Secondly, it assumes that it only holds for firms that survived throughout the period. Thirdly, it can be valid for firms that are beyond the minimum efficient size. These approaches have inspired a lot of econometrics in the literature, particularly on sample selection.

[8] It was used in the 1970s to analyse the reasons for an observed inexorable rise in concentration of manufacturing industry, which led to concern that this would continue and lead to increasing monopoly power (Hannah and Kay, 1977).

The stochastic model has been critiqued by the Jovanovic (1982) theoretical passive learning model which argues that, overtime, firms are able to adapt to the competitive environment and improve their efficiency. The passive learning model predicts that firm growth can be explained by both size and age of the firm. The model was later refined by Pakes and Ericson (1998) with the active learning model which observed that managers are different in the level of human capital that they possess. Managers that have extensive experience and qualifications are likely to steer their firms to grow faster than the ones with little experience.

Despite these criticisms, Gibrat's law has attracted a lot of attention in the empirical literature since the 1960s. The results from testing the validity of the law has produced mixed results. While initial studies overwhelmingly supported the validity of LPE, it has been continually rejected by recent evidence (Hart, 2000). Lotti et al. (2009) refer to the differing results as a puzzle worth reconciling. Nassar et al. (2013) reconcile evidence on the validity of LPE from developed and developing countries. They argue that if the law is tested in developing countries, it is highly likely that the law will also be rejected as smaller firms are growing faster than large firms. However, as surveyed by Santarelli et al. (2006), comparison of the results is compromised since the bulk of evidence on the validity of LPE cover developed countries. Santarelli et al. (2006) also point out that the comparison of the results poses a challenge due to differing samples, time periods and methodologies. This is further emphasised in Hart (2000) who surveyed the recent influential empirical evidence from the United Kingdom (UK) and the United States (US) presented in Hart and Oulton (1996, 1998), Dunne and Hughes (1994), Geroski (1998), Evans (1987a, 1987b) and Hall (1987).

Different interesting angles have been followed in testing the validity of Gibrat's law, which aims to address potential econometrics problems. The study by Mansfield (1962) was quite novel as it introduced industrial disaggregation analysis into the framework. He argued that industries differ significantly in terms of size and have different minimum efficient sizes. In industries with high MES, it is generally difficult for new firms to enter and compete. As such, industrial disaggregation has become central to testing LPE. While initial analysis was dominated by the manufacturing sector in the belief that Gibrat's law is not applicable to the services industries, services sectors are now also beginning to be analysed. Audrestch et al. (2004) test the validity of LPE on small scale industries such as hospitality. In addition, the literature also notes the diversity of services sector by investigating its specific sub-sector. For instance, Daunfeldt and Elert (2013) for the Swedish retailing sector, Hardwick and

Adams (2002) for the UK life insurance industry and Benito (2008) for the banking sector in Spain. These studies emphasises the importance of correcting for potential econometric problems when testing for validity of the Law of Proportionate Effects.

The life cycle of the firms has also been incorporated into the analysis by Lotti et al. (2003) who tested the validity of LPE post entry among new entrants in three industries in Italy. They found that in the initial years of establishment smaller firms grow faster than large ones. This suggests that post entry smaller firms have to grow faster to reach the MES otherwise they will not survive. Hence, Gibrat's law is rejected among the new entrants.

Until now, the empirical review has focused on evidence obtained from developed countries. As indicated earlier, there is less evidence from testing Gibrat's law on developing countries due to limited data. Earlier studies had mainly used the limited survey data. The availability of stock exchange data has provided a more reliable and comprehensive source of firm level data (Claessens et al., 2012).  A testimony to the scarcity of research in Africa can be seen in survey articles. None of the 80 studies surveyed by Santarelli et al. (2006) focused on an African country. They are mainly from the developed countries – United States (US), United Kingdom (UK) and other European countries.  Like Africa, the evidence from Asia and Latin America is also absent. Table 3.1 summarises a selection of studies which tested the law in developing countries. For comparison, the table reports the country, sample period, sample size, firm size measure, methodology followed, sample, estimation method and the main result for all selected studies. The countries are classified into Africa, Asia and Latin America. The aim is to compare the case of South Africa with comparable other emerging and developing countries, particularly The BRICS (Brazil, Russia, India and China).

Zhang et al. (2009), focusing on the analysis of the broad industrial structure reported mixed results. They used data on Chinese listed firms for the period 1997–2003. It is important to note that the Chinese economy, in the same way as South Africa, has experienced significant reforms as the authorities try to integrate their economies into the global economy. In view of this, Zhang et al. (2009) characterise the Chinese economy as transformational.  Using the logarithmic specification, the study tested the validity of Gibrat's law across five industries over seven different time periods. They found that support for LPE was conditional on the industry and the length of time being considered. Smaller firms are growing faster than their large counter parts. It is necessary to note that Zhang et al. (2009) did not correct for sample selection in their estimates as they argued that during the period considered, few companies delisted from the stock exchange. This study also used data on listed companies.

Another interesting study against which to compare the South African case is by Shanmugan and Bhadura (2002) who investigated the relationship between size and growth in the Indian manufacturing sector during the period 1989–93. Using the growth specification, they found that smaller firms grow faster than large firms. Methodologically, Shanmugan and Bhadura (2002) used the fixed effects estimator on a balanced panel based on the Centre for Monitoring Indian Economy (CMIE) database. It is not clear whether firm exits were dropped in order for the panel to be balanced.

In the case of South Africa, the only available study is McPherson (1996), who tested the law of proportionate effects in four developing countries including South Africa using survey data from two townships. Using growth regression methodology, McPherson (1996) rejected the validity of Gibrat's law in South Africa and found that smaller firms are growing faster than their large counterparts. While the study is ground-breaking on testing the law in the African setting and in looking at South Africa, a number of shortfalls can be identified. First, it used survey data from two townships only. As such, the results are likely to be relevant to the township economy, which may have very different characteristics to that of the overall South Africa industrial structure. Second, the data coverage was mainly focused on small and medium enterprises. A small enterprise was defined as that employing 11–50 employees. Therefore, there are still questions that need to be adequately addressed in South Africa, particularly relating to the broad industrial structure. Also from Africa, the evidence by Page and Soderbom (2012), Bigsten and Gebreeyesus (2007) and Gunning and Mangistae (2001) on Ethiopia, Sleuwaegen and Goedhuys (2002) on Cote d'Ivoire and Teal (1998) on Ghana reject the validity of Gibrat's law.

Evidence from the Latin America also rejects the validity of Gibrat's law in favour of smaller firms growing faster than the large firms (Ribeiro, 2007; Alvarez and Vergara, 2006). The study by Ribeiro (2007) addressed the possible biases of the OLS estimates by using instrumental variables and quantile regression. Their findings also rejected the validity of Gibrat's law, confirming results from other regions. The relevance of this to the current study is that they also followed the Law of Proportionate Effects approach.

## Table 3.1 Summary of Evidence from Selected Emerging and Developing Countries

| Study | Country | Period<br>N | Size Measure | Methodology | Sample<br>Estimation Method | Main Result |
|---|---|---|---|---|---|---|
| **Africa** | | | | | | |
| McPherson(1996) | South Africa | Period:<br>N=244 | Number of workers | Growth rate specification | Sample: Survey of micro and small enterprises in two townships.<br>Method: OLS | Rejects the law |
| | Swaziland | Period:<br>N=277 | Number of workers | Growth rate specification | Sample: Survey of micro and small enterprises<br>Method: OLS | Rejects the law |
| | Lesotho | Period:<br>N=599 | Number of workers | Growth rate specification | Sample: Survey of micro and small enterprises<br>Method: OLS | Rejects the law |
| | Botswana | Period:<br>N=206 | Number of workers | Growth rate specification | Sample: Survey of micro and small enterprises<br>Method: OLS | Rejects the law |
| | Zimbabwe | Period:<br>N=345 | Number of workers | Growth rate specification | Sample: Survey of micro and small enterprises<br>Method: OLS | Rejects the law |
| Bigsten and Gebreeyesus(2007) | Ethiopia | Period:1996-2003<br>N=5542 | Number of workers | Growth rate specification | Sample: Annual Census of manufacturing establishments<br>Method: OLS and Panel based methods | Rejects the law |
| Page and Soderbom(2012) | Ethiopia | Period:2001-2008<br>N=263 | Number of employees | Growth rate specification | Sample: Large and medium Enterprise Survey<br>Method: Least squares | Rejects the law |
| Gunning and Mangistae (2001) | Ethiopia | Period:1983-1993<br>N=220 | Number of workers | Logarithmic specification | Sample: Ethiopian Industrial Enterprise Survey<br>Method: Least squares | Rejects the law |
| Teal(1998) | Ghana | Period:1992-1999<br>N=263 | Number of workers and sales | Growth rate specification | Sample: Enterprise Survey and sales tax data<br>Method: Least squares | Rejects the law |
| Sleuwaegen and Goedhuys(2002) | Cote d'ivoire | Period: 1989-1994<br>N=185 | Number of workers and sales | Growth rate specification | Sample: Survey of manufacturing firms<br>Method: two stage least squares | Rejects the law |
| **Asia** | | | | | | |
| Zhang et al.(2009) | China | Period:1997-2003<br>N=570 | Total assets | Logarithmic specification | Sample: Chinese listed companies<br>Method: Quantile Regression | Mixed results |
| Shanmugan and Bhaduri (2002) | India | Period:1989-1993<br>N=1568 | Sales | Growth rate specification | Sample: CMIE Database<br>Method: OLS and Fixed Effects | Rejects the law |
| **Latin America** | | | | | | |
| Ribeiro(2007) | Brazil | Period:1996-1999<br>N=5745 | Number of employees | Growth rate specification | Sample: Annual Industrial survey<br>Method:IV and Quantile Regression | Rejects the law |
| Estevez L(2007) | Brazil | Period:1998-2002<br>N=7689 | Number of employees | Growth rate specification | Sample: Annual Census<br>Method:OLS | Rejects the law |
| Alvarez and Vergara(2006) | Chile | Period:1979-1999<br>N=11644 | Number of workers | Growth rate specification | Sample: Annual Industrial Enterprise Survey<br>Method: Least squares and MLE heckman | Rejects the law |

## 3.3 Data and Descriptive Analysis

To investigate the evolution of the firm size distribution, we use data on South African companies listed on the Johannesburg Stock Exchange (JSE). These are available from Datastream for the period 2000–2010. As indicated in Chapter 2, the data comprises income statements, profit and loss accounts and the balance sheet for each of the companies during the period and additional non-financial data were obtained from various sources including the Profiles Stock Exchange Handbooks, Macgregor Handbooks and online databases, Financial Times top companies online and Who Owns Whom online database. To consider the development of the size distribution of firms, data is taken from the first year 2000, the period the middle year, 2005, and the final year, 2010. The variables of interest are sales, assets, age, industries and sectors.

The empirical literature on firm size distribution has utilised many indicators as firm size measures, for instance net assets (Dunne and Hughes, 1994), employment (Hart and Oulton, 1996) and sales (Shanmugan and Bhaduri, 2002). Smyth et al. (1975) and Shalit and Sankar (1977) investigate the interchangeability of the alternative measures. They argue that the choice of the most suitable measure depends on data availability. In this study, net sales is adopted as the main measure because it is the most relevant for understanding the economic growth performance. Furthermore, it is among the most reported indicators together with total assets. Using net sales as an indicator minimises missing values and it provides the largest sample. Total assets are used for comparison purpose only. Employment numbers, cover about 50 per cent of the sample, are not reported well in the dataset, Table 3.2 below reports the descriptive statistics of logarithm of sales for the years 2000, 2005 and 2010. As expected, the mean of log of sales has been increasing with time moving from 12.39 to 12.88 and 13.64 in 2000, 2005 and 2010 respectively. The measures of skewness and kurtosis suggest that the variables are not normally distributed.

**Table 3.2 Descriptive Statistics**

| Variables | Mean | Median | Standard Deviation | Variance | Skewness | kurtosis | N |
|---|---|---|---|---|---|---|---|
| Log of sales 2000 | 12.39 | 12.50 | 2.4 | 6.1 | -0.61 | 3.9 | 502 |
| Log of sales 2005 | 12.88 | 12.90 | 2.6 | 7.0 | -0.50 | 3.4 | 377 |
| Log of sales 2010 | 13.64 | 13.72 | 2.5 | 6.5 | -0.56 | 3.6 | 357 |

As discussed in Chapter 2 an inspection of the evolution of the number of companies listed in the JSE during the period 1995–2010 indicates that the larger number of firms in the earlier period reflects some changes in the JSE listing practice over the period. While this change will not affect the analysis of surviving firms, it does impact the results in the analysis of non-survivors, which focuses on the reasons why companies did not survive both overall and broken down by size group[9]. As such in the empirical analysis the econometric problem of sample selection will have to be addressed.

To analyse the changing size distribution of firms over the period 2000–10, a useful procedure is to construct a transition matrix over a number of years. Starting with the distribution in 2000 and considering how firms moved (or didn't) across size groups or out of the sample by 2005 and then repeating this for 2005–10, gave the results in Table 3.3. Out of the 400 companies that were alive in 2005, 288 (72 per cent) survived to 2010. As expected, the highest survival rate is observed in higher size groups with survival rate of over 90 per cent compared to 54.7 per cent in the lowest size group. Of the surviving companies 121 (42 per cent) remained in their size groups as represented by the diagonal line. In addition, a sizable number of the companies moved up to the next size group, with fewer moving beyond three groups. A smaller number of companies moved to lower size groups. The notable downward movement was the two companies that declined from the size groups' R3-4 billion and R4-5 billion respectively to the lowest size group of less than R0.1 billion.

[9] It may also affect the results of sample selection models used later, as the full number of firms will be included in the survival equation. This is discussed in section 3.5.

The pattern is similar for the period 2000–05 as presented in panel 2 of Table 3. There were 518 companies alive in 2000 and 294 (56.8 per cent) survived the five years and 139 (47.2 per cent) remained in their size groups. Interestingly, the ratio of firms remaining in their size groups during the five years is comparable with 45.6 per cent found by Dunne and Hughes (1994) in the case of UK firms. Bigsten and Gebreeyesus (2007) reported 75 per cent in the case of Ethiopia for the five year period. This suggests that the dynamics in South Africa mimic those of other countries.

## Table 3.3 Transition Matrices by Sales

| Panel 1: 2005-2010 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Companies alive in 2005 by Sales Size** | | **Survivors** | | **Sales2010(billions)** | | | | | | | | |
| | | | | **<0.1b** | **0.1-0.5b** | **0.5-1b** | **1-2b** | **2-3b** | **3-4b** | **4-5b** | **5-10b** | **>10b** |
| **Rbn** | **Number** | **Number** | **%** | **Number** | | | | | | | | |
| <0.1b | 128 | 70 | 54.7 | 39 | 24 | 4 | 2 | 1 | 0 | 0 | 0 | 0 |
| 0.1-0.5b | 101 | 72 | 71.3 | 5 | 25 | 24 | 16 | 0 | 1 | 0 | 1 | 0 |
| 0.5-1b | 33 | 27 | 81.8 | 0 | 1 | 5 | 13 | 3 | 3 | 1 | 1 | 0 |
| 1-2b | 24 | 18 | 75.0 | 0 | 0 | 2 | 4 | 6 | 5 | 1 | 0 | 0 |
| 2-3b | 16 | 13 | 81.3 | 0 | 0 | 0 | 0 | 1 | 5 | 2 | 4 | 1 |
| 3-4b | 17 | 15 | 88.2 | 1 | 0 | 0 | 0 | 1 | 1 | 4 | 5 | 3 |
| 4-5b | 16 | 12 | 75.0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 3 |
| 5-10b | 24 | 23 | 95.8 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 8 | 14 |
| >10b | 41 | 38 | 92.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 38 |
| Total | 400 | 288 | 72.0 | 46 | 50 | 35 | 35 | 12 | 15 | 9 | 27 | 59 |
| **Panel 2: 2000-2005** | | | | | | | | | | | | |
| **Companies alive in 2000 by Sales Size** | | **Survivors** | | **Sales2005(billions)** | | | | | | | | |
| | | | | **0.1b** | **0.1-0.5b** | **0.5-1b** | **1-2b** | **2-3b** | **3-4b** | **4-5b** | **5-10b** | **>10b** |
| **Rbn** | **Number** | **Number** | **%** | **Number** | | | | | | | | |
| <0.1b | 182 | 96 | 52.7 | 67 | 24 | 2 | 2 | 0 | 1 | 0 | 0 | 0 |
| 0.1-0.5b | 146 | 71 | 48.6 | 12 | 38 | 18 | 3 | 0 | 0 | 0 | 0 | 0 |
| 0.5-1b | 44 | 23 | 52.3 | 0 | 5 | 4 | 9 | 4 | 1 | 0 | 0 | 0 |
| 1-2b | 47 | 30 | 63.8 | 0 | 0 | 2 | 5 | 8 | 6 | 6 | 3 | 0 |
| 2-3b | 22 | 14 | 63.6 | 0 | 0 | 0 | 1 | 0 | 3 | 6 | 4 | 0 |
| 3-4b | 13 | 8 | 61.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 1 |
| 4-5b | 10 | 8 | 80.0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 4 | 2 |
| 5-10b | 26 | 19 | 73.1 | 1 | 0 | 0 | 0 | 1 | 0 | 3 | 3 | 11 |
| >10b | 28 | 25 | 89.3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 22 |
| Total | 518 | 294 | 56.8 | 80 | 69 | 26 | 20 | 14 | 12 | 15 | 22 | 36 |

Another important concern is exactly why the companies did not survive. The implications for the economy are rather different when companies are going bankrupt, than if they are being taken over while growing. The earlier period has a larger number of firms, but also a considerable larger number and proportion of firms failing. The categories for firm deaths are identified as takeover, liquidation, delisting and others. The study departs from Dunne and

Hughes (1994) and includes delisting category in order to investigate the effects of the listing boom identified in the period 1997–98. Takeover refers to the transfer of control of a firm from one group of shareholders to another and can take different forms including mergers and acquisition (M&A). A merger being the consolidation of two companies in which one survives and the merged one goes out of existence. In essence the acquiring firm assumes the assets and liabilities of the merged company, though sometimes the target company becomes the subsidiary of the parent company and does not disappear from the sample[10]. Changes in scheme of arrangement, offers to minorities and offer to shareholders are all considered as takeovers, which may be by other listed companies or by non-listed ones. Liquidations include no dividend liquidation, voluntary winding up and disposal, while Delisting include voluntarily delists suspension and failure to comply with listing requirements. Others include unbundling of assets and companies that based on the available data we cannot confidently classify. Firms categorised as failing to comply with listing requirements or suspended could be in transitory states that is being in the process of being taken over or liquidated. As such more information was collected to verify the final classification.

As Table 3.4 shows, the death rate between 2005 and 2010 was lowest in the upper most size groups and highest in the lowest size groups. Takeover was the main cause of death (13.5 per cent) and varied across the size classes, with the highest proportions in the R1-2 billion and R4-5 billion groups, at 25 per cent each. The figures for 2000–2005 were somewhat different in scale, but had a similar pattern. The death rate was considerably higher, 42 per cent compared to 22 per cent and the main cause of death was again found to be takeover. A delisting category was added to the usual categories to isolate the pure delisting. This reduced the number in the ‘other’ category, but did not alter the takeover and liquidation categories much suggesting that there was no tranche of firms listing and then delisting, although it is likely that a number of the newly listed firms were liquidated or taken over.

[10] A consolidation is when the two or more companies form an entirely new entity, so in our panel we will see a birth. It may be an issue whether you treat the new company as a birth or just a combination of the two in dealing with historical data.

## Table 3.4 Sales Size Distribution by Type of Death

| Panel 1: 2005-2010 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Companies alive in 2005 by Sales Size** | | **Non-Survivors** | | **Type of Death** | | | | | | | | |
| | | | | **Takeover** | | **Liquidated** | | **Delisting** | | **Other** | | **Missing(1)** |
| **Rbn** | **Number** | **Number** | **%** | **Number** | **%** | **Number** | **%** | **Number** | **%** | **Number** | **%** | **Number** |
| <0.1b | 128 | 35 | 27.3 | 14 | 10.9 | 2 | 1.6 | 10 | 7.8 | 2 | 1.6 | 7 |
| 0.1-0.5b | 101 | 29 | 28.7 | 18 | 17.8 | 5 | 5.0 | 1 | 1.0 | 0 | 0.0 | 5 |
| 0.5-1b | 33 | 6 | 18.2 | 6 | 18.2 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| 1-2b | 24 | 6 | 25.0 | 6 | 25.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| 2-3b | 16 | 3 | 18.8 | 2 | 12.5 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 1 |
| 3-4b | 17 | 2 | 11.8 | 1 | 5.9 | 0 | 0.0 | 1 | 5.9 | 0 | 0.0 | 0 |
| 4-5b | 16 | 4 | 25.0 | 4 | 25.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| 5-10b | 24 | 1 | 4.2 | 1 | 4.2 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| >10b | 41 | 3 | 7.3 | 2 | 4.9 | 1 | 2.4 | 0 | 0.0 | 0 | 0.0 | 0 |
| Total | 400 | 89 | 22.3 | 54 | 13.5 | 8 | 2.0 | 12.0 | 3.0 | 2 | 0.5 | 13 |

| **Panel 1: 2000-2005** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Companies alive in 2000 by Sales Size** | | **Non-Survivors** | | **Type of Death** | | | | | | | | |
| | | | | **Takeover** | | **Liquidated** | | **Delisting** | | **Other** | | **Missing(1)** |
| **Rbn** | **Number** | **Number** | **%** | **Number** | **%** | **Number** | **%** | **Number** | **%** | **Number** | **%** | **Number** |
| < 0.1b | 182 | 86 | 47.3 | 39 | 21.4 | 21 | 11.5 | 20 | 11.0 | 6 | 3.3 | 0 |
| 0.1-0.5b | 146 | 75 | 51.4 | 51 | 34.9 | 16 | 11.0 | 4 | 2.7 | 4 | 2.7 | 0 |
| 0.5-1b | 44 | 21 | 47.7 | 13 | 29.5 | 6 | 13.6 | 1 | 2.3 | 1 | 2.3 | 0 |
| 1-2b | 47 | 17 | 36.2 | 13 | 27.7 | 2 | 4.3 | 1 | 2.1 | 0 | 0.0 | 1 |
| 2-3b | 22 | 8 | 36.4 | 7 | 31.8 | 1 | 4.5 | 0 | 0.0 | 0 | 0.0 | 0 |
| 3-4b | 13 | 5 | 38.5 | 3 | 23.1 | 1 | 7.7 | 1 | 7.7 | 0 | 0.0 | 0 |
| 4-5b | 10 | 2 | 20.0 | 2 | 20.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| 5-10b | 26 | 7 | 26.9 | 5 | 19.2 | 1 | 3.8 | 0 | 0.0 | 1 | 3.8 | 0 |
| >10b | 28 | 3 | 10.7 | 3 | 10.7 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 |
| Total | 518 | 224 | 43.2 | 136 | 26.3 | 48 | 9.3 | 27 | 5.2 | 12 | 2.3 | 1 |

**Notes:** (1) Includes missing and zero values in the second period

## 3.4 Empirical Analysis

The formal framework for testing Gibrat's law is by utilising the regression analysis (Dunne and Hughes, 1993; and Hart and Oulton (1996, 1999). The law states that the probability distribution of growth rates is the same for all sizes of firms and can be stated by the following equation,

$$\frac{S_{it}}{S_{it-1}} = \varepsilon_{it} \qquad 3.1$$

Where $S_{it}$ is firm size in the current period, $S_{it-1}$ is firm size in the previous period and $\varepsilon_{it}$ is the random error term distributed independently of $S_{it-1}$. Empirical investigations of Gibrat 's law rely on the following generalised equation in logarithmic specification:

$$logS_{it} = \alpha + \beta \log S_{it-1} + \varepsilon_{it} \qquad 3.2$$

Our interest is the magnitude of the beta coefficient and the Wald test can be used to assess the null hypothesis. If β=1 means that Gibrat's law is valid, it can be expected that concentration will develop overtime. However, if the hypothesis is rejected as, if $\beta < 1$ smaller firms are growing faster than the larger firms and if $\beta > 1$ the large firms are growing faster than the smaller firms. As indicated, this is the method referred to as the logarithmic specification in the literature and is the one followed in this chapter. Alternatively, the model in equation 2 can also be reparameterised as a growth rate equation and the method is referred to as the growth rate specification. The growth rate specification has been used in Evans (1987a,1987b) and others.

$$\Delta \log S_{it} = \alpha + (\beta - 1) \log S_{it-1} + \varepsilon_t \qquad 3.3$$

In this case the test is for the coefficient on $\log S_{it-1}$ to be zero for the Gibrat's law to hold. If the coefficient is below zero it means that smaller firms are growing faster than the large ones. If it is above zero then the opposite is true, that large firms are growing faster than smaller firms.

While the equation of interest in this thesis remains equation 3.2, it is worth presenting another way of interpreting the Gibrat law equation to measure concentration. Dunne et al (2005) shows that the model can be considered in log deviations form, defined as,

$$y_{it} = \log S_{it} - \log S_t$$
$$\log S_t = N^{-1} \sum_{i=1}^{N} \log S_{it} \qquad 3.4$$

then

$$y_{it} = \beta y_{it-1} + \varepsilon_{it}. \qquad 3.5$$

Squaring, summing over $i$ and dividing by $N$, and taking expected values, noting that $\varepsilon_{it}$ is independent of $y_{it-1}$ gives

$$E(\frac{\sum y_{it}^2}{N}) = \beta^2 E(\frac{\sum y_{it-1}^2}{N}) + E(\frac{\sum \varepsilon_{it}^2}{N}) \qquad 3.6$$

which gives the relationship determining the evolution of the variance of log firm size:

$$\sigma_t^2 = \beta^2 \sigma_{t-1}^2 + \sigma_\varepsilon^2. \qquad 3.7$$

This implies

$$1 = \beta^2 \frac{\sigma_{t-1}^2}{\sigma_t^2} + \frac{\sigma_\varepsilon^2}{\sigma_t^2} \qquad 3.8$$

or

$$\beta^2 \frac{\sigma_{t-1}^2}{\sigma_t^2} = 1 - \frac{\sigma_\varepsilon^2}{\sigma_t^2}. \qquad 3.9$$

The right hand side of this equation is the $R^2$ of the cross-section regression, so

$$\frac{\sigma_t^2}{\sigma_{t-1}^2} = \frac{\beta^2}{R^2} \qquad 3.10$$

As such the evolution of the variance of logarithms of firm sizes which is a measure of concentration is determined by the ratio of the $R^2$ to $\beta^2$. Whether the variance increases or decreases depends both on $\beta$ and the size of the stochastic shocks. If $\beta = 1$, as implied by Gibrat's law, the ratio of current to previous variance is $1/R^2$ which must be greater than unity for variance and concentration is increasing through time. This implies that the size distribution will tend to become highly skewed (Benito, 2008).

To investigate the relationship between firm size and growth assuming that the factors that influence firm growth are complex and there is no obvious systematic pattern across different sizes of firms, implies that the probability distribution of growth rates is the same for all sizes. Thus growth could be treated as random shocks distributed across the size distribution and is the hypothesis representing the Law of Proportionate Effects. One way of checking whether this holds is to follow Dunne and Hughes (1994) method and look at the distribution mean growth rates, which should be the same across size classes if the Law of Proportionate Effects holds. Thus, there should not be any differences in the mean growth rates across the size classes. Table 3.5 presents the net growth of net sales and standard errors tabulated across all the size classes. It is clear for both periods that the growth rates are not distributed equally, providing evidence against the Law of Proportionate Effects. It is the lowest size classes that show the highest growth rates. There are also interesting differences across the two periods, with the middle size classes registering the highest mean growth for 2000-5 while companies with sales greater than R10 billion were the slowest growing. This result suggests that firm growth in South Africa is not random as postulated by Gibrat law.

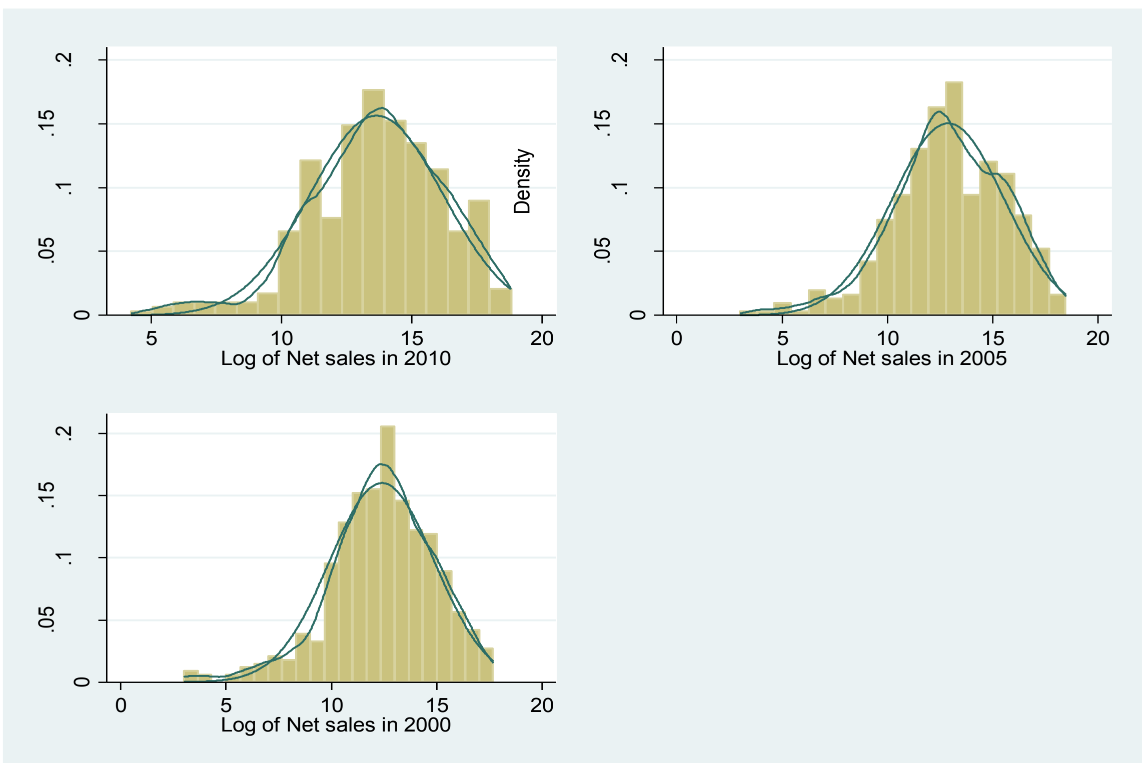
**Table 3.5 Mean Growth of Net Sales**

| | 2005–2010 | | | | | 2000–2005 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Rbn** | **N** | **Mean** | **Std. Err.** | **[95% Conf. Interval]** | | **N** | **Mean** | **Std. Err.** | **[95% Conf.Interval]** | |
| < 0.1bn | 70 | 1.52 | 0.23 | 1.07 | 1.98 | 82 | 0.58 | 0.23 | 0.13 | 1.04 |
| 0.1-0.5bn | 72 | 0.82 | 0.10 | 0.63 | 1.02 | 70 | 0.17 | 0.14 | -0.10 | 0.44 |
| 0.5-1bn | 27 | 0.81 | 0.12 | 0.56 | 1.06 | 23 | 0.43 | 0.14 | 0.13 | 0.73 |
| 1-2bn | 18 | 0.47 | 0.12 | 0.22 | 0.73 | 30 | 0.61 | 0.10 | 0.39 | 0.82 |
| 2-3bn | 13 | 0.58 | 0.10 | 0.36 | 0.81 | 14 | 0.54 | 0.08 | 0.36 | 0.72 |
| 3-4bn | 15 | 0.26 | 0.33 | -0.45 | 0.97 | 8 | 0.81 | 0.14 | 0.47 | 1.14 |
| 4-5bn | 12 | 0.32 | 0.40 | -0.57 | 1.21 | 8 | 0.42 | 0.26 | -0.20 | 1.03 |
| 5-10bn | 23 | 0.46 | 0.10 | 0.26 | 0.67 | 19 | 0.11 | 0.29 | -0.50 | 0.73 |
| >10bn | 38 | 0.55 | 0.05 | 0.44 | 0.66 | 25 | 0.05 | 0.30 | -0.58 | 0.67 |

Notes: The table shows the mean growth of net sales by size classes during the period 2005–10 and 2000–05. Growth is calculated as the log difference in sales.

Also the Law of Proportionate Effects implies that the log of the size measure is normally distributed (Bigsten and Gebreeysus, 2007). An informal way is to use the graphical representation to check normality. Figure 3.1 presents histograms for the log of sales overlaid by the kernel density functions and the normal distribution for the years 2000, 2005 and 2010. It can be seen that the distribution are close to normality. For concrete conclusion, we further use the formal tests of normality – skewness and kurtosis tests and the Shapiro-Francia test. Table 3.6 presents the normality test results for log of sales in 2010, 2005 and 2000. In all the three variables the null hypothesis that the distributions are normally distributed is rejected indicating that the Law of Proportionate Effects is likely not to hold. The preliminary analysis seems to suggest that overall the Law of Proportionate Effects is likely to be rejected.

**Figure 3.1:Sales Distributions**




Notes: The figure presents histograms for log of sales in 2000, 2005 and 2010 overlaid by the kernel density functions and the normal distribution.

**Table 3.6 Normality Tests**

| | | Skewness/Kurtosis tests for Normality | | | | Shapiro-Francia W' test for normal data | | | |
|---|---|---|---|---|---|---|---|---|---|
| Variable | N | Pr(Skewness) | Pr(Kurtosis) | adj chi2(2) | Prob>chi2 | W' | V' | z | Prob>z |
| ls2000 | 502 | 0 | 0.000 | 31.88 | 0 | 0.975 | 8.914 | 4.691 | 0 |
| ls2005 | 377 | 0 | 0.0672 | 15.80 | 0 | 0.980 | 5.470 | 3.641 | 0 |
| ls2010 | 357 | 0 | 0.0335 | 18.38 | 0 | 0.976 | 6.333 | 3.933 | 0 |

Estimating the log linear equation represented by equation 3.2 above gave the results in Table 3.7, which confirm the results of the more informal tests. For 2005–10 the beta coefficient for all firms is 0.80 and significantly less than one. The R-squared and the Wald test statistics reported in the last two columns indicate the goodness of fit of the model and test for (beta=1) respectively.[11] Thus, Gibrat's law is rejected as smaller firms are growing faster than larger firms. For the earlier period, the estimated coefficient was larger at 0.90, but still significantly less than one. This rejects the validity of Gibrat's law. The observed difference in the magnitude of the beta coefficient is indicative of some process at play between the two periods. It is important to observe that the listing boom noted earlier will not explain these differences as it is only companies that survive over the five years period that make up the sample. However, the result provides evidence that over both periods smaller firms were growing relatively faster than larger firms.

The results from other studies testing the validity of LPE in other countries are consistent with the results of this study. For instance, studies from developing countries, Zhang et al. (2009) for China, Shanmugan and Bhaduri (2002) for India, McPherson(1996) for Southern African countries including South Africa, Ribeiro (2007) for Brazil and Alvarez and Vergara (2006) for Chile all reject the validity of Gibrat's law and find that smaller firms are growing faster than large ones. Using similar data source of the stock exchange listed companies, Zhang et al. (2009) found that the beta coefficient tended to increase when the period was shortened to year on year. The economy of China, like that of South Africa is undergoing some form of transition towards integration with the global economy. It is also interesting to compare our results with

[11] $W=(Rb-r)'(RVR')^{-1}(Rb-r)$ where V is the estimated variance-covariance matrix of the estimators

those obtained from developed countries. Gibrat's law was also rejected in Dunne and Hughes (1994), Hart and Oulton (1996, 1999) in the UK and Evans (1987a, 1987b) and Hall (1987) for the US. It is worth noting that the magnitude of beta for South Africa ( 0.8 and 0.9 for the two periods) are lower than that reported in Dunne and Hughes (1994) of 0.93 and 0.95 reported in Hart and Oulton (1996). This suggests wider deviation from Gibrat's law.

## Table 3.7 OLS Estimates

| Panel 1 | | Continuing Companies,2005–2010 | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Dependent Variable: Log of sales in 2010** | **N** | **Log of sales in 2005** | | **Constant** | | **R-squared** | **Wald(beta=1)** | |
| ALL | 288 | 0.80*** | (0.02) | 3.41*** | (0.32) | 0.79 | 65.4 | 0.00 |
| SMALL | 70 | 0.46*** | (0.10) | 6.64*** | (1.06) | 0.21 | 23.9 | 0.00 |
| MEDIUM | 157 | 0.83*** | (0.05) | 2.92*** | (0.80) | 0.55 | 7.9 | 0.00 |
| LARGE | 61 | 0.95*** | (0.06) | 1.21 | (1.10) | 0.77 | 0.4 | 0.53 |
| PRIMARY SECTOR | 46 | 0.95*** | (0.05) | 1.26 | (0.78) | 0.87 | 0.5 | 0.44 |
| SECONDARY SECTOR | 107 | 0.80*** | (0.03) | 3.35*** | (0.51) | 0.81 | 25.0 | 0.00 |
| SERVICES SECTOR | 135 | 0.75*** | (0.03) | 4.01*** | (0.49) | 0.75 | 41.9 | 0.00 |
| MANUFACTURING | 94 | 0.81*** | (0.03) | 3.27*** | (0.46) | 0.86 | 31.6 | 0.00 |
| BASIC MATERIAL | 44 | 0.95*** | (0.05) | 1.29 | (0.85) | 0.85 | 0.5 | 0.46 |
| INDUSTRIALS | 79 | 0.75*** | (0.05) | 4.15*** | (0.68) | 0.73 | 22.7 | 0.00 |
| CONSUMER GOODS | 27 | 0.92*** | (0.03) | 1.66*** | (0.51) | 0.96 | 4.5 | 0.04 |
| CONSUMER SERVICES | 40 | 0.78*** | (0.06) | 3.64*** | (0.96) | 0.77 | 9.6 | 0.00 |
| TECHNOLOGY | 20 | 0.78*** | (0.10) | 3.50** | (1.31) | 0.75 | 4.0 | 0.06 |
| FINANCIALS | 64 | 0.72*** | (0.05) | 4.38*** | (0.72) | 0.72 | 24.2 | 0.00 |
| **Panel 2** | | ***Continuing Companies,2000–2005*** | | | | | | |
| **Dependent Variable: Log of sales in 2005** | **N** | **Log of sales in 2000** | | **Constant** | | **R-squared** | **Wald(beta=1)** | |
| ALL | 279 | 0.90*** | (0.03) | 1.58*** | (0.41) | 0.74 | 8.5 | 0.00 |
| SMALL | 82 | 0.58*** | (0.11) | 4.60*** | (1.16) | 0.23 | 12.4 | 0.00 |
| MEDIUM | 153 | 1.15*** | (0.06) | -1.67* | (0.84) | 0.68 | 5.8 | 0.01 |
| LARGE | 44 | 1.12*** | (0.37) | -1.89 | (6.12) | 0.17 | 0.1 | 0.74 |
| PRIMARY SECTOR | 40 | 0.74*** | (0.06) | 4.17*** | (0.81) | 0.79 | 18.3 | 0.00 |
| SECONDARY SECTOR | 94 | 1.04*** | (0.06) | -0.39 | (0.80) | 0.76 | 0.5 | 0.46 |
| SERVICES SECTOR | 145 | 0.90*** | (0.04) | 1.62*** | (0.57) | 0.73 | 4.7 | 0.03 |
| MANUFACTURING | 83 | 0.92*** | (0.05) | 1.32* | (0.75) | 0.76 | 1.8 | 0.18 |
| BASIC MATERIAL | 38 | 0.72*** | (0.06) | 4.32*** | (0.88) | 0.77 | 17.2 | 0.00 |
| INDUSTRIALS | 64 | 1.10*** | (0.08) | -1.03 | (1.05) | 0.75 | 1.5 | 0.21 |
| CONSUMER GOODS | 29 | 0.97*** | (0.09) | 0.47 | (1.28) | 0.79 | 0.0 | 0.77 |
| CONSUMER SERVICES | 45 | 1.03*** | (0.07) | -0.15 | (1.07) | 0.80 | 0.2 | 0.65 |
| TECHNOLOGY | 25 | 0.70*** | (0.13) | 3.87** | (1.71) | 0.53 | 4.7 | 0.03 |
| FINANCIALS | 67 | 0.87*** | (0.07) | 1.97** | (0.85) | 0.70 | 3.2 | 0.07 |

The table shows the OLS estimates for testing Law of Proportionate Effects for the period 2005–2010 and 2000–2005. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Next we disaggregate the sample to check whether these aggregate results are a reasonable representation of the overall picture, or can be explained by the behaviour of particular sectors, industry or size groups, (Mansfied, 1962). Disaggregation also allows a closer analysis of sectors of particular interest, such as manufacturing and services. The study uses three size classes, small, medium and large companies. In doing, this the official South African definition of small company is not followed for the obvious reason that the sample is drawn from the stock exchange listed companies and is biased towards relatively large enterprises.[12] In general, publicly listed firms tend to be larger (Wu, 2012). This is because for a company to list in the stock exchange it has to meet certain requirements which may be expensive for typical small company as defined in the official definition. A small company is defined as the one with net sales of less than R0.1 billion. These companies also have an average of less than 500 employees, which is in line with the European Union (EU) definition and that used by Haltiwanger at el. (2010) in the United States (US). Medium companies are the ones with net sales of R0.1-5billion, while large is above R5 billion. The results are shown in rows 2 – 4 of each panel in Table 3.7. The table also shows variation across the size classes. Interestingly, the results for 2005–10 show that the small and medium sized firms reject the LPE restriction, but the large firms do not. This is a feature shared with the 2000–05 period, but with generally lower coefficients. This implies that in addition to the evidence that small firms tend to grow faster, it is also the case that within the small firm group, it is the smaller firms that tend to grow faster. The result is similar to that of Dunne and Hughes (1994).

Below the size, the results for the three economic sectors – primary, secondary and services. The manufacturing sector, defined as all industries that are in the international standard industrial classification (ISIC) 15– 37 was also isolated. The results show variation across the sectors with the primary sector coefficient for 2005–10 not being significantly less than one, as shown by the Wald test reported in the last column. This means that the LPE is not rejected. For the secondary and services sectors and manufacturing sub-sectors the coefficient is significantly different from one, suggesting that smaller firms grew faster than the larger ones. Interestingly the results for 2000–05 were different with the secondary sector and manufacturing not rejecting the LPE, but

[12] The official definition of small business in South Africa is defined in the National Small Business Act of 1996. The definition is based on three size measures –sales, assets and employment- and is disaggregated by sectors or sub-sectors.

the others doing so. It seems that there is some process of change at work over this time period, moving away from a tendency towards concentration in manufacturing and the secondary sector as a whole, but with the primary sector developing a tendency to concentration in the later period. Certainly, the change in results for the primary industry across the periods is striking. Viewed in relation to the services sector, the results are consistent between the two periods (hence rejecting Gibrat's law). The magnitude of beta, though, is lower in the period 2005–10.

The results for the six Industry Classification Benchmark (ICB) industries – basic material, industrials, consumer goods, consumer services, technology and financials–are presented. Industries with less than 20 observations are excluded. The results also show variation across industries. For the period 2005–2010, the unitary restriction tested by the Wald test does not reject the null hypothesis that beta is one, which implies that growth is random. Thus LPE holds for the basic material industry. This is not surprising since basic material constitute a larger share of the primary sector. In other industries (industrials, consumer goods, consumer services, technology and financials) LPE is rejected, indicating that smaller firms grow faster than larger ones. For the period 2000–05, the change in the results is observed. This reaffirms the earlier observation that there is some process of change taking place over the time periods. LPE is rejected for basic material and holds for industrials, consumer goods and consumer services. The industry variation of Gibrat's law may be due to a number of reasons including the level of MES (Daunfeldt and Elert, 2013). The law is likely to be rejected in industries with high MES but hold in those with mature industries. Daunfeldt and Elert (2013) identify some approaches to measuring MES such as the median revenue divided by total revenue in industry j at time period t and the average revenue of the largest firms contributing to 50 per cent of output divided by the total output in industry j at time period t. It is argued that industries with larger MES require small firms to grow faster, otherwise they are bound to fail and be forced to exit. In line with Mansfield (1962), the law of proportionate effects may hold for firms above the MES.[13]

[13] In this study we do not disaggregate the firms in each industry using MES as the threshold because of the limited sample size.

## 3.5 Specification Tests

While the presented results are compelling, there are a number of specification issues that need to be dealt with. Firstly, it may be that slow growing small firms, are not growing slowly because they are small per se, but because they are old. If the age of the firm is important, this could lead to heteroscedasticity (Dunne and Hughes, 1994). The presence of heteroscedastic errors is common in the literature (Ribeiro, 2007). One way to address econometric problem of heteroscedasticity is to add a firm age variable to the specification and check whether it is significant. Table 3.8 below shows that adding age to the regression did not affect the results. It was insignificant in all equations except the technology industry for 2005–10 and full sample in the previous period. The significance of age variable did not change the rejection of the unitary restriction in the full sample equation, but it changed to failing to reject the null hypothesis in the technology equation.

**Table 3.8 Summary of OLS Results with Age**

| | OLS | | | |
|---|---|---|---|---|
| | *Without Age* | | *With Age* | |
| | **(1)** $\beta_{\text{Log of sales 2005}}$ | **(2)** $\beta_{\text{Log of sales 2000}}$ | **(3)** $\beta_{\text{Log of sales 2005}}$ | **(4)** $\beta_{\text{Log of sales 2005}}$ |
| ALL | 0.805* | 0.906* | 0.812* | 0.883* |
| | | | | |
| SMALL | 0.468* | 0.582* | 0.446* | 0.568* |
| MEDIUM | 0.832* | 1.153* | 0.857* | 1.121* |
| LARGE | 0.958 | 1.121 | 0.989 | 1.138 |
| | | | | |
| PRIMARY SECTOR | 0.958 | 0.740* | 0.949 | 0.737* |
| SECONDARY SECTOR | 0.809* | 1.045 | 0.825* | 1.008 |
| SERVICES SECTOR | 0.759* | 0.902* | 0.767* | 0.891* |
| | | | | |
| MANUFACTURING | 0.811* | 0.923 | 0.809* | 0.878* |
| | | | | |
| BASIC MATERIAL | 0.956 | 0.726* | 0.947 | 0.723* |
| INDUSTRIALS | 0.753* | 1.101 | 0.770* | 1.054 |
| CONSUMER GOODS | 0.921* | 0.973 | 0.930 | 0.958 |
| CONSUMER SERVICES | 0.786* | 1.036 | 0.825* | 0.997 |
| TECHNOLOGY | 0.788* | 0.700* | 0.864 | 0.791 |
| FINANCIALS | 0.721* | 0.874* | 0.719* | 0.872* |

**Notes**: The table shows the beta coefficients with and without the variable age. (*) reject the null that the beta coefficient is 1.Dependant variable for column 1 and 3 is Log of sales 2010. Dependent variable for column 2 and 4 is Log of sales 2005.

Also, there is the possibility of the existence of econometric problem of persistence, or serial correlation, which could invalidate the test. The presence of serial correlation can lead to upward bias of the beta coefficient. To check this, the current period growth is explained by growth in the previous period. Firm growth in the five year period 2005-10 was regressed on growth in previous five year period. The results are presented in Table 3.9. Of the 518 companies alive in 2000, about 217 companies survived through the two periods. For the aggregate, the first period growth is statistically significant, but the R-squared is only 0.2. The coefficient is also statistically significant for the small, medium and large companies. In the economic sectors, the coefficient is significant in the secondary sector, services and manufacturing, but not in the primary sector. For the industries, the coefficient is significant for industrials and financials, but insignificant for all other industries. There is evidence of persistence, but this is for companies that survived over the whole period 2000–10. Hence, it may not have a particularly large impact on the results of the growth equations. It certainly suggests that the parameter estimates are consistent rather than unbiased, with any bias likely to increase the value of the parameter estimates. This implies that there is a stronger case for any rejection of the LPE restriction that beta is equal to one.

**Table 3.9 Testing for Growth Persistence**

| **Dependent Variable: growths20102005** | **N** | **growths20052000** | | **Constant** | | **R-squared** |
|---|---|---|---|---|---|---|
| ALL | 213 | -0.41*** | (0.05) | 0.93*** | (0.07) | 0.20 |
| SMALL | 57 | -0.52*** | (0.10) | 1.47*** | (0.21) | 0.32 |
| MEDIUM | 117 | -0.42*** | (0.06) | 0.85*** | (0.06) | 0.25 |
| LARGE | 39 | 0.24* | (0.12) | 0.31** | (0.12) | 0.09 |
| PRIMARY SECTOR | 34 | -0.18 | (0.20) | 0.78*** | (0.22) | 0.02 |
| SECONDARY SECTOR | 77 | -0.49*** | (0.08) | 0.84*** | (0.11) | 0.30 |
| SERVICES SECTOR | 102 | -0.39*** | (0.08) | 1.01*** | (0.12) | 0.18 |
| MANUFACTURING | 68 | -0.61*** | (0.09) | 0.86*** | (0.10) | 0.40 |
| BASIC MATERIAL | 32 | -0.22 | (0.22) | 0.79*** | (0.23) | 0.03 |
| INDUSTRIALS | 54 | -0.58*** | (0.10) | 0.93*** | (0.15) | 0.36 |
| CONSUMER GOODS | 22 | -0.20 | (0.12) | 0.64*** | (0.13) | 0.12 |
| CONSUMER SERVICES | 31 | 0.39 | (0.25) | 0.21 | (0.20) | 0.07 |
| TECHNOLOGY | 17 | -0.01 | (0.17) | 0.99*** | (0.26) | 0.00 |
| FINANCIALS | 47 | -0.55*** | (0.09) | 1.16*** | (0.18) | 0.41 |

**Notes:** The table shows the OLS results for testing the presence of growth persistence. growths20102005 is the log difference of sales in 2010 and 2005, growths20052000 is the log difference of sales in 2010 and 2005, N-number of observations, Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1.

The OLS estimates are also likely to suffer from the sample selection bias because they only include companies that have survived over the estimation period. If the non-surviving companies share certain characteristics, such as being slow growing, then this can obviously bias the estimation results. For example, it is possible that most of the companies that 'died' were of a particular type, small and slow growing, as opposed to big and slow growing. This would mean that the coefficient estimates would be biased.

One way of dealing with sample selection is to use the Heckman sample selection model, which starts with a survival equation that estimates the probability of survival based on opening size and the square of firm size. The exclusion restrictions refer to variables that are not present in the outcome equation but are in the probit. In this case, the variable square of firm size is the exclusion restriction. The square of age may also be used. Then, that probability in a suitably transformed form is used in the growth equation specification to deal with the bias. This model can be estimated using the standard Heckman two stage procedure or using a maximum likelihood procedure. The maximum likelihood procedure is chosen in this study because of its advantages in ensuring convergence of the system (Dunne and Hughes, 1994).

More formally, what we have is:

$$\begin{aligned} logS_{it} &= \alpha + \beta \log S_{it-1} + \varepsilon_{it} \text{ if } S_{it} > 0 \\ &= 0 \text{ otherwise} \end{aligned} \quad 3.11$$

thus

$$E(\log S_{it} \mid \log S_{it-1,} S_{it} > 0) = \alpha + \beta \log S_{it-1} + E(\varepsilon_{it} \mid S_{it} > 0) \quad 3.12$$

with

$$\varepsilon_t N(0, \sigma^2) \quad 3.13$$

This can be written as

$$E(\log S_{it} \mid \log S_{it-1}, S_{it} > 0) = \alpha + \beta \log S_{it-1} + \sigma \lambda_i \quad 3.14$$

where

$$\lambda_i = \frac{f(V_i)}{1 - F(V_i)} \text{ and } V_i = [\frac{\alpha + \beta \log S_{it-1}}{\sigma}] \quad 3.15$$

with $f(..)$ the density function for the standard normal and $F(..)$ the distribution function for the standard normal. If there is sample selection bias and we were to estimate a simple OLS regression omitting $\sigma\lambda_i$ it would give biased and inconsistent estimators.

To deal with this, a Heckman two stage procedure can be used. This entails letting:

$$d_i = 1 \text{ when } S_{it} > 0$$
$$d_i = 0 \text{ otherwise}$$

Then we can set up a likelihood function

$$\begin{aligned} L &= \Pi_{i=1}^{N}\left[\Pr(\varepsilon_i - V_i\right]^{1-d_i}\left[\Pr(\varepsilon_i - V_i\right]^{d_i} \\ &= \Pi\, F\left[\frac{V_i}{\sigma}\right]^{d_i}\left\{1 - F\left[\frac{V_i}{\sigma}\right]\right\}^{1-d_i} \end{aligned} \qquad 3.16$$

As $F(-t) = 1 - F(t)$ this is the likelihood function for the probit estimation on $d_i$ and $E(d_i) = V_i/\sigma$. So we estimate a probit:

$$\Pr(d_i = 1) = P(V_i) \qquad 3.17$$

compute $V_i$ and

$$\lambda_i = \left[\frac{f(V_i)}{1 - F(V_i)}\right] \qquad 3.18$$

For the second stage we use the consistent estimator of $\lambda_i$, $\lambda_i$ to estimate

$$E(S_{it} \mid S_{it-1}, S_{it} > 0) = \alpha + \beta S_{it-1} + \sigma\lambda_i \qquad 3.19$$

giving a consistent estimator of $\beta$.

It is also possible to use a maximum likelihood method that uses this consistent estimator as a starting value to search for a solution on the highly non-linear likelihood function;

$$L = \Pi_{d_{i=0}} F\left(-V_i, \sigma^2\right) \Pi_{d_i=1}\left(S_{it} - V_i, \sigma^2\right) \qquad 3.20$$

now as $1 - F(-V_i, \sigma^2) = 1 - F(V_i, \sigma^2)$ which we call $1 - F_i$

$$L = \sum_{d_{i=0}} \ln(1 - F_i) - \frac{N-S}{2} ln\sigma^2 - \frac{1}{2\sigma^2} \sum_{d_i=1}\left(S_{it} - V_i, \sigma^2\right) \qquad 3.21$$

which can be solved using an iterative process such as Newton Raphson.

Table 3.10 present a summary of results of the maximum likelihood estimations. The full maximum likelihood results are presented in appendix Table B1 and B2. The maximum likelihood estimation results for 2005–10 show that the coefficients are similar but lower than the OLS ones, for the total sample, except for the primary sector, basic material industry and consumer goods industry which remained the same while technology industry edged up slightly. Using the Wald test, the null hypothesis of beta coefficient being equal to unity is rejected in all equations, except for the primary sector and basic material. It was not possible to get a maximum likelihood estimate for the consumer services industry. Lower coefficients with a similar pattern of rejections of the null was also evident for the earlier 2000–05 period, particularly for the aggregate, services sector, industrials and financials equations. The coefficient for consumer services industry remained the same as the OLS.  No ML results could be obtained for the consumer services and technology industries. The Heckman maximum likelihood may not converge if the model is not properly specified or the data does not support the model assumptions. To address this problem, the two stage approach is used which, it is argued, is more stable even when the exclusion restrictions are not good (Greene, 2008). In this case, the two-stage estimation approach did not provide sensible estimates. The problem may arise due to disaggregation which reduces the number of companies and the correlation coefficient cannot be located within (-1, 1) bounds.  The two stage results are shown in the appendix Table B3 and B4.

The maximum likelihood results for consumer services and technology seemed to improve when age of the firm was added as an independent explanatory variable in the specification to deal with the potential omitted variable bias. This suggests that the non-convergence emanated from the less perfect exclusion restrictions. Basically, age is added in the main equation and the quadratic age is added in the selection model. For both periods, the age variable was insignificant and had little effect on the results of other categories. The findings indicate that smaller firms are growing faster than large ones.

**Table 3.10  Summary of Maximum Likelihood and Two Stages Estimates**

| | **MAXIMUM LIKELIHOOD** | | | |
|---|---|---|---|---|
| | ***Without Age*** | | ***With Age*** | |
| | **1** | **2** | **3** | **4** |
| | $\beta_{\text{log of sales 2005}}$ | $\beta_{\text{log of sales 2000}}$ | $\beta_{\text{log of sales 2005}}$ | $\beta_{\text{log of sales 2000}}$ |
| ALL | 0.72* | 0.78* | 0.73* | 0.75* |
| SMALL | 0.45* | 0.56* | 0.44* | 0.65* |
| MEDIUM | 0.76* | 1.15* | 0.80* | 1.12 |
| LARGE | 0.95 | 1.15 | 0.98 | 1.15 |
| PRIMARY | 0.95 | 0.61 | 0.94 | 0.63* |
| SECONDARY | 0.76* | 0.92 | 0.77* | 0.86 |
| SERVICES | 0.69* | 0.78* | 0.70* | 0.78* |
| MANUFACTURING | 0.75* | 0.85* | 0.74* | 0.79* |
| BASIC MATERIAL | 0.95 | 0.59* | 0.94 | 0.60* |
| INDUSTRIALS | 0.70* | 0.96 | 0.72* | 0.87 |
| CONSUMER GOODS | 0.92* | 0.97 | 0.94 | 0.95 |
| CONSUMER SERVICES | NC | NC | 0.73* | 1.03 |
| TECHNOLOGY | 0.79* | NC | 0.85 | 1.04 |
| FINANCIALS | 0.68* | 0.77* | 0.66* | 0.79* |

**Notes**: The table shows the Summary of Coefficients from Maximum Likelihood estimations. Dependant variable for column 1 and 3 is Log of sales 2010. Dependent variable for column 2 and 4 is Log of sales 2005. (*) reject the null that the beta coefficient is 1. NC indicates no convergence

The validity of Gibrat's law may also be sensitive to the length of the growth period being considered (Evans, 1986; Bigsten and Gebreeyesus, 2007; Zhang et al., 2009). If the time period is very short, the results may reflect transitory components of firm growth such as changes in the demand cycle. Variyam and Krayhill (1992) argue that the transitory components are distributed independently across firms over time. In the short term, firms have limited capacity to alter their sizes (Johnson et al., 1999). The transitory components are believed to bias the OLS estimates downwards (Hart and Oulton, 1996). As a result, the null hypothesis that beta is equal to unity may be rejected. The permanent components, on the other hand, reflect managerial efficiency.

So far the study has considered the two five year periods. In order to investigate the size-growth relationship over time, we consider alternative time spans 2003-07, 2006–10, 2006–10 and 2001–05. Table 3.11 presents the summary of the OLS results for the additional periods. For the aggregate, the results indicate that the LPE is rejected for all the alternative periods. In terms of the size of the beta coefficient, there is no clear pattern except that the shortest time span 2008–10, which seems to have the highest beta of 0.95. But the opposite cannot be said about the longest time span 2000–10. The results for the size disaggregated regression also confirm that LPE holds for large firms and it is the smallest within the small category that are growing faster except in the long period. It is surprising that for all the size categories in 2000–10 we fail to reject the null hypothesis. The sectoral and industrial disaggregation points out some heterogeinety between the periods except for services sector, technology and financial industries which reject LPE throughout all periods. It is also surprising that for the secondary industry the null hypothesis is rejected at the beta equal to 0.959. In general, our results are confirmed in aggregate and size groups, but not in sectoral and industrial disaggregation suggesting sensitivity to the length of time being considered. The sensitivity is more pronounced when the period is both longer and very short. The longest period in the table is eleven years while the shortest is three years.

**Table 3.11 Summary of OLS Results for Different Time Periods**

| | 2003-07 | 2006-10 | 2008-10 | 2000-10 |
|---|---|---|---|---|
| **Sample** | **(1)** $\beta_{\text{log of sales2003}}$ | **(2)** $\beta_{\text{log of sales2006}}$ | **(3)** $\beta_{\text{log of sales2008}}$ | **(4)** $\beta_{\text{log of sales2000}}$ |
| ALL | 0.873* | 0.852* | 0.953* | 0.839* |
| | | | | |
| SMALL | 0.618* | 0.532* | 0.82* | 0.786 |
| MEDIUM | 0.905 | 0.853* | 1.013 | 0.985 |
| LARGE | 1.086 | 0.920 | 0.959 | 0.982 |
| | | | | |
| PRIMARY | 1.019 | 0.930 | 0.98 | 0.799* |
| SECONDARY | 0.792* | 0.781* | 0.98 | 0.959* |
| TERTIARY | 0.857* | 0.865* | 0.921* | 0.800* |
| | | | | |
| MANUFACTURING | 0.897* | 0.768* | 0.937* | 0.926 |
| | | | | |
| BASIC MATERIALS | 1.021 | 0.930 | 0.984 | 0.799* |
| INDUSTRIALS | 0.77* | 0.710* | 0.985 | 0.970 |
| CONSUMER GOODS | 0.817* | 0.920 | 0.934 | 0.933 |
| CONSUMER SERVICES | 0.835* | 0.905 | 0.955 | 0.881 |
| TECHNOLOGY | 0.811* | 0.826* | 0.846* | 0.457* |
| FINANCIALS | 0.855* | 0.836* | 0.893* | 0.835* |

**Notes**: Dependent variable for column 1 is log of sales in 2007;Dependent variable column 2 is log of sales in 2010; Dependent variable column 3 is log of sales in 2010; Dependent variable column 4 is log of sales in 2010; (*) reject the null that the beta coefficient is 1.

Equally interesting is to check whether the results obtained from sales as the measure of size would change if another size measure such as net assets is used. Hart and Oulton (1996) found consistent results in the case of UK for the period 1989–93. Table 3.12 presents the OLS coefficients for testing the validity of LPE during the period 2005–2010 using sales and assets. The OLS estimation results based on assets indicate that for the whole sample the coefficient is 0.72 and rejects the null hypothesis that beta is equivalent to unity. When the sample is disaggregated by size classes, the Law of Proportionate Effects seems to hold for large firms but not for the small and medium firm categories. This result is similar to sales measure. It is also interesting to observe that the magnitudes of the beta coefficients are lower but close to those of the sales measure. For all the sectors and industries, the unitary restriction is rejected. The rejection in the case of primary sector and basic material industry is inconsistent with the sales measure. The results suggest that the measure of firm size being used does not really matter since the results are consistent.

**Table 3.12 OLS Coefficients for Sales and Assets size measures for the Period 2005-10**

| Sample | Sales<br>(1)<br>$\beta_{\text{log of sales}}$ | Assets<br>(2)<br>$\beta_{\text{log of assets}}$ |
|---|---|---|
| ALL | 0.805* | 0.726* |
| SMALL | 0.468* | 0.386* |
| MEDIUM | 0.832* | 0.745* |
| LARGE | 0.958 | 0.951 |
| PRIMARY | 0.958 | 0.673* |
| SECONDARY | 0.809* | 0.737* |
| SERVICES | 0.759* | 0.752* |
| MANUFACTURING | 0.811* | 0.695* |
| BASIC MATERIAL | 0.956 | 0.658* |
| INDUSTRIALS | 0.753* | 0.692* |
| CONSUMER GOODS | 0.921* | 0.879* |
| CONSUMER SERVICES | 0.786* | 0.809* |
| TECHNOLOGY | 0.788* | 0.577* |
| FINANCIALS | 0.721* | 0.727* |

**Notes**: Dependent variable for column 1 is log of sales in 2010,Dependent variable column 2 is log of assets in 2010(*) reject the null that the beta coefficient is 1

## 3.6 Conclusions

The chapter set out to analysed the changing firm size distribution in South Africa and empirically investigate the validity of LPE during the period 2000–10. Using sales as the measure of size, takeover was found to be the main cause of death for 2005–10 and varied across the size classes, with the highest proportions in the R1-2 billion and R4-5 billion groups. Just under half of all non-survivors in the smallest size category were taken over. The figures for 2000–05 were somewhat different in scale, but had a similar pattern. This suggests that a major cause of non-survival among small firms is takeover. This is partly in line with the small firms' literature which suggests that some entrepreneurs operate as innovators with the deliberate intention of selling off the firm and cashing in so that they can move to the next innovation. As to whether the firms are taken over to improve efficiency or to reduce potential competition, there is need of further research. The study found that firm growth among listed companies in South Africa has not been completely random, suggesting the rejection of Gibrat's law. Smaller firms have been growing relatively faster than larger firms and, in the small category, it was the very smallest that were growing the fastest.

Testing the law on aggregate data poses the challenge of whether the results are a reasonable representation of the overall picture, or can be explained by the behavior of particular sectors, industry or size groups (Mansfied, 1962). As such, the data was disaggregated by size, sector and industry. Overall, the results are consistent on the rejection of LPE except for large firms. Comparing the two periods, some variation was observed across sectors with LPE not rejected for the primary sector. In addition, a number of specification issues were dealt with to address serial correlation, heteroscedasticity and sample selection. On sample selection in particular, the maximum likelihood estimates were found to be consistent with the OLS estimates. While non-convergence was found in consumer services and technology industries due to the less perfect exclusion restrictions, this was addressed by the addition of age and quadratic age in the specification. The results were found to be robust to different time periods and alternative measure of firm size.

Evidence from the study suggests that the South African industrial structure is relatively healthy with the overall tendency moving away from concentration. The smaller firms seem to be the fastest growing compared with the large ones. The Competition Commission of South Africa is already legally charged with ensuring that the industrial structure is competitive. This amongst other things includes the approval of any mergers and acquisition in South Africa.

The finding that the death rate in highest among small firms can be interpreted to mean that future large firms never realise that dream. This is because current small firms are the future large firms. The policy support gearing towards improving the survival chances for small firms would address this finding. However, it is important that such support do not occur at the expense of large firms which have their role to play in the industrial structure. This is also in support of Page and Soderbom (2012) which argues for support for firms all sizes.

However, the study was based on the sample of JSE listed companies only, which are likely to be large. So expanding the sample to cover non-listed firms and aligning the definition of small firms to the South African legislation could be interesting.

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# Chapter Four : Firm Survival in South Africa[14]

## 4.1 Introduction

In developing economies the existence of a healthy corporate structure is vital to the pursuit of long term policy objectives of sustainable economic growth and employment. Industrial structure comprises of firms of differing sizes and face varying hazards. Small firms have low survival rate compared to large firms and, as a result, cannot be relied upon for long term economic growth (Page and Soderbom, 2012). On the one hand, at any point in time many small firms enter the market (Mata and Portugal, 1994). On the other hand, large firms tend to be more mature and stable. Governments have put emphasis on the role of small firms as the engine for job creation. Despite controversies, there has been scanty evidence in the industrial organisation literature from developing countries on firm survival. This is particularly true in Africa, where few studies exist that provide an understanding of firm failure and survival in order to inform policies necessary for industrial development. This is because of the general unavailability of firm panels in Africa. Most of the studies on firm survival in Africa use the survey data. The studies that investigate firm survival in African countries include Frazer (2005), Soderbom et al (2006) and Nkurinziza (2012).

For implementation of appropriate interventions necessary for industrial development it is important for policymakers in developing countries to fully understand the duration and the factors that influence firm failure. This is because efforts geared towards assisting with the establishment of small to medium enterprises should be accompanied with measures aimed at supporting firm survival. This could result in meaningful impact in achieving the medium term objectives of job creation and economic growth (Page and Soderbom, 2012; Geroski, 1995; Wagner, 1994). Therefore, a comprehensive understanding of the survival process is paramount in order to inform policy on the options available for intervention.

This chapter empirically investigates the duration of firms and the determinants of survival among the JSE listed companies during the period 2000–2010. Following the work of

[14] Version of this paper was presented at Economic Society of South Africa biannual conference held in Cape Town September 2015

Nkurinzuza (2012), Perez and Castillejo (2006) and Perez et al(2004), it specifies a simple logit binary survival model that allow for firm size, age, financial characteristics and other industry specific factors. Then, it improves the analysis by employing the non-parametric Kaplan-Meier product limit method and estimating Cox proportional hazard model. These models have an advantage over binary regression because they adequately account for the evolution of exit risk by thoroughly controlling for the occurrence and timing of the exit event. Moreover, they take care of right censoring which is a problem in this type of studies. In the process, the chapter contributes to the empirical evidence on firm survival in developing countries specifically South Africa. We are not aware of any similar study undertaken in South Africa except Worku (2013) who focused on small and medium enterprises located in Pretoria in the Gauteng Province.

The rest of the chapter is organized as follows; Section 4.2 presents the theoretical and empirical literature on the determinants of firm survival. Section 4.3 discusses the data to be used. Section 4.4 presents the empirical analysis. Section 4.5 discusses the robustness tests. Section 4.6 concludes the study.

## 4.2 Theory and Empirical Literature Review

The neoclassical theory of the firm provides early insights to the analysis of the survival of firms. In a perfectly competitive market, firms which are not able to compete find it difficult to stay in the market and are driven out of the market. In this kind of environment, the market is dominated by productive and competitive firms. There are a number of facets to this. One is that firms which are below the minimum efficient size are not able to break even. Hence they cannot survive. The other is that the industry itself may be highly competitive to the extent that a slight decline in efficiency leads to loss of market share by the firm. As a result, other theories have emphasised the competitiveness of the industry in which the firm is operating as an important factor in understanding firm survival. Small firms operating in highly concentrated markets are likely to find it very difficult to sustain the competitive pressures. From this perspective, the degree of competition in an industry is linked to firm survival (Lopes-Garcia and Puente, 2006).

The market structure in which a firm is operating also plays an important part in its survival. This is well articulated in the neoclassical theory of the firm when perfect competition is assumed.

The model becomes slightly complex when the perfect competition assumption is relaxed in favor of imperfect markets. In a situation where there are few players sharing the market, firms can survive despite being inefficient. This may be due to several factors including regulations, sunk costs and barriers to entry in general. This study is not covering the entry of firms because it is not possible to integrate entry into the data. The difficulty arises because with the stock market data, firms entering are not new as they are just becoming listed. Among the requirements to list in the stock exchange is that the company should possess several years of operation. Despite this limitation, entry is an avenue in which new firms coming into the market often bring new products, ideas and innovation, all of which are critical for subsequent survival of the firm (Baldwin and Gorecki, 1990; Geroski, 1995).

The models of industrial evolution discussed in chapter three have also provided the theoretical underpinning of the analysis of the determinants of firm survival. The Law of Proportionate Effects (LPE) which relates firm size to growth provides some insight on what drives firm survival specifically arguing about the importance of size. Firms that start small tend to survive less than those that commence large. However, small firms have some advantages over the large ones. The advantages include flexibility and specialization. These may assist the firm to manage the potential loses in case of unforeseen factors in the business. Thus, firms that are better informed about the industry start big, while those that are uncertain prefer to enter small (Lopes-Garcia and Puente, 2006). The model of passive learning by Jovanovic (1982) and its extension into active learning model by Pakes and Ericson (1998) have been dominating the theoretical framework for analysis of firm survival. The models predict that young firms are more at risk of failure than the older experienced firms. Also firms with highly qualified management are better placed to lead successful growth process. These theories suggest firm size and age are key determinants for firm survival.

The theories on liquidity constraints also link firm survival to firm financial position. It is argued that firms with weaker financial positions are likely to exit the markets (Stiglitz and Weiss, 1981; Clementi and Hopenhayn, 2006). Financial constraints influence firm behaviour in a number of ways, such as investment in fixed capital, inventories and research and development (Bridges and Guariglia, 2008). The financial health of the firm is reflected by the strength of its balance sheet. It is expected that firms with stronger balance sheets will be better placed to navigate the negative shocks. In addition, constrained firms are likely to find it difficult to survive compared to unconstrained firms. These constraints may hinder the growth of the firm from reaching the minimum efficient size. This increases the probability of failure. On the other hand, corporate finance theories, such as the agency theory argue that firms with debt financing have higher chances of survival. A firm with high leverage tends to survive due to increased monitoring and oversight by the lenders which limit the managers from engaging in non-productive activities. Consequently, lenders may use the Z-scores to assess companies which are at higher risk of bankruptcy. Previous studies relied on Z-scores for predicting bankruptcy in publicly listed companies. Z-scores are defined as a function of the following four variables of the firm, profitability, sales, retained earnings and working capital (Altman, 1968). If indeed lenders base their decision on the Z-scores, it may suggest that companies with better Z-scores may be more leveraged. While this study does not apply the Z-scores but the liquidity constraints and corporate finance theories are relevant to this study because financial health indicators are considered as some of the determinants of firm survival.

The theories presented up now do not cover other drivers of firm survival which are relevant to this study. The resource based theory of the firm has also suggested other determinants of firm survival. The theory states that the ability of the firm to develop distinct capabilities is critical for their survival (Perez and Castillejo, 2008). They argue that a firm's capabilities depend on research and development and advertising. These characteristics are not likely to be imitated by other firms and tend to continuously improve efficiency of the firm. Related to research and development is innovation which provides firms with the ability to cope with the changing technological environment. Highly innovative firms increase their survival changes. Successful innovation enables firms to become more productive, generating an increase in output while lowering the requirements of inputs (Coad, 2009). In addition, the literature also suggests other factors such as foreign ownership, geographic location, legal status of the firm and macroeconomic variables such as economic growth.

A number of studies have been done to investigate the key drivers of firm survival and have mainly been on developed countries. They include Lopez-Garcia and Puente (2006) for Spain, Wagner and Gelubcke (2011) for Germany, Audretsch et al. (2000) for the Netherlands and Bridges and Guariglia (2008) for the United Kingdom. The literature has also been extensively surveyed in Manjon-Antolin and Arauzo-Carod (2008), Iwasaki (2014,) Siegfried et al (1994) and Somnez (2013). The literature has also covered stock market survival of firms which related survival to financial ratios only. (Altman, 1968; Chacharat et al., 2007; Xu and Zhang, 2009; Ong et al., 2011; Gupta, 2017).The mostly used financial ratios include current asset turnover, asset turnover, and total asset to liabilities.  Overall, these studies show that most of the empirical work on the survival of firms often takes a rather eclectic approach to specifying the survival equation. They draw on variables that reflect a range of theoretical perspectives. The evidence from developed countries identifies firm size, firm age, financial factors and industry characteristics as some of the main drivers of survival. The findings indicate that firm size, firm age and availability of finance positively influence survival.

Some studies have investigated firm survival in developing countries. Table 4.1 below presents the summary of studies on firm survival on developing countries. For comparison, the countries are classified into four regions Sub-Saharan Africa, Latin America and Asia. Also reported is the country, sample period, data used, focus industry, methodology followed and the main explanatory variables used. Firm survival is positively related to size (Spaliara and Tsoukas, 2013; Varum and Rocha, 2012). Firm size increases the probability of survival for a firm through a number of channels. The first is through the notion of 'big is better' in which a large company is better placed to withstand the negative shocks than the smaller firm. A large firm has access to sizable financial and human resources compared to their smaller counterparts. They are able to reap the benefits of economies of scale. The second avenue is logical; a large firm takes more steps to fail than a small firm. A firm's survival chances will increase with its size. Evidence from other African countries has already pointed to the positive relationship. Harding et al. (2004) and Frazer (2005) find that larger firms are less vulnerable to failure compared to smaller firms. Thus being small exposes a firm to the risk of failure.

The dominance of firm size in the survival model has been rejected in some studies. McPherson (1995) investigated firm survival in the four Sub-Saharan countries – Swaziland, Botswana, Malawi and Zimbabwe – based on surveys collected in the early 1990s. Recently, Nkurunziza

(2012), in the case of Kenya, also found firm size to be insignificant. This has been explained by the relative flexibility of small firms which position them better to seize emerging opportunities and respond swiftly to challenges. In addition, decision making is relatively easy in small firms compared to large ones since the red tape is much shorter. These studies suggest that size of the firm play an important role in firm survival.

There is a positive relationship between age and the probability of firm survival. Older firms are less likely to fail compared to their younger counterparts (Geroski, 1995). This is referred to as the 'liability of newness' in the industrial organisation literature. According to industrial evolution theories, older firms are believed to have acquired the necessary experience of the market and its challenges. But the empirical evidence on the link between firm age and survival has at best been mixed. There has been evidence of the liability of adolescence (Perez et al., 2004). The liability of adolescence suggests that older firms, in most cases, are overtaken by new entrants in the market who are more innovative and flexible. Therefore, being an older firm in itself may not be a guarantee for survival. This contradictory evidence has also been found in SSA countries. Nkurunziza (2012) and Frazer (2005) reported significant but weak age effects, while Soderbom et al. (2006) found no significant age effect. As a result, in modeling firm survival, age has to be taken into account.

A crucial consideration for assessing the effects of the financial sector on firm survival is selecting the most appropriate measure of the firm's financial position. The commonly used measure of a firm's financial health is leverage, defined as the ratio of total debt to total assets. Leverage captures a firm's ability to access external finance. Higher leveraged firms are expected to stand a better chance of survival as they are closely monitored by the financiers who expect their returns. As a result, the managers are not free to divert the funds towards activities that are not productivity enhancing. However, the evidence has been mixed on the effect of leverage on firm survival. Audretsch et al. (2000) found no evidence that high leverage reduces the probability of failure in the Netherlands. Other financial variables have been used in firm survival studies are profitability and tangibility (Spaliara and Tsoukas, 2013). It is argued that profitability measures a firm's ability to generate internal funds, while tangibility is the ability to pledge collateral for external finance. Other studies have used the credit amount directly.

Nkurunziza (2012) found strong support for the effect of credit on firm survival in Kenya. The results were robust to different specifications such as the probit model, Cox proportional hazard models and other parametric hazard models. This is relevant to our study by suggesting the different measures of financial indicators and the use of hazard models in modeling firm survival.

Survival rates may differ across the industries or sectors with others being more risky than others. Industries differ in a number of aspects such as competitiveness, capital requirement, innovation activity and barriers to entry. Audretsch (1995) investigated the reasons behind the differing survival rates across the industries or sectors and found that innovation requirement played an important role. McPherson (1995) found that survival rates differ across industries in Sub-Saharan African countries. Lopez-Garcia and Puente (2006) included concentration measure in the specification to capture competition and found that firms in highly concentrated industries have lower survival rate. This means that the inclusion of the industry dummies will also capture industry heterogeneity.

Finally, the origin and ownership of a firm are likely to influence survival. Firms that originate from abroad are likely to have high survival rate compared to local firms due to domestic investment laws which at times are favorable to foreign investors. Foreign firms also have better access to improved technology and financial resources (Shirefaw, 2009). In most cases, they borrow from their home country's banking systems at very low interest rates compared to the ones prevailing in the local markets. Wagner and Gelubcke (2011) investigated the relationship between foreign ownership and firm survival in Germany and found that foreign firms faced a higher risk of exit in West Germany but not in East Germany. This is relevant to this study since they emphasize the importance of origin and ownership in survival.

## Table 4.1 Summary of Previous Studies on Firm Survival in Developing Countries

| Study | Country<br>Data Period | Focus Industry | Method | Main Explanatory Variables |
|---|---|---|---|---|
| **Sub-Saharan Africa** | | | | |
| McPherson(1995) | Botswana, Swaziland, Zimbabwe and Malawi<br>Surveys | All industries | Discrete time duration model | Annual growth rate, size, age, location, gender, credit, industrial dummies. |
| Harding et al(2004) | Ghana, Kenya and Tanzania<br>Survey1993/94-1998/99 | Manufacturing | Probit model | Productivity, firm size, age, ownership |
| Frazer(2005) | Ghana<br>Survey 1991-1997 | Manufacturing | Probit model | Productivity, firm size, age, size of capital stock, dummy for exporting, share of unionisation, foreign ownership, state ownership |
| Soderbom et al (2006) | Ghana, Kenya and Tanzania<br>Survey 1993/94-1998/99 | Manufacturing | Probit model | Productivity, firm size, age, factor intensity, ownership |
| Shiferaw(2009) | Ethiopia<br>Annual census 1996-2002 | All Industries | Discrete time duration model | Productivity, firm size, age, factor intensity, ownership, location, herfindahl index |
| Klapper and Richmond (2011) | Cote d Ivoire<br>1976-1997 | All Industries | Discrete time duration model | GDP growth, location, sector, ownership, firm size, reforms dummies |
| Nkurunziza (2012) | Kenya<br>Survey 1992-1999 | All industries | Probit and Discrete time duration model | Size, age, origin, industry dummies, overdraft use, loan use |
| Buyinza F (2011) | Uganda<br>Survey 2006 | Manufacturing | Discrete time duration model | Age, size, ownership, export status, value added per worker |
| **Latin America** | | | | |
| Malerba and Molina(nd) | Brazil<br>Innovation survey<br>2001-08 | Industrial companies | Discrete time duration model | Research and development, technology, age, investments, innovation, sector, domestic |
| Benavente and Ferrada(2003) | Chile<br>National Industrial Annual Survey<br>1979-1999 | Manufacturing | Discrete time duration model | Initial Size, size, growth, productivity, exports, profits, investment |
| **Asia** | | | | |
| Tsoukas, S. (2011) | Indonesia, Korea, Malaysia, Singapore and Thailand<br>Stock market<br>1995-2007 | All industries | Discrete time duration model | Leverage, profitability, size, age , minimum efficient size, bond issuance, exchange rate, private sector credit, market value traded, market capitalisation |
| Spaliara M, Tsoukas S (2010) | Indonesia, Korea, Malaysia, Singapore and Thailand<br>Stock market data 1997- 98 | All industries | Probit model | Leverage, profitability, size, age , minimum efficient size, bond issuance, exchange rate, |

## 4.3 Data and Survival Patterns

To investigate the determinants of firm survival, the first step is to look at the causes of failure and the patterns in the data. The study uses data on South African companies listed in the JSE during the period 2000–2010. As indicated in Chapter 2, the data comprise of yearly company income statements, balance sheets and profit and loss accounts. This allows us to assemble the panel of firm and track them over time, recording their exit points and reason for leaving the database.

In the following paragraphs, the explanatory variables in the estimations will be described. Data is available to construct the measures that theory and previous empirical literature suggest are important, namely firm size, age, leverage, profitability, ownership and sector.

- Firm size ($SIZE_i$) is measured by net sales. Three size classes are defined to distinguish small, medium and large companies. In line with the previous chapter, the official South African definition of small company is not followed, since the sample is drawn from the stock exchange listed companies and is biased towards relatively large enterprises. Therefore, a small company is defined as one with net sales of less than R0.1 billion. Medium size companies are the ones with net sales of R0.1 - 5billion, while large firms are above R5 billion.
- Firm age ($AGE_i$) is measured by the difference between the current year and the year of establishment. Firms are classified into three age classes: young, middle aged and mature firms. A young firm is one with age of less than 5 years, while a middle aged firm is one with ages between 5 and 10 years. The last category, mature firm is one with age greater than 10 years.
- Firm leverage ($LEVERAGE_i$) is measured as the ratio of total debt to total assets. It captures the firm's access to external finance such as debt and equity. Two leverage groups are identified. Low leveraged firms are defined as those with leverage below the median and high leverage are those with leverage above the median.
- Profitability ($PROFITABILITY_i$) is measured as the ratio of profits before interest and taxes to total assets. Profitability is also disaggregated into two groups. Low profitability firms are defined as those with profitability below the median, while high profitability firms are those above.
- Origin dummy ($ORIGIN_i$) captures the origin of the firm. The variable is a binary variable equal to one if the firm is of South African origin and zero otherwise. The

dataset does not have the foreign ownership variable, so the origin dummy is expected to mimic foreign ownership.

- Sector dummies (*$SECTOR_i$*) for primary, secondary and tertiary sectors are constructed. The control is not at industry level due to small number of companies in some industries. The data comprise of the following nine International Classification Benchmark (ICB) industries: basic material, consumer goods, consumer services, health care, industrials, oil and gas, technology, telecommunications financials and utilities.

Companies exit from the dataset due to different reasons. The reasons for exit include takeover, liquidation and others. Takeover includes mergers and acquisitions while liquidation is the ultimate corporate failure. These causes are discussed in Chapter 3. Understanding the patterns of the causes of exit is important since they have different implications. Table 4.2 below presents the patterns of non-survival by size groups decomposed into takeover, liquidations and other during the period 2000-10. Out of 518 firms that were alive in 2000, 285 firms had exited at the end of 2010. This translates to death rate of 55 per cent during the period. Death by takeover accounted for 32 per cent, liquidations for 10.8 per cent and other for 9.7 per cent. It seems that the activity of mergers and acquisitions in the sample are higher than liquidations. Overall, firm exit seems to be more prevalent among the lower size groups compared to the higher ones.

**Table 4.2 Analysis of Firm Non-Survival 2000-10**

| Companies Alive in 2000 by Sales | | Non-Survivors | | Takeover | | Liquidated | | Other | | Missing(1) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Rbn** | **Number** | **Number** | **%** | **Number** | **%** | **Number** | **%** | **Number** | **%** | |
| <0.1b | 182 | 106 | 58.2 | 45 | 24.7 | 23 | 12.6 | 35 | 19.2 | 3 |
| 0.1-0.5b | 146 | 96 | 65.8 | 62 | 42.5 | 20 | 13.7 | 9 | 6.2 | 5 |
| 0.5-1b | 44 | 27 | 61.4 | 17 | 38.6 | 7 | 15.9 | 2 | 4.5 | 1 |
| 1-2b | 47 | 21 | 44.7 | 17 | 36.2 | 2 | 4.3 | 2 | 4.3 | 0 |
| 2-3b | 22 | 10 | 45.5 | 9 | 40.9 | 1 | 4.5 | 0 | 0.0 | 0 |
| 3-4b | 13 | 5 | 38.5 | 3 | 23.1 | 1 | 7.7 | 1 | 7.7 | 0 |
| 4-5b | 10 | 5 | 50.0 | 3 | 30.0 | 1 | 10.0 | 0 | 0.0 | 1 |
| 5-10b | 26 | 10 | 38.5 | 8 | 30.8 | 1 | 3.8 | 1 | 3.8 | 0 |
| >10b | 28 | 5 | 17.9 | 5 | 17.9 | 0 | 0.0 | 0 | 0.0 | 0 |
| Total | 518 | 285 | 55.0 | 169 | 32.6 | 56 | 10.8 | 50 | 9.7 | 10 |

**Notes:** (1) Includes missing and zero values in the second period

Next, we compare our results with other studies. It should be noted that the comparison may be compromised by the differences in time periods, duration and coverage of the firms included. As reflected in Table 4.3, the death rate among JSE listed companies is comparable with some African countries. The overall rate of 55 per cent is close to the ones reported for in Tanzania (40 per cent) and Kenya (40 per cent), although the period is slightly longer. Given that in South Africa the death rate seems to be driven by the smaller companies, it is possible that the surveys undertaken in Kenya and Tanzania may have had a higher number of small firms, which our dataset is probably under covering due to the nature of our data source. This is because companies that list in the stock market are organised and relatively larger than the typical small firms. Nevertheless, the similarity of the death rate of large size groups with the UK is indicative that, excluding the small firms, the death rate in South Africa is slightly higher than developed countries. The situation becomes diluted when we consider the cases of Ethiopia, Columbia and Morocco, which have reported low death rates. This suggests that the length of time considered plays a role in analysing survival.

**Table 4.3 Comparison of Firm Death Rates**

| **Study** | **Country** | **Target Industry** | **Period** | **Length (Years)** | **Death Rate** |
|---|---|---|---|---|---|
| Dunne and Hughes(1994) | UK | All Industries | 1980-85 | 5 | 20.5% |
| Dunne et al(1988) | US | Manufacturing | 1977-82 | 5 | 50.0% |
| Roberts and Tybout (1996) | Chile | Manufacturing | 1984-85 | 1 | 7.1 % |
| Soderbom et al (2006) | Tanzania | Manufacturing | 1992-99 | 7 | 44% |
| Soderbom et al (2006) | Ghana | Manufacturing | 1992-99 | 7 | 20% |
| Soderbom et al (2006) | Kenya | Manufacturing | 1992-99 | 7 | 40% |
| Shiferaw (2009) | Ethiopia | All industries | 1996-02 | 6 | 16% |
| Roberts and Tybout (1996) | Colombia | Manufacturing | 1984-85 | 1 | 14.9% |
| Roberts and Tybout (1996) | Morocco | Manufacturing | 1984-89 | 5 | 6% |

## 4.4 Empirical Analysis

Following Nkurinzuza (2012), Harding et al., (2004) and Frazer (2005), we use the binary outcome model to analyse the determinants of firm survival. We use the following logit/probit model:

$$\Pr(FAILURE_i = 1) = F\left(x'\beta\right) \qquad 4.1$$

Where $FAILURE_i$ is a binary variable equal to 1 if a firm exited the database and equal to 0 otherwise. Company failure or exit may be due to takeovers, liquidation and others (Dunne and Hughes, 1992; Bhattacharjjee et al, 2009; Coad, 2014).[15] The vector (*x)* contains the firm and industry characteristics such as firm size ($SIZE_i$), firm age ($AGE_i$), leverage ($LEVERARAGE_i$) Profitability *(*$PROFITABILITY_i$*)*, origin dummy ($ORIGIN_i$) and industry ($INDUSTRY_i$). The model followed is comprehensive as it takes into account factors that the theoretical perspectives and other empirical work suggest are important in the survival equation.

[15] Manjon-Antolin and Arauzo-Carod (2008) points out that there is no general agreement on the definition of business failure. The common practice is that the firm has exited if it does not appear in the database.

The logistic / probit model assumes that the dependent binary variable ($y$) takes the value 1 if the firm did not survive throughout the entire period and 0 otherwise. The variable is observable, but the underlying continuous unobservable variable ($y^*$) satisfies the following single index model

$$y^* = x^{'}\beta + u \qquad 4.2$$

Although $y^*$ is not observable, we observe

$$y = \begin{cases} 1\ if\ \ y^* < 0 \\ 0\ if\ \ y^* \geq 0 \end{cases} \qquad 4.3$$

Where the zero threshold is a normalisation that is of no consequence if $x$ includes an intercept

Given the latent variable models we have,

$$\Pr(y = 1) = \Pr(x^{'}\beta + u > 0) \qquad 4.4$$

$$\Pr(y = 1) = \Pr(-u < x^{'}\beta) \qquad 4.5$$

$$\Pr(y = 1) = F(x^{'}\beta) \qquad 4.6$$

Where $F(.)$ is the cumulative distribution function(CDF) of $-u$. This yields a probit model if $F(.)$ is standard normally distributed and a logistic model if it is the logistic distribution. The coefficients from the probit model are not interpretable but we can only infer the direction from the signs. In order to infer the magnitude, we have to derive the marginal effects. The marginal effects of the probit model are determined by the following equation;

$$\frac{\partial \Pr(y = 1 \mid x_i)}{\partial x_{ij}} = F'(x_i'\beta)\beta_j \qquad 4.7$$

The marginal effects differ with the point of evaluation $x_i$ and the choice of cumulative distribution function.

Estimating the survival model using the logistic regression gave the results in Table 4.2. The dependent variable for the logistic model is a binary variable equal to unity if a firm died during the period and zero if it is found alive at the end of the period in 2010. The table reports coefficients and standard errors in brackets. In general, the signs and significance in all the explanatory variables are as expected. Since our equation captures non-survival, the signs should be reversed for survival. Beginning with the firm size, the probability of survival for larger and medium firms is higher than the probability of survival for small firms which is the base category. The coefficient for large firms is statistically significant at 1 per cent level, while that of medium firms is found to be insignificant. This result suggests that larger firms are better placed to effectively handle negative shocks compared to small firms. This provides support for the empirical literature from other countries which suggests that firm size is an important determinant of survival **(**Soderbom et al., 2006)**.** The probability of survival is lower for firms in the secondary and tertiary sectors compared with those in the primary sector which is the base category. The result seems intuitive particularly in the case of South Africa where the primary sector is mainly dominated by mining companies which tend to survive for a long time. The lifespan of a mine can exceed 30 years.

The coefficients of middle aged and old firms are both positive and statistically significant at 1 per cent and 5 per cent respectively. This suggests that the probability of survival for the middle aged and old firms is lower than that of young firms which is the base category. The result is contrary to the theoretical predictions that age increases survival probability. It appears that young firms have higher survival chances. This indicates that age does not increase a firm's resilience.

The results also show that the financial indicators are important for survival. The coefficient of high profitability is negative and statistically significant at 5 per cent level. This indicates that the probability of survival is higher for high profitability firms compared to the low profitability ones which is the base category. A similar result is observed in leverage. The coefficient of high leverage is negative and statistically significant. This suggests that the probability of survival for high leverage firms is higher than those with lower leverage. Firms that are profitable have access to financial resources that assist them to better manage the negative shocks. Regarding leverage, the hazard ratio for high leverage firms is less than unity. This indicates that high leverage firms face lower hazard compared to the leverage firms. The results emphasises that firm's access to external resources is important for survival (Nkurunziza, 2012; Lopez-Garcia and Puente, 2006).

Finally, the coefficient for the dummy for domestic origin is positive and insignificant, suggesting that firms of domestic origin have lower probability of survival compared with firms of foreign origin. This is in line with theory and empirical findings. The fact that it is not significant may be due to the small number of foreign firms in our sample.

The survival results are likely to have been influenced by the global financial crisis of 2008 which occurred during the study period. The global financial crisis saw South African GDP contract by 1.5 per cent in 2009. To address that possible impact on the results, column 2 of Table 4.4 reports the logistics estimation results for the pre-crisis period 2000-07. Comparing the results, the signs of the coefficients are consistent except for medium sized firms which is positive in the pre-crisis period This indicates that the probability of survival for medium firms is lower than the probability of survival for small firms which is the base category. Despite this change, the coefficient of medium firms is insignificant in both cases. The significance of the coefficients is also consistent between the equations, except for origin, which changed from insignificant for the whole period to significant at 10 per cent during the pre-crisis period.  Overall the global financial crisis had little effect on the results.

**Table 4.4 Logistic Results**

| Dependent Variable: Failure | (1) Whole Period | (2) Pre Crisis Period |
|---|---|---|
| Medium Firms | -0.0989 | 0.0576 |
| | (0.196) | (0.200) |
| Large Firms | -1.789*** | -1.694*** |
| | (0.392) | (0.425) |
| Secondary Sector | 0.283 | 0.217 |
| | (0.259) | (0.267) |
| Tertiary Sector | 0.890*** | 0.851*** |
| | (0.249) | (0.257) |
| Middle Aged Firms | 0.714** | 0.976*** |
| | (0.313) | (0.322) |
| Old Firms | 0.656*** | 0.764*** |
| | (0.206) | (0.216) |
| High profitability | -0.390** | -0.464** |
| | (0.179) | (0.184) |
| High Leverage | -0.395** | -0.444** |
| | (0.173) | (0.178) |
| Origin | 0.153 | 0.407* |
| | (0.224) | (0.231) |
| Constant | -0.571* | -1.094*** |
| | (0.306) | (0.326) |
| Log Likelihood | -390.2987 | -373.2423 |
| LR chi2(9) | 57.83(0.00) | 58.81(0.00) |
| Pseudo R2 | 0.0696 | 0.073 |
| Observations | 605 | 588 |
| Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 | | |
| Dependent variable is equal to unity if a firm died during the period and zero if it is found alive at the end of the period | | |

Analysing survival patterns based on two data points poses a problem since it does not take into account the evolution of survival over time and ignores that some companies drop out of the database at different lengths of time. The Kaplan-Meier estimate is the simplest way of computing the survival over time and is able to handle drop out of the sample. The Kaplan-Meier product limit estimates duration of survival over time, even when firms drop out at different time lengths.

The Kaplan-Meier estimator *s(t)* is given by

$$\hat{s}(t) = \prod_{j|t_j \le t} \frac{r_j - d_j}{r_j} \qquad 4.8$$

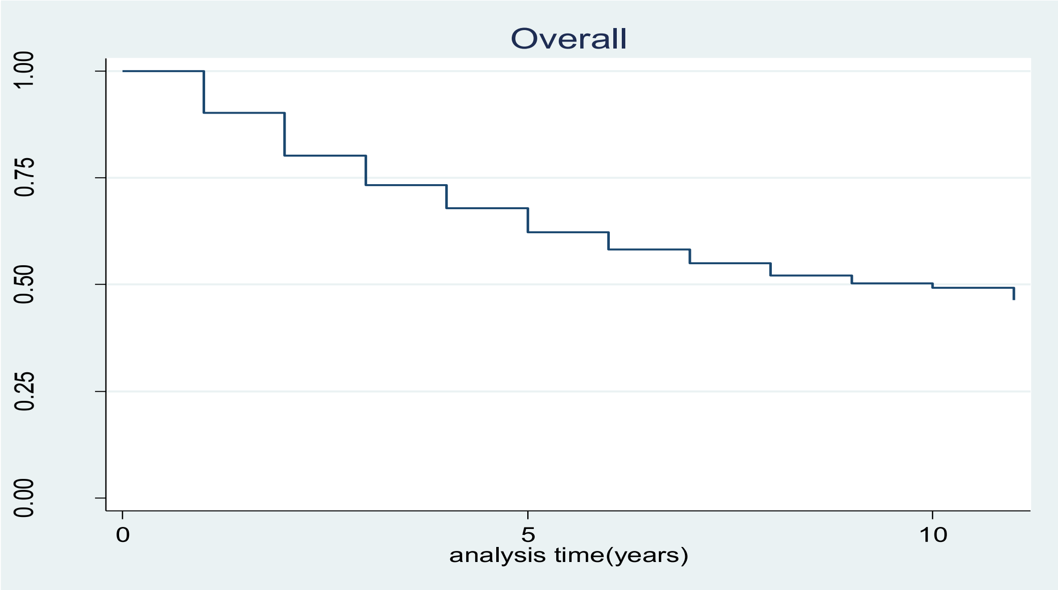
Where $d_j$ is the number of firms that end at time $t_j$ and $r_j$ is the number of firms that are still in the database and at risk at the time just before time $t_j$. The resultant survivor function is a decreasing step function with jump at each failure time. The hazard rate measures the rate at which the risk is being accumulated, while the hazard function is the instantaneous probability of leaving a state conditional on survival to time t. The hazard function *h(t)* is defined as,

$$\mathrm{h(t)} = \lim_{\Delta t \to 0} \frac{\mathrm{pr}\left[t \le T < t + \Delta t | T \ge t\right]}{\Delta t} \qquad 4.9$$

$$h(t) = \frac{f(t)}{S(t)} \qquad 4.10$$

Where T is the firm's life duration, *f(t)* is the probability density function and *S(t)* is the survival function. Estimating the survival rates using the Kaplan-Meier product limit estimate procedure gave the results presented in Figure 4.1. The vertical axis represents the estimated probability of survival, while the horizontal axis is the number of years. About 50 per cent of the firms listed in the JSE survive for 10 years, while about 75 per cent of the firms survive less than 3 years.

**Figure 4.1: Overall Survival Estimates**




The decline in the survival probability can be a result of the effects of the explanatory variables (Perez et al., 2004). In order to investigate the effects of the explanatory variables on firm survival, the non-parametric log rank tests of equality is used to compare the distributions of sub-samples in the data. The log–rank test is a large-sample chi-square test that uses, as its test criterion, a statistic that provides an overall comparison of the Kaplan Meier curves being compared (Kleinbaum and Klein, 2005). The log–rank statistic makes use of the observed (O) versus expected (E) number of events in each group.[16] The categories for the log–rank statistic are defined by each of the ordered failure times for the entire set of data being analysed (Collett, 2003). The approximate log-rank statistic is given as,

$$\log \textit{rank statistic} = \sum_{i=1}^{p} \frac{(O_i - E_i)^2}{E_i} \qquad 4.11$$

Where p is the total number of groups. The decision about the significance is made using chi square with p-1 degrees of freedom. The results for the non-parametric log-rank test of equality of survival functions and median survival times obtained by Kaplan Meier product limit method are shown in Table 4.5. Column 1 presents the explanatory variables, while column 2 is the log rank results with p-values in brackets. Column 3 provides the groups of

[16] $O_i = \sum_{j=1}^{r_i} O_{ij}, E_i = \sum_{j=1}^{r_i} E_{ij}$ are observed and expected number of events in the ith group.

firms classified by explanatory variables, while the last column is the median survival time in years. The results show that there are significant differences between the survival functions across the groups within the explanatory variables in all variables except age and origin of the firm. The survival functions of small, medium and large firms are significantly different. The null hypothesis of no difference is rejected. This suggests that large firms have higher survival chances compared to small and medium firms. Just above 75 per cent of large firms survive longer than 10 years compared with less than 50 per cent for the small and medium firms. The distance between the large and the medium firms is smaller than that between large and small firms. The pattern of survival for small and medium is almost similar, up to seven years where the latter survival function declines slowly, thereby increasing the distance. This suggests that smaller firms become more vulnerable.

Regarding the economic sectors, the difference between tertiary, secondary and tertiary economic sector groups is statistically significant with the null hypothesis for no difference being rejected. Firm in primary sector survive longer compared to those in secondary and tertiary sectors. The survival function for primary and secondary do not reach the median, while those in the tertiary sector about 50 per cent of them survive for 7 years. The difference between the primary and the secondary is smaller than the distance between the primary and the tertiary sectors.

As relates to the financial indicators, the null hypothesis for no difference is rejected in profitability and leverage. This indicates the strong influence of financial variables on firm survival. High profitability and leveraged firms have better survival chances compared to the ones in the lower category. As shown, for age and origin the null hypothesis is not rejected. This suggests the weak role of the variables on survival. The rejection is not surprising. Visual inspection of the survival functions show that the functions of young, middle aged and old firms are close to each other throughout the time spell. A similar pattern is observed for origin with domestic and foreign being close to each other. Figure 4.2 presents all the results from the log rank tests by the survival functions for the explanatory variables -firm size, age, sector, profitability, leverage and firm origin.

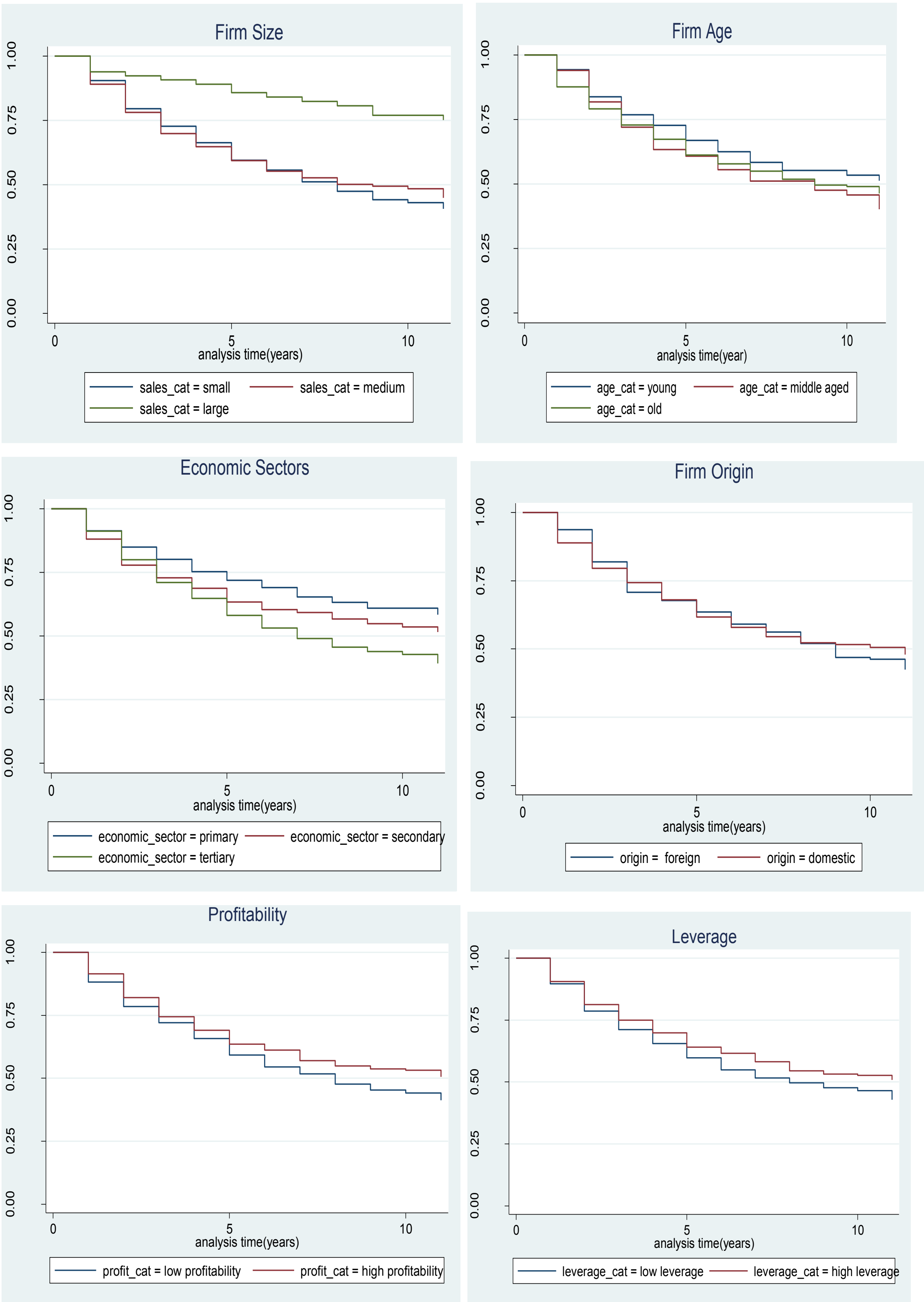
**Table 4.5 Non-Parametric Test for Equality of Survivor Functions**

| Variable | Log-Rank | Median Survival Times in years | |
|---|---|---|---|
| Size | 19.69(0.00) | Small | 8 |
| | | Medium | 9 |
| | | Large | - |
| Age | 2.53(0.28) | Young | - |
| | | Middle | 9 |
| | | Old | 9 |
| Economic Sector | 12.11(0.00) | Primary | - |
| | | Secondary | - |
| | | Tertiary | 7 |
| Profitability | 4.17(0.04) | Low Profitability | 8 |
| | | High Profitability | - |
| Leverage | 3.14(0.07) | Low Leverage | 8 |
| | | High Leverage | - |
| Origin | 0.37(0.54) | Foreign | 9 |
| | | Domestic | 11 |

*pvalues in parenthesis

(-) indicates survival function does not reach the median value

**Figure 4.2: Kaplan-Meier Survival Estimates**



As discussed the problem with logistic regression is its simplicity. More importantly, the probit/logit models fail to recognise the time dependence of our data. If there is time dependence in the data, then probit and logit estimates may be inefficient and underestimate the standard errors. Recent empirical work has used techniques based on transition or time to event data. These are able to account for the evolution of exit risk, by thoroughly controlling for the occurrence and timing of the exit event (Varum and Rocha, 2012; Manjon-Antolin and Arauzo-Carod (2008). They also account for right censoring or censoring from above. Firms are followed up from the time they register on the stock exchange to the time they exit. However, since the study does not cover the whole period of the existence of the stock exchange, firms are followed up from 2000 for a period of 10 years ending in 2010. This means that at end of the follow-up time there were some companies that had exited the stock exchange while some were still in existence. Companies that were still alive when the follow–up ends were right censored. Right censoring occurs when some spells are completed and others are incomplete. The event will occur in the interval between the time we censor and infinity. The methodologies involve the use of the semi-parametric Cox proportional hazard model (Varum and Rocha, 2012).

Following Nkurinziza (2012), the proportional hazard model for analyzing the determinants of firm survival is specified as,

$$h(t, X) = h_0(t)\phi(X, \beta) \qquad 4.12$$

Where $h_0\ (t)$ is the baseline hazard and is a function of time, X is the set of explanatory variables - firm size ($SIZE_i$), firm age ($AGE_i$), leverage ($LEVERAGE_i$), profitability ($PROFITABILITY_i$), origin dummy ($ORIGIN_i$) and industry ($INDUSTRY_i$) - and beta is the vector of parameters. The proportional hazard model implies that the hazard faced by each firm is multiplicatively proportional to the baseline hazard and is the same for each firm. This is a strong assumption which requires testing before it can be adopted. The commonly used test for proportionality assumption is the Covariate rho-test proposed by Grambsch and Therneau (1994).

The results for the test of proportional hazard assumption are presented in Table 4.6. The null hypothesis is that the explanatory variable has the same proportional impact on the hazard everywhere along the hazard function. As a result, we do not want to reject the null hypothesis so the probability should be greater than 0.05. The hazard ratio of failure for all explanatory variables fails to reject the null hypothesis that the hazard ratio is constant over time. The null hypothesis for medium sized firms, large firms, secondary sector, tertiary sector, middle aged firms, old firms, high profitable firms, high leverage firms and domestically originating firms are not rejected. The last row indicates the global test which confirms that the constant proportional hazard assumption is satisfied. The null hypothesis of constant proportional hazard is not rejected since the probability is higher than 0.05. The result indicates that it is suitable to use Cox proportional hazard models in the data.

**Table 4.6 Test of the Proportional Hazards Assumption**

| Variables | rho | chi2 | prob>chi2 |
|---|---|---|---|
| Medium firms | -0.03476 | 0.36 | 0.5499 |
| Large firms | -0.06214 | 1.15 | 0.2844 |
| Secondary sector | -0.00855 | 0.02 | 0.8816 |
| Tertiary sector | 0.05615 | 0.89 | 0.3462 |
| Middle aged firms | 0.04152 | 0.52 | 0.4693 |
| Old firms | -0.01798 | 0.1 | 0.757 |
| High profitability | -0.01537 | 0.07 | 0.7858 |
| High leverage | -0.05566 | 0.94 | 0.3313 |
| Domestic origin | -0.02485 | 0.16 | 0.6847 |
| Global test | | 8.24 | 0.5097 |

Estimating survival model in equation 4.12 with unspecified baseline hazard gave the results reported in Table 4.7. The results report both the hazard ratios and the p-values. The hazard ratio has the base category as one, so a value below one indicates that the variable has a lower hazard ratio than the base category, and a value above unity indicates that the hazard ratio is greater than the base category. To a large extent, some of the results confirm the earlier results from the logistic regression and the stylized facts on firm survival except for weak significance for age variables. In line with the logit results, the hazard ratio of middle aged firms is greater than unity. This suggests that middle aged firms face higher hazard compared to the young firms which are the base category. Nevertheless, it should be noted that the ratio is not significant even at 10 per cent. The hazard ratio for old firms is also higher than unity, indicating more hazards compared to the young firms. The significance is now barely at 5 per cent level.

The hazard ratio for being a medium sized firm is less than one. This indicates that they face less risk compared to small sized firms which are the base category. The hazard, however, is statistically insignificant. The hazard ratio for large firms is lower than that of small firms, suggesting that large firms have higher survival chances compared to small firms and is statistically significant. Moving to the sectors, the hazard ratio for firms operating in the secondary sector and tertiary sectors is higher than those of firms in the primary sector. The dummy variable for tertiary sector is higher than unity and significant at 1 per cent, implying that compared with the base category, which is the primary sector, the hazard for tertiary sector is higher. The hazard ratio for the secondary sector is not significant, but still above unity. Regarding origin, the hazard ratio for firms originating domestically is greater than unity, suggesting that they face higher hazard compared to firms of foreign origin. The results for profitability and leverage are also as expected. The hazard ratio for high profitability and leveraged firms is lower than unity and significant. This suggests that high profitability and leverage firms face lower hazard compared to base category low profitability and leverage firms. Overall, the results suggest that firm size, economic sector, leverage and profitability are important determinants of firm survival. This confirms the findings from the logit regression.

**Table 4.7 Cox Proportional Hazard Models Results - Unspecified Baseline Hazard**

| Variables | Unspecified Baseline Hazard | |
|---|---|---|
| | **Hazard Ratio** | **P-value** |
| Medium firms | 0.921 | 0.535 |
| Large firms | 0.253 | 0.000 |
| Secondary sector | 1.273 | 0.209 |
| Tertiary sector | 1.737 | 0.002 |
| Middle aged firms | 1.376 | 0.127 |
| Old firms | 1.315 | 0.059 |
| High profitability | 0.789 | 0.054 |
| High leverage | 0.808 | 0.073 |
| Domestic origin | 1.149 | 0.345 |
| Constant | | |
| Log likelihood | -1772.5374 | |
| LR chi2(9) | 44.66(0.00) | |
| AIC | 3563.075 | |
| Observations | 605 | |

## 4.5 Robustness Checks

There is an issue that needs to be dealt with to ensure that the results are robust. *Incorrectly* specifying the functional form of the baseline hazard may lead to inconsistent parameter estimates. One way to address the problem is to check whether the results will change when the functional form of the baseline hazard is assumed to follow particular distributions. In line with Perez and Castillejo (2006), the baseline is assumed to follow exponential and Weibull distributions which are most commonly used. Exponential distribution assumes that the logarithm of survival function is linearly related to time, while Weibull distribution implies that the logarithm of hazard increases or decreases with the logarithm of time (Nkurunziza, 2012). The regression results are presented in Table 4.8. They are consistent with the ones where the baseline hazard is unspecified in terms of direction of the hazard ratio and significance. They indicate that large, high profitability and high leverage firms operating in the primary sector have higher survival chances.

The three models performance can be compared using Akaike Information Criterion (AIC), and the results reveal that the exponential is a better model as it is the one that minimises AIC. This suggests that the model that could be preffered for modelling firm survival among the JSE listed companies is the exponential baseline hazard model.

**Table 4.8 Cox Proportional Hazard Models Results**

| | Weibull Baseline Hazard | | Exponential Baseline Hazard | |
|---|---|---|---|---|
| | **Hazard Ratio** | **P-value** | **Hazard Ratio** | **P-value** |
| Medium firms | .901 | 0.429 | .904 | 0.443 |
| Large firms | .230 | 0.000 | .233 | 0.000 |
| Secondary sector | 1.298 | 0.175 | 1.293 | 0.181 |
| Tertiary sector | 1.791 | 0.001 | 1.781 | 0.001 |
| Middle aged firms | 1.371 | 0.132 | 1.372 | 0.131 |
| Old firms | 1.261 | 0.110 | 1.269 | 0.100 |
| High profitability | .783 | 0.048 | .785 | 0.050 |
| High leverage | .803 | 0.065 | .804 | 0.066 |
| Domestic origin | 1.183 | 0.250 | 1.178 | 0.264 |
| Constant | .047 | 0.000 | .054 | 0.000 |
| Log likelihood | -707.3413 | | -708.0857 | |
| LR chi2(9) | 49.96(0.00) | | 49.14(0.00) | |
| AIC | 1436.683 | | 1436.172 | |
| Observations | 605 | | 605 | |

## 4.6 Conclusions

This chapter investigated the duration and determinants of firm survival among the JSE listed companies in South Africa during the period 2000–10. Building on the static analysis of pattern of firm survival presented in Chapter 3, the chapter decomposed death rate by three causes of exit which are takeover, liquidation and other. Takeovers account for 32.6 per cent, liquidations for 10.8 per cent and other for 9.7 per cent. Firm exit seems to be more pronounced among the lower sized companies. This suggests that some companies never reach the large size. The study also used the Kaplan-Meier product limit estimate procedure to investigate the survival patterns in among the companies. The results indicate that, overall, about 50 per cent of the companies listed in the JSE survive up to 10 years. In addition, there are significant differences between the survival functions across the groups within the explanatory variables in all variables except age and origin of the firm.

To investigate the determinants survival, we specify a simple logit binary survival model that allow for firm size, age financial characteristics and sectoral factors. The results indicate that large, high profitability and high leverage firms operating in the primary sector are expected to have higher survival chances among the JSE listed companies. This is largely in line with the theoretical predictions and evidence found from other countries. Age and origin of the firm, however, are found not to be significant factors that explain survival. The results remain consistent even after taking into account of the global financial crisis by considering the period before the crisis for the analysis.

The use of the hazard model improves on binary regression because they adequately account for the evolution of exit risk by thoroughly controlling for the occurrence and timing of the exit event. They also take care of right censoring which is a problem in studies of this nature. The results are subjected to robustness by specifying alternative baseline distribution of exponential and Weibull distributions.

Finally, the study contributes to the discussion on strengthening the work of the Competition Commission of South Africa because clearly it is found that mergers and acquisitions is the main cause of firm death compared to corporate failure. Strong competition regulation is critical in ensuring a healthy industrial sector.

# Chapter Five : Firm Productivity and Financial Development: Evidence from South Africa

## 5.1 Introduction

The role of finance in the growth process has received considerable attention over the years and two views have been most prevalent. An overwhelming literature supports the view that financial sector development leads to economic growth (Levine, 2005), whilst the other view argues that finance can have detrimental effects to economic growth (Rajan, 2006; Rodrik and Subramanian; 2009). The first view argues that an efficient allocation of resources is vital for economic growth. This is because deeper, broader and better functioning financial markets can stimulate higher economic growth (Levine, Loayza and Beck 2000). Financial development is characterized by the existence of financial institutions, financial markets and instruments, which all reduce information and transaction costs. This means that financial services avail savings for investment purposes, supports technology innovation, ensures efficient allocation and positively influence economic growth (Gehringer, 2014). As such, economies with more developed financial systems tend to grow faster than those without (Levine, 2005). This is because borrowers are able to finance more productive projects through the financial system. Empirical literature surveyed in Gehringer (2014), Levine (2005), Eschenbach (2004) Heil (2017) and Ang (2008) supports this view.

Despite the overwhelming empirical evidence in support of the positive role of finance in promoting economic growth, some studies have questioned the robustness of the result (Arcand et al., 2012). The second view argues that, financial development does not necessarily lead to higher economic growth. This is because while access to finance plays an important role for economic growth, it also increases the risk exposure of the real economy to severe fluctuations (Rajan, 2006; Rodrik and Subramanian; 2009). This perceives the financial system as inherently unstable and focuses on the destabilizing effects of financial overtrading and crisis. The recent global financial crisis in developed countries is one of the clear examples of the effects of such risk exposures.

Significant amount of empirical evidence have centered on investigating the finance-growth nexus with less attention on the link between finance and productivity. This is despite compelling empirical evidence in support of total factor productivity in explaining economic growth. Hall and Jones (1999) observed that cross country differences in real gross domestic product could be explained by differences in total factor productivity. Also, Easterly and Levine (2002) emphasized the importance of total factor productivity relative to factor accumulation in explaining economic growth. Most of the studies on developing countries are based on aggregate macro level data with little use of firm level data, despite it being more appropriate for unpacking the relationship between finance and productivity (Gomis and Khatiwada, 2016; Levine, 2003; Levine and Warusawitharana, 2012). The situation is worse in developing countries because of the unavailability of firm level panel data.

This chapter contributes to the literature on developing countries by empirically investigating the effects of financial development on a firm's total factor productivity in South Africa. There are few studies that use firm level data to provide evidence on the relationship between finance and productivity such as Gomis and Khatiwada, 2016; Levine and Warusawitharana, 2012; Gatti and Love, 2008; Chen, 2012; Chen and Guariglia, 2013; Thangavelu and Chongvilaiven, 2013.[17] This study estimates total productivity model augmented with financial indicators employing panel data estimation methods (Gatti and Love, 2008; Chen and Guariglia, 2013; Thangavelu and Chongvilaiven, 2013). Data on the companies listed in the JSE for the period 2000-2010 is used.

The rest of the chapter is structured as follows; Section 5.2 presents the theory and empirical literature review. Section 5.3 discusses data to be used and descriptive statistics. Section 5.4 presents the empirical methodology. The study follows Chen and Guariglia (2013), Gatti and Love (2008), Thangavelu and Chongvilaiven (2013), Gomis and Khatiwada( 2016), Levine and Warusawitharana (2012) and others, by adopting the two stage methodology that involves estimating the production function to determine total factor productivity. Then, estimates the total factor productivity model augmented with financial development indicators. Section 5.5 presents the empirical results and investigates some of the potential econometric problems. Section 5.6 is the conclusions.

[17] For survey article see Heil (2017)

## 5.2 Theory and Empirical Literature Review

Papaioannou (2007) observes that theories that link the role of the financial system to economic growth through productivity can be traced back to Schumpeter (1911) and Bagehot (1873). The work was extended by Diamond (1984), Greenwood and Jovanovic (1990) and King and Levine (1993). The idea behind the relationship is that an efficient financial system is able to assess the most innovative and productive firms or industries and efficiently allocate capital to foster economic growth (Papaioannou, 2007). The models in the area can be characterised within the growth accounting framework. The framework decomposes economic growth into three components: capital deepening, human capital accumulation and total factor productivity. Capital deepening involves addition to existing capital stock through investment, while human capital accumulation involves the education, training and improvement in health facilities to make labour more productive. Total factor productivity (TFP) relates the efficiency of firms in transforming factor inputs into final output during the production process and is not observable. This growth accounting framework is relevant to this study because the total factor productivity channel is being tested.

Formally, the growth accounting framework assumes the following neoclassical aggregate production,

$$Y_{it} = AK^{\alpha}(Lh)^{1-\alpha} \quad 5.1$$

Where $Y_{it}$ is the output in period t, K is the capital stock, L is the labor input adjusted for average human capital of workers (h) and A is the technology. This can be expressed in per worker terms as follows,

$$y = Ak^{\alpha}h^{1-\alpha} \quad 5.2$$

Differentiating with respect to time we get the following,

$$\frac{\dot{y}}{y} = \alpha\frac{\dot{k}}{k} + (1-\alpha)\frac{\dot{h}}{h} + \frac{\dot{A}}{A} \quad 5.3$$

The term in the left hand side is the output growth per worker. It is decomposed into three components in the right hand side; the first being capital deepening, followed by human capital accumulation and total factor productivity. This framework provides the theoretical link for analysing the relationship between finance and total factor productivity which is the focus of this study.

The capital accumulation channel argues that the financial sector mobilises savings from the surplus units and directs them to the deficits units to fund the investments projects. This results in capital accumulation and higher output growth. The total factor productivity channel on the other hand, which is the focus of this chapter recognises the financial sector role in reducing information asymmetries and ensuring efficient allocation of financial resources. It is able to reduce the cost of information by investing in technologies that allow for better management of information on borrowers and project monitoring, which leads to improvement in technological innovation (Boyde and Prescott, 1986; Beck et al., 2000). Innovation can impact technological progress either through research and development leading to invention of new products and processes or adoption and adaptation of existing technology (Dabla-Norris et al., 2010). These innovative projects are very risky and require sizable financing. In most cases, due to the magnitude of the required finance, firms may not afford to finance these projects from their internal resources. Hence the financial sector facilitates additional funding.

King and Levine (1993) develop an endogenous growth model that link finance to innovative activity and productivity. The model suggests that the financial system in evaluating different investment projects and ultimately providing finance to the promising ones improves the probability of successful innovation. As a result, it is highly likely that innovative projects will end up being financed. It is that process of identifying viable innovative projects that is important to economic growth. This is done through the overall reduction in the misallocation of capital by the financial sector. Resource misallocation is characterised by high return yielding projects not being able to get funding, thus requiring entrepreneurs to accumulate funds for the projects to go ahead. This leads to inefficiency because resources are placed where they do not yield the highest return. As such, the financial sector ensures that the more efficient firms are able to secure funds and undertake more productive investments projects. This impacts positively on economic growth. It has been argued that part of the reason for the exceptional performance of China and India in the last decade has been driven by the reallocation of resources from low to high productive sectors (Hseih and Klenow, 2009).

In the presence of the financial sector, the pool of funds available is far more than they would otherwise be. Therefore, it has been argued that the financial sector actually facilitates funding of more investment projects (Bencivenga and Smith, 1991). All these models support the strength of total factor productivity in influencing economic growth.

Corporate finance theories also provide the link between the firm financial structure and total factor productivity. Trade-off theory and pecking order theory posit that firm capital structure is explained by firm specific factors, such as size, age, profitability, sales growth, tax environment and asset tangibility. On one hand, the trade-off theory argues that in deciding on the capital structure, a firm's choice is based on the difference between the costs and benefits of debt. The benefits include the mitigation of agency problems, while the costs include debt overhang, risk shifting and bankruptcy costs. On the other hand, the pecking order theory by Myers and Majluf (1984) indicates that firms will prefer internal generated cash before they contract external debt or raise equity. These theories have provided some explanations to the relationship between finance and productivity which is relevant to this thesis.

Besides finance, there are other determinants of total factor productivity, which are important to this study. First, the innovation based growth models argue that research and development (R&D) activities are a prerequisite for successful innovation which will lead to increased output (Romer, 1990, Grossman and Helpman, 1991; and Aghion and Howitt, 1998). While the effect may not be immediate, but research and development leads to better production processes through improved technology. R&D has domestic and international spillovers. International spillovers are transferred through international trade and foreign direct investment (Coe and Helpman, 1995).[18] Second, the role of human capital in driving productivity has been emphasized (Romer, 1986; Lucas; 1998). This is because highly skilled human capital can efficiently utilise technology and influence further innovation. Last, managerial talent is posited to influence productivity. Better skilled managers tend to be more productive than unskilled ones.

The empirical work on the relationship between total factor productivity and financial development using firm data has attracted a lot of attention in recent years due to the limitations posed by the macro data (Gomis and Khatiwada, 2016; Love et al., 2011; Gatti

[18] There are methodologies that are applied to estimate the R&D spillovers and their implementation depends on the availability of the R&D data.

and Love, 2008; Nickell and Nicolitsas, 1999; Nucci et al., 2004; Schiantarelli and Sembenelli, 1999; Heil , 2017 ). The main limitation is that macro data fail to adequately pick the relationship. In addressing the concern, firm level data has been used. However, firm level studies have been characterised by the use of different measurements of the relevant financial indicators at the firm level, which has made comparison of the results across the studies very difficult. Several measures have been used in the literature such as leverage, liquidity and direct indicators such as overdrafts. The most widely used measure of financial development at the firm level has been leverage and liquidity. To a large extent, this has been driven by the availability of data (Love et al., 2011).This study will also adopt leverage and liquidity as the appropriate measures of financial development.

The results on the relationship between leverage and total factor productivity have been mixed. Some studies have reported a positive relationship, indicating that external finance improves the efficiency of the firms. This suggests that the financial sector is able to allow firms to finance relatively expensive and more productive projects, which they would otherwise not afford to undertake. Hence the development of the financial sector is important for productivity growth. Among the studies that reported a positive relationship are Nickell and Nicolitsas (1999) for United Kingdom (UK), Thangavelu and Chongvilaiven (2013), Avarmaa et al. (2013) for the Baltic countries and Gomis and Khatiwada (2016) for advanced and developing countries. Gomis and Khatiwada (2016) used publicly listed countries in over 100 countries including South Africa covering the period 1986-2014. The data is accessed through Factset, a privately owned data company. Measuring total factor productivity by the Olley and Pakes method and leverage by debt to asset ratio, they found that firm leverage is positively associated with productivity. Other variables that are included in the regression are firm age, sales and capital expenditure. Their results are robust to controlling for endogeneity.

The negative effects on leverage of total factor productivity have also been found, indicating that external finance is not utilised for productivity enhancing activities such as research and development (Ghosh, 2009; Nucci et al., 2004; Schiantarelli and Sembenelli, 1997). Moreover, it has also been found that the relationship between leverage and productivity is non-linear. Investigating the nature of the relationship is identified as a potential area for future research (Degryse et al., 2009). Deidda and Fattouh (2001) developed the model that establishes this non-linearity. In explaining non-linearity, the agency theory in corporate finance argues that there is a limit to the amount of debt that can be beneficial to a firm's productivity implying that there exists a point beyond which debt is considered excessive and detrimental. Coricelli et al. (2012) investigated the relationship between leverage and productivity using firm level data from 16 Central and Eastern European (CEE) countries during the period 1999–2008 employing the threshold regression. The study finds evidence that total factor productivity increases with leverage until up to a critical point after which it becomes excessive. In addressing the potential endogeineity between total factor productivity and leverage, Coricelli (2012) replaced leverage with its fitted values. The fitted values were found to be highly correlated to leverage and uncorrelated with the error term in the total factor productivity equation. Hence, arguably, this is a better instrument. This study follows this approach in addressing endogeinety.

A common approach to investigate non-linearity in the specification is to augment the model with the quadratic leverage term as followed by Nunes et al. (2007). Using the quantile regression estimation method, Nunes et al. (2007) also found that leverage and labour productivity had a non-linear relationship. Leverage decreased productivity for lower productive firms and increased for the most productive firms. The findings from these studies indicate that financial sector development can hamper economic growth, but that may be due to the non-linearity of the relationship.

Unlike leverage, there is general consensus in the empirical literature that there is a positive relationship between liquidity and productivity, indicating that a firm that has high liquid assets is able to finance more productive investments. Recently, Chen and Guariglia (2013) investigated the relationship using the panel of Chinese manufacturing firms for the period 1998–2007. The study found that internal finance directly improves firm total factor productivity. They argued that internal resources will always be used when there is a challenge in raising sufficient capital outside the firm. They measured internal finance as the ratio of cash flow to capital. Thangavelu and Chongvilaiven (2013) included both leverage and liquidity, arguing that they measure different aspects of the financial sector, and found that in the case of Vietnam both measures have positive effects productivity. This suggests that there is a role that finance play in promoting economic growth.

Other direct indicators such as overdrafts, availability of credit line, equity finance and debt finance have generally confirmed the importance of the financial sector to productivity. Gatti and Love (2008) used availability of overdraft facility to a firm in Bulgaria and found positive and significant effect on firm productivity. The result was found to be consistent among various measures of productivity such as labour productivity, OLS based productivity and Levinsohn-Petrin based total factor productivity. Similarly, Love et al. (2011) who focused on five Central American countries (Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua), measured access to credit by the availability of overdraft facility or credit line. They found a strong and positive effect of access to credit on productivity. Levine and Warusawitharana (2012) also in the case of four European countries (United Kingdom (UK), France, Italy and Spain) used the level of debt and equity finance. Xu and Pal (2012) explored the relationship between credit and total factor productivity in India and found that financial development significantly enhanced firm level productivity. The study used both financial development and financial health indicators to check for consistency between the results provided by the micro level indicators and the macro.

A lot of attention has also been focused on estimating the financial constraints and investigating how they affect firm productivity. Financial constraints are barriers to access external finance and are unobservable as there is no specific variable from the financial statements that reflect whether a company is constrained or not (Ferrando and Ruggieri, 2015). As such, reliance has been on its identification and measurement. Estimating financial constraints have posed a major challenge in the empirical work. Its estimation is informed by the literature of investment sensitivity to internal finance as proposed by Modigliani and Miller (1958) (Molina-Badia and Slootmaekers, 2009; Ferrando and Ruggieri, 2015). Modigliani and Miller (1958) showed that under certain assumptions, including perfect capital markets, internal and external finance are perfect substitutes as such the financial structure is irrelevant. Initially, the Q theory of investment was used in the empirical work, but recent studies have used the Euler Equation model of investment (Molina-Badia and Slootmaekers, 2009). Several problems have been cited against Q methodology including measurement errors, unrealistic assumptions and identification issues (Schiantarelli, 1996). The seminal paper by Rajan and Zingales (1998) used industry level data to derive the methodology for estimating the financial constraints faced by firms in accessing external finance, which has been widely applied (Molina-Badia and Slootmaekers, 2009).

Given the relevance of total factor productivity in this study it is worth reviewing the literature on its estimation. The literature on the estimation of total factor productivity is dominated by debates around its measurement because it is unobservable. A common approach is to measure total factor productivity as a residual in the production function (Solow, 1957).[19] At the firm level this approach is prone to econometric problems of simultaneity and sample selection (Van Beveren, 2012; Pavcnik, 2002; Syverson, 2012; Eberhardt and Helmers, 2010). Simultaneity bias arises because there is a potential correlation between unobserved productivity and firm input decisions. If more productive firms hire more workers due to higher current and expected future profitability, the OLS will provide upward biased estimates on the input coefficients. On the other hand, sample selection bias arises because firms with larger capital stocks can expect larger future returns for any given level of current productivity and will, therefore, continue in operation for lower levels of productivity levels. This leads to negative bias in the OLS capital coefficient. Failure to adequately deal with these econometric issues may result in biased estimates (Van Beveren, 2012; Pavcnik, 2002; Syverson, 2012; Eberhardt and Helmers, 2010). To circumvent the problems the Olley and Pakes method, Levinsohn-Petrin (LP) semi-parametric method and Ackerberg et al. (2006) have been used.

In general, the literature review has raised a number of issues which are relevant to this study. First, there is no consensus in the empirical literature on the appropriate measures of finance at the firm level. Studies have used various measures depending on data availability and the nature of the question being investigated. This study adopts leverage as the main indicator of finance and liquidity as the secondary one. The choice is because leverage and liquidity are widely used in the empirical literature and can be constructed with ease from the dataset. Second, the estimation of the production function to determine total factor productivity is subject to econometric problems, which needs to be adequately addressed. This study uses Levinsohn-Petrin semi-parametric method because of its data requirements. Last, in modeling total factor productivity and leverage there is a potential for endogeneity and different methodologies have been suggested to deal with the problem. This study follows Coricelli (2012) who instrumented leverage with its fitted values. This is because the fitted values qualify the criteria for a good instrument. Again the data is available for estimating the leverage equation.

[19] Total factor productivity may not only capture the technological changes and other spillovers but may also reflect everything else that is wrongly measured (inputs or outputs) or unmeasured in the production function. This needs to be taken into account when interpreting the results.

## 5.3 Data and Descriptive Statistics

The study uses data on the non-financial companies listed in the JSE in South Africa during the period 2000-10. The details about the data are discussed in Chapter 2. All the data reflect book values rather than market values. The variables are deflated by consumer price index since the industry deflators are not available.

The first issue for consideration is how to measure financial development at the firm level. The empirical literature suggests a wide range of financial sector indicators that can be used to measure financial development and the consensus is that leverage and liquidity are the most intensively used. The study follows Thangavelu and Chongvilaivan (2013) and argues that these indicators best capture financial health of the company because leverage captures the firm's access to external finance while liquidity reflects on the availability of internal funds to the firm. In line with Nucci et al. (2007) and Gomis and Khatiwada (2016), leverage is measured as the ratio of total debt to total assets. It should be noted that there are several ways in which leverage has been defined in the empirical literature such as the ratio of total assets to total liabilities (Ghosh, 2009). Using total debt to total assets is preffered because it allows for separation of long term and short term debt. This is because firms may respond differently to long term debt compared to short term. As a result, an alternative leverage measure to separate long term and short term based measure of leverage can be constructed. Liquidity, on the other hand, is measured by the ratio of cash holdings to total assets (Thangavelu and Chongvilaivan, 2013).

Next, other variables to be used in the analysis are described. Firm output is measured by value added. Value added is the sum of income, income tax, interest expense paid on debt, salaries and benefits and depreciation (Chen, 2012). Labour input is measured by the wage bill because employment series in the data result in many missing observations. Capital stock is measured by total tangible assets calculated as the difference between total assets and total intangible assets (Chen, 2012). Intermediate input is measured by the operating expenses. Firm age is measured as the difference between the current year and the year of establishment. Firm size is measured by total assets. This is in line with the empirical literature on finance-growth nexus, which uses total assets instead of sales or employment. Sales growth is measured as the log difference in net sales. Tangibility is measured as the ratio of fixed assets to total assets. Firms that have fixed assets are able to offer them as collateral in order to secure funding. Origin dummy captures the original country of the firm. The variable is a binary variable coded unity for South Africa and zero otherwise. The industry dummies capture the effect of difference in industries. As indicated in chapter 2, our firms are classified according to nine International Classification Benchmark (ICB) industries – basic material, consumer goods, consumer services, health care, industrials, oil and gas, technology, telecommunications and utilities.

Summary statistics of the key variables are provided in Table 5.1. The variables of interest for this study are the measures of financial development. The logarithm of leverage has a negative mean of 2.1 and its distribution is skewed to the left. The alternative measure, which is logarithm of liquidity, has a positive mean of 10.3 and the distribution is also skewed to the left.

**Table 5.1 Descriptive Statistics**

| Variable | N | mean | median | sd | skewness | kurtosis | minimum | maximum |
|---|---|---|---|---|---|---|---|---|
| leverage | 2970 | -2.174 | -1.801 | 1.476 | -1.522 | 6.693 | -9.983 | 4.019 |
| leverage_long | 2760 | -3.004 | -2.613 | 1.793 | -1.012 | 5.361 | -14.58 | 6.921 |
| liquidity | 3433 | 10.38 | 10.76 | 2.956 | -0.618 | 3.172 | 0 | 17.41 |
| lsize | 3535 | 12.97 | 12.99 | 2.441 | -0.316 | 3.330 | 0 | 18.95 |
| ltang | 3394 | -1.793 | -1.545 | 1.375 | -1.946 | 9.719 | -11.72 | 0 |
| lage | 3421 | 3.033 | 3.135 | 1.118 | -0.497 | 2.639 | 0 | 5.024 |
| growth | 2746 | 0.1346 | 0.1175 | 0.6926 | 2.353 | 55.593 | -7.122 | 9.727 |
| origin | 3544 | 0.913 | 1 | 0.281 | -2.939 | 9.638 | 0 | 1 |

**Notes**. leverage is log of the ratio of total debt to total assets, leverage_long is the log of leverage based on long term debt, liquidity is log of the ratio of cash holdings to total assets; lsize is log of firm size measured by total assets; ltang is long of tangibility measured by the ratio of fixed assets to total assets; lage is log of age of the firm; growth is annual sales growth measured by log difference;origin is the dummy for the origin of the firm.;

## 5.4 Empirical Method

To investigate the effects of financial development on firm level total factor productivity the paper follows a two stage method in line with Gatti and Love (2008), Gomis and Khatiwada (2016) and Chen and Guariglia (2013). In the first stage, the study estimated the production function and uses the residual as the measure of firm level total factor productivity. Then, in the second stage, firm level total factor productivity is regressed on a set of explanatory variables including measures of financial development.

### 5.4.1 Production Function Estimation and Specification Issues

Total factor productivity is derived as the residual from the production function in line with the concept of Solow residuals. Assuming the Cobb-Douglas production function with two input factors, the production function is specified as follows,

$$y_{it} = \beta_0 + \beta_1 l_{it} + \beta_2 k_{it} + e_{it} \qquad 5.4$$

Where ($y_{it}$ ) is the measure of firm output, $k_{it}$ is the firm capital stock, $l_{it}$ is the labour input. The error term ($e_{it}$) is composed of firm specific efficiency ($w_{it}$) and the unexpected productivity shock ($\mu_{it}$). The equation can be estimated using ordinary least squares (OLS) and the logarithm of total factor productivity is calculated as the difference between the actual output and the predicted output. This method is criticised in the literature for being plagued with a number of econometric and specification issues such as simultaneity bias, sample selection, omitted price bias and multiproduct firms (Pavcnik, 2002; Madina-Badia and Slootmaers, 2009; Van Bereven, 2010). The error term in the production function comprises two parts, the productivity shock which is observable by the firm but not by the econometrician and the unpredictable zero mean shocks to productivity after the inputs have been chosen. First, simultaneity bias occurs because there is a potential correlation between unobserved productivity and firms input decisions. If more productive firms hire more workers due to higher current and expected future profitability, the OLS will provide upward biased estimates on the input coefficients. The panel data fixed effects estimation method can be exploited to address the simultaneity problem because it assumes that the unobserved firm specific efficiency is time invariant.

Second, sample selection bias arises because firms with larger capital stocks can expect larger future returns for any given level of current productivity and will continue in operation for lower levels of productivity levels, thereby leading to negative bias in the OLS capital coefficient. Eberhardt and Helmers (2010) point out that firm exit may be a function of unobserved productivity and observed capital stocks, implying that exits are likely to be firms with low capital and low productivity. Conversely, firms that survive are those with high capital or high productivity.

Last, the omitted price variable arises due to the use of industry level price indices for deflating firm level sales and input expenditures due to the unavailability of firm level prices for researchers (De Loeker, 2007). If firm level price variation is correlated with input choice, using these deflated outputs and inputs will result in biased input coefficients. The last issue has to do with the fact that firms are producing more than one product with different technologies (Bernard et al., 2010). Production decisions are made at a more disaggregated level than the one that data is reported. If a firm produces multiple products in the same industry and if they differ in their production technology the estimated coefficients are likely to be biased (Van Bereven, 2010).

Several methods have been suggested in the empirical literature as the most appropriate to effectively control the simultaneity and selection bias in the estimation of production function at the firm level. They include Olley and Pakes (1996), Blundell and Bond (1999), Levinsohn and Petrin (2003) and Ackerberg et al (2006). This chapter adopts Levinsohn - Petrin (LP) which is the semi-parametric method that use intermediate input as the proxy for productivity shocks as opposed to Olley and Pakes (OP) which uses capital and investment. The Levinsohn - Petrin procedure improves the Olley and Pakes procedure by relaxing some of the assumptions in the latter framework and its popularity has to a large extent been boosted by the availability of data (Modina-Badia and Slootmaers, 2009). While Olley and Pakes procedure relies on firm investments which are rarely available, Levinsohn - Petrin (LP) procedure uses intermediate inputs which can be found directly from the income statement. However, subsequently Levinsohn-Petrin procedure has also been critiqued for its identification leading to Ackerberg et al (2006).

The following paragraphs describe the Levinsohn-Petrin procedure. It assumes that the firm specific efficiency ($w_{it}$) evolves according an exogenous Markov process in which the firm decides whether to continue operations or to exit. When it decides to continue the firm chooses the input variables labour, capital and materials. The input demand function depends on capital and the known productivity, $m_{it} = (k_{it}, w_{it})$. $m_{it}$ is assumed to be monotonically increasing in $w_{it.}$ Therefore, $w_{it}$ can be obtained by inverting the input function and it becomes a function of intermediate inputs.

$$w_{it} = m_t^{-1}(m_{it}, k_{it}) = \varphi_t(m_{it}, k_{it}) \qquad 5.5$$

This can be substituted into the production function in equation 5.4,

$$y_{it} = \beta_0 + \beta_1 l + \theta_t(m_{it,} k_{it}) + \mu_{it} \qquad 5.6$$

Where,

$$\theta_t(m_{it}, k_{it}) = \alpha + \beta_2 k_{it} + \varphi_t(m_{it}, k_{it}) \qquad 5.7$$

Either gross output or value added can be used in the equation. If value added is used as the measure of output the functional form can be approximated by a third order polynomial expansion in $m_{it}$ and $w_{it}$ (Petrin, et al, 2004). Value added has been used in a number of studies mainly because of data limitations, however, it may exaggerate the total factor productivity heterogeneity.[20] Once the model has been estimated, total factor productivity ($TFP_{it}$) can be calculated as the residual of equation 5.4.

### 5.4.2 Total Factor Productivity-Finance Model

In the second stage, the study follows Chen and Guariglia (2013), Gatti and Love (2008), Thangavelu and Chongvilaiven (2013), Gomis and Khatiwada (2016)) and specify the empirical model to assess the relationship between firm total factor productivity and measures of financial development as follows:

$$\begin{aligned} LTFP_{it} &= \alpha_0 + \alpha_1 LEVERAGE_{it} + \alpha_2 LEVERAGE^2{}_{it} + \alpha_2 LIQIUDITY_{it} + \alpha_3 SIZE_{it} \\ &+ \alpha_4 TANG_{it} + \alpha_5 AGE_{it} + \alpha_6 GROWTH_{it} + \alpha_7 ORIGIN_i + \alpha_8 INDUS_i + \varepsilon_{it} \end{aligned} \qquad 5.8$$

where $LTFP_{it}$ is firm $i$ log of total factor productivity at time $t$ and $\varepsilon_{it}$ is the error term. The explanatory variables of interest are leverage ($LEVERAGE_{it}$) and liquidity ($LIQUIDITY_{it}$) which are key financial development indicators. In line with Avarmaa et al. (2013) the square of leverage is included in the specification to capture the non-linearity of the relationship between productivity and leverage. Other explanatory variables included in the model are tangibility ($TANG_{it}$), firm age ($AGE_{it}$), firm size ($SIZE_{it}$), sales growth ($GROWTH_{it}$), origin dummy ($ORIGIN_i$) and industry dummies ($INDUS_i$).

The expected sign on leverage may be either positive or negative due to the posited non-linear relationship with productivity. Access to external funds may provide firms with an

[20] Assumptions under which value added should be used include that it does not take into account other inputs other than labor and capital. At least one of labor and capital should be static. There is no unpredicted production disturbance. The measurement error affect the output and value added in the same way.

opportunity to invest in highly productivity projects which they may not afford if they only had internal funds. Firms may not necessarily use debt amounts for productivity enhancing projects. The sign on liquidity is expected to be positive, indicating that the availability of internal funds has positive effect on productivity (Chen and Guariglia, 2013). Firm age is expected to bear a negative sign indicating that younger firms are more productive than their older counterparts. Firm size is expected be positive indicating that larger firms are able to capture the economies of scale to bolster their productivity levels (Van Biesebroeck, 2005). Sales growth is expected to be positive indicating that firms high growth firms have to continuously improve on their productivity. Tangibility is expected to have a negative coefficient indicating that a firm investment on fixed assets is likely to occur at the cost of productivity enhancing investments (Chen and Guariglia, 2013). Origin dummy is included to capture the effect of foreign origin. The expected sign is positive indicating that firms with foreign linkages are expected to be productive as they are expected to have access to more resources. Industry dummies are expected to reflect the differences in the industries. Amongst other things the differences may be due to capital requirement and technology.

The model is estimated using panel data models pooled ordinary least squares (OLS), fixed effects and random effects. Panel data models are preferred because they are able to take into account the unobserved individual firm heterogeneity that may be correlated with the explanatory variables and this may bias the estimates.

Formally deriving the panel data model, the general linear model is specified as follows:

$$y_{it} = \alpha_{it} + X_{it}^{'}\beta + u_{it} \qquad 5.9$$

where $y_{it}$ is the scalar dependent variable, $X_{it}$ is a vector of independent variables, $u_{it}$ is the scalar of disturbance term, $i$ indexes firms in the cross section and $t$ indexes time. To make the model estimatable, some restrictions are imposed on $\alpha_{it}$, $\beta_{it}$ and the behavior of $u_{it}$. The pooled model assumes that the regressors are exogenous and the error term is not decomposed as below:

$$y_{it} = \alpha + X_{it}^{'}\beta + u_{it} \qquad 5.10$$

Then, allowing for individual specific effects results in the fixed effects model presented by the following equation;

$$y_{it} = \alpha_i + X_{it}^{'}\beta + \varepsilon_{it} \qquad 5.11$$

where $\alpha_i$ are random individual-specific effects and $\varepsilon_{it}$ is an idiosyncratic error. The model assumes that the unobserved random effects are not related to the explanatory variables. The fixed effects estimator is not a panacea as it also has some weaknesses (Cameron and Trivedi, 2005). Specifically, it does not allow for estimation of time invariant coefficients. Relaxing the assumptions allows for potential correlation of the unobserved effects with the observed regressors resulting with the random effects model. The random effect model assumes that the unobservable individual effects are random variables that are distributed independently of the explanatory variables. The Hausman tests should be used to test for the appropriate model, because if the individual effects are fixed, the fixed effects estimator is consistent but random effects estimator is inconsistent (Cameron and Trivedi, 2005).

## 5.5 Empirical Results

### 5.5.1 Production Function Estimation

The regression results from estimating the production function in equation 5.4 are presented in Table 5.2. Column 1 shows the main regression results for the Levinsohn - Petrin procedure. The coefficient for capital is 0.64 while that of labour input is positive at 0.31 and is statistically significant at 1 per cent level. To see whether the Levinsohn - Petrin procedure has successfully dealt with the simultaneity and sample selection biases, we compare the coefficients with that of the OLS regression. Comparing the logarithm of capital coefficients, the one from Levinsohn - Petrin based production function is higher than 0.61 found in the OLS. According to Levinsohn et al. (2003), there is no prior expectation on the direction of the bias as it depends on the degree of correlation among inputs and the productivity shocks. The magnitude of the coefficient of labour is lower compared to that of the OLS. This reflects the expected simultaneity bias in the OLS estimation, suggesting that it has been corrected. Similar results are observed with the fixed effects estimation results presented in column 3.

The results seems to indicate that companies listed in the JSE use more capital compared to labour and the models fail to reject the null hypothesis of constant returns to scale. One way to verify the coefficients is to compare with those from the already existing studies. Arora and Bhundia (2003) estimated shares of capital and labour as 0.7 and 0.8 in the period 1995-

2003. Therefore, it can be argued that the estimated production function represents the case of South Africa and the estimated residuals can be used as estimates of total factor productivity in South Africa.

**Table 5.2 Production Functions Regression Results**

| VARIABLES | Model 1<br>Levinsohn Petrin Procedure | Model 2<br>Ordinary Least Squares | Model 3<br>Fixed Effects |
|---|---|---|---|
| lcapital | 0.645***<br>(0.0981) | 0.611***<br>(0.0314) | 0.610***<br>(0.01) |
| llabour | 0.317***<br>(0.04) | 0.392***<br>(0.0327) | 0.273***<br>(0.013) |
| Constant | | -0.368**<br>(0.170) | 1.152***<br>(0.19) |
| Industry Dummies | No | Yes | Yes |
| Observations | 1,657 | 2,275 | 2,275 |
| R-squared | n/a | 0.933 | 0.671 |
| Number of newid | n/a | n/a | 383 |

**Notes**: The dependent variable is log of value added. Robust standard errors are reported in brackets. (***): coefficient significant at less than 1 percent; (**): coefficient significant at 5 percent; (*): coefficient significant at 10 percent.

### 5.5.2 Total Factor Productivity –Finance Model

Estimating the total factor productivity-finance model in equation 5.8 gave the results in Table 5.3. The pooled OLS results are reported in Column 1. The robust standard errors are used to address heterogeneity arising from variations in the sizes of the firms in the dataset. The coefficient on leverage is negative and statistically significant at one per cent level, indicating that a one per cent increase in the ratio of debt to total assets will result in 0.15 per cent decline in the firms total factor productivity. The result suggests that more leveraged firms are less productive compared to less leveraged firms. It is not difficult to imagine that high levels of debt may actually be detrimental to the productivity since firms with high level of debt are mainly concerned with repaying the loans than in investing in productivity enhancing investments. A similar result was found by Nicci et al. (2004) in the case of Italy. The coefficient on the quadratic leverage also bears a negative sign and is statistically significant at 1 per cent level. This implies the existence of non-linear effects in the relationship. As expected, the coefficient on liquidity is positive but insignificant. A percentage increase in firm liquidity position leads to 0.01 per cent increase in firm productivity, suggesting that highly liquid firms are more productive compared to the less liquid. It appears that the availability of funds within the firm enables the firm to undertake productivity enhancing projects. The findings are consistent with Chen (2012) and Thangavelu and Chongvilaiven (2013) in China and Vietnam respectively.

Firm size seems to be the only significant control variable in the model. The coefficient of firm size is positive and significant at 10 per cent level, suggesting that larger firms were more productive compared to the smaller ones. Other variables with positive signs were growth and origin. Firm age and tangibility both bore negative signs but are insignificant.

**Table 5.3 Results of Total Factor Productivity and Financial Development**

| Dependent Variable: LTFP | OLS | FIXED EFFECTS | RANDOM EFFECTS |
|---|---|---|---|
| leverage | -0.15*** | -0.18*** | -0.18*** |
| | (0.04) | (0.03) | (0.02) |
| leverage_sq | -0.01*** | -0.01*** | -0.01*** |
| | (0.00) | (0.00) | (0.00) |
| liquidity | 0.015 | 0.01 | 0.02* |
| | (0.013) | (0.01) | (0.01) |
| lsize | 0.03* | -0.09*** | -0.01 |
| | (0.01) | (0.02) | (0.01) |
| ltang | -0.02 | -0.20*** | -0.09*** |
| | (0.02) | (0.02) | (0.01) |
| lage | -0.015 | 0.03 | -1.31e-06 |
| | (0.02) | (0.05) | (0.02) |
| growth | 0.05 | 0.06*** | 0.05*** |
| | (0.04) | (0.01) | (0.01) |
| origin | 0.06 | | 0.19 |
| | (0.16) | | (0.12) |
| Constant | -0.90*** | 0.54** | -0.61*** |
| | (0.29) | (0.24) | (0.20) |
| Industry Dummies | Yes | No | Yes |
| Observations | 1,761 | 1,761 | 1,761 |
| Overall R-squared | 0.094 | 0.100 | 0.098 |
| Hausman Test | | Chi2 64.70(0.00) | |
| Number of newid | | 332 | 332 |

**Notes**: The dependent variable is log of total factor productivity estimated using Levinsohn and Petrin procedure. leverage is log of the ratio of total debt to total assets.liquidity is log of the ratio of liquid assets to total assets; lsize is log of firm size measured by total assets,;ltang is long of tangibility measured by the ratio of fixed assets to total assets; lage is log of age of the firm, growth is annual sales growth measured by log difference; origin is the dummy for the origin of the firm. Robust standard errors are reported in brackets. (***): coefficient significant at less than 1 percent; (**): coefficient significant at 5 percent; (*): coefficient significant at 10 percent.

The OLS estimation results presented in Model 1 in Table 5.3 fails to take into account the unobserved heterogeneity among the firms in our panel. As a result, the fixed and random effects estimators are employed and the results are presented in Model 2 and 3 respectively. The Hausman test indicated that the most suitable model is the fixed effects model, hence our analysis will focus results of the fixed effects model. In general, the fixed effects model results confirm the findings from the OLS regression results. The results show that the coefficient on leverage is negative and significant at 1 per cent level of significance. A percentage increase in leverage leads to 0.18 per cent decline in firm total factor productivity, confirming that debt is detrimental to firm productivity. The magnitude of the coefficient is slightly higher than the 0.15 per cent found for the OLS estimates. The quadratic leverage is also negative and significant, further supporting the existence of the non-linear relationship. Similar to the OLS, liquidity is found to bear a positive sign but insignificant. A one percent increase in liquidity results in 0.01 per cent increase in the firm productivity. However, in an alternative specification that excludes leverage, liquidity was found to be significant[21].

Some differences are observed when the control variables are compared to the OLS results with firm size and age changing signs. The coefficient on firm size is found to be negative and significant, which is the complete opposite with the OLS. An increase in firm size results in 0.09 per cent decline in productivity, indicating that smaller firms are more productive compared to their large counterparts. This is surprising since we expected large firms to be more productive (Van Biesebroeck, 2005). The coefficient of firm age also changed sign to positive but remained insignificant. The coefficient of tangibility maintained the sign but increased in magnitude from 0.02 per cent in the OLS to 0.20 per cent in the fixed effects, implying that fixed assets have a huge drag on productivity of the firm. As expected, sales growth has a positive and significant coefficient indicating that aggregate demand effects are vital for productivity. The results of the random effects model are similar to the fixed effects except liquidity is found to be significant at 10 per cent significance level.

The results may be affected by the global financial crisis of 2008-09 which occurred during the sample period. In order to control for the global financial crisis a dummy variable capturing the crisis was constructed. The crisis dummy variable takes the value one for the period 2008-2010 and zero otherwise. Including the dummy variable in the estimation model did not change the results that financial sector variables are significant determinants of firm productivity.[22] The results are further emphasized when the broad macroeconomic financial development indicators- stock market capitalization and private sector credit - are used in the model.[23] Overall, the results suggest that putting more focus on the development of the financial sector can help in fostering economic growth.

The results may be sensitive to the measure of leverage used because long term debt can have different effects on firm performance compared to that based on short term debts. In particular, long term debt reflects the companies' ability to provide collateral. Companies

[21] The results are included in the Appendix D4 and Appendix D5.
[22] The results are included in Appendix D9
[23] Appendix D10 shows when stock market capitalization and private sector credit are used as financial development indicators.

with sizable fixed assets tend to access more long term finance than those without. To investigate the effects of the long term based leverage on productivity, a long term debt based measure of leverage is constructed and used in the finance-total factor productivity model. The results are shown in Table 5.4. Both the pooled OLS and fixed effects results effects show that the coefficient on the long-term debt based leverage is negative and statistically significant at 1 per cent. The OLS results presented in column 1 suggests that a unit increase in leverage leads to 0.10 per cent increase in firm total factor productivity. The magnitude of the coefficient is smaller than in the case of overall leverage. The coefficient on the square of leverage is also negative and statistically significant. This reaffirms the earlier result that supported the existence of the quadratic relationship between productivity and leverage. Interestingly, the coefficient of liquidity yielded a positive and significant coefficient of 0.02. The specification also controlled for firm size, age, tangibility, growth and origin. The results of the fixed effects and random effects models provided similar results. They confirm a significant negative coefficient on leverage and a positive one on liquidity. They also point to the existence of the non-linear relationship between productivity and leverage. The findings are also confirmed by the two way fixed effects results reported in Appendix D6. The significant and negative leverage result is also found when the lagged dependent variable is added in equation 5.8. The results are reported in Appendix D7 for OLS and Appendix D8 for fixed effects and random effects models. However, it should be noted that estimating the lagged autoregressive by OLS biases the estimates upwards and using fixed effects model biases them downwards.

**Table 5.4 Total Factor Productivity and Long Term Leverage**

| **Dependent Variable: LTFP** | **OLS** | **FIXED EFFECTS** | **RANDOM EFFECTS** |
|---|---|---|---|
| leverage_long | -0.10*** | -0.09*** | -0.10*** |
| | (0.03) | (0.02) | (0.02) |
| leverage_longsq | -0.008** | -0.007*** | -0.008*** |
| | (0.003) | (0.002) | (0.002) |
| liquidity | 0.02* | 0.02** | 0.03*** |
| | (0.01) | (0.01) | (0.01) |
| lsize | 0.02 | -0.11*** | -0.01 |
| | (0.01) | (0.02) | (0.01) |
| ltang | -0.001 | -0.21*** | -0.07*** |
| | (0.03) | (0.03) | (0.02) |
| lage | -0.03 | 0.05 | -0.01 |
| | (0.02) | (0.06) | (0.02) |
| growth | 0.05 | 0.06*** | 0.05*** |
| | (0.04) | (0.02) | (0.02) |
| Origin | -0.03 | | 0.11 |
| | (0.14) | | (0.13) |
| Constant | -0.71*** | 0.66** | -0.48** |
| | (0.27) | (0.27) | (0.21) |
| Industry Dummy | Yes | No | Yes |
| Observations | 1,644 | 1,644 | 1,644 |
| R-squared | 0.085 | 0.081 | 0.051 |
| Hausman Test | | Chi2 66.45(0.00) | |
| Number of newid | n/a | 325 | 325 |

**Notes**: The dependent variable is log of total factor productivity estimated using Levinsohn and Petrin procedure. leverage is log of the ratio of total debt to total assets.; liquidity is log of the ratio of liquid assets to total assets; lsize is log of firm size measured by total assets; ltang is long of tangibility measured by the ratio of fixed assets to total assets; lage is log of age of the firm; growth is annual sales growth measured by log difference; origin is the dummy for the origin of the firm.; Robust standard errors are reported in brackets. (***): coefficient significant at less than 1 percent; (**): coefficient significant at 5 percent; (*): coefficient significant at 10 percent.

### 5.5.4 Endogeneity

The estimated results are likely to suffer from potential endogeneity between total factor productivity and leverage because more productive firms are likely not to use external finance as they are able to generate sufficient profits. Again, the firm's innovative activities can directly influence its decision to acquire external finance. To address endogeneity problem, the study follows Ghosh (2009) and Coricelli et al (2012) by using the two-step approach. In the first stage, the exogenous variation in leverage caused by factors that do not influence total factor productivity is identified and the model for the determinants of leverage is estimated and the fitted values are generated. Using the exogenously driven variation of leverage in the model help addresses the endogeneity problem between total factor productivity and leverage. The fitted values are correlated to leverage making then qualify for being a good instrument.  In the second stage, the fitted values are used to instrument leverage in the model for total factor productivity.

Following Ghosh (2009) and Coricelli et al. (2012), the determinants of leverage model is specified as follows,

$$\begin{aligned} LEVERAGE_{it} = \beta_0 + \beta_1 ASSETS_{it-1} + \beta_2 AGE_{it-1} + \beta_3 PROFIT_{it-1} + \beta_4 INTANGIBLES_{it-1} \\ + \beta_5 LSTMARKET_{it-1} + \mu_i + \varepsilon_{it} \end{aligned} \quad 5.12$$

Where $LEVERAGE_{it-1}$ is the log of leverage, $ASSETS_{it-1}$ is the log of assets, $PROFIT_{it-1}$ is the log of profitability, $INTANGIBLES_{it-1}$ is the log of share of intangible assets to total assets, $LSTMARKET_{it-1}$ is the log of the ratio of stock market capitalisation to GDP, $\mu_i$ is the fixed specific effects and $\varepsilon_{it}$ is the error term. The ratio of stock market capitalization is an indicator of financial development which indicates the size of the stock market relative to the size of the economy. The expected sign may be either negative or positive depending on how firms respond to the availability of additional sources of funds. Overall, the choice of the explanatory variables in the model is informed by theory and previous empirical research. The explanatory variables are all lagged by one year to address simultaneity problem because firms cannot predict their productivity one year in advance.

Estimating the determinants of leverage model gave the results in Table 5.5. As expected, the coefficient of firm size is positive and statistically significant, indicating that large firms have higher leverage. This is because large firms have low chances of default and as a result lenders are willing to provide them with funding. The coefficient of age is negative and insignificant. Empirical evidence is quite mixed on the sign of age variable on leverage. Profitability is found to be negative and statistically significant, indicating that more profitable firms are less indebted. Profitable firms use internal finances in the form of retained earnings before they seek external funds. The share of intangibles is positive but insignificant. The ratio of stock market capitalisation to GDP bears a negative sign and is significant indicating that improvement in the stock market conditions reduces firm's appetite for debt. Overall, the results confirm the empirical results in South Africa on the leverage model (Ramjee and Gwatidzo, 2012; Danso and Adamako, 2014). Then, the estimated fitted values of leverage can be used as instruments in the total factor productivity - finance model.

**Table 5.5 Determinants of Leverage Model**

| DEPENDENT VARIABLE: LEVERAGE | FIXED EFFECTS |
|---|---|
| Log of size(-1) | 0.11** |
| | (0.04) |
| Log of age(-1) | -0.12 |
| | (0.11) |
| Log of profitability(-1) | -0.18*** |
| | (0.04) |
| Log of share of intangible(-1) | 0.03 |
| | (0.02) |
| Log of stock market(-1) | -0.20** |
| | (0.09) |
| Constant | -2.60*** |
| | (0.66) |
| Observations | 1,509 |
| Number of newid | 330 |
| R-squared | 0.035 |

**Notes**: The dependent variable is log leverage; leverage is log of the ratio of total debt to total assets.; lsize is log of firm size measured by total assets; ltang is long of profitability measured by the ratio of fixed assets to total assets; lage is log of age of the firm; log of share of intangible is the log of the ratio of intangible assets to total assets; Log of stock market is the log of the ratio of stock market capitalisation to GDP. (***): coefficient significant at less than 1 percent; (**): coefficient significant at 5 percent; (*): coefficient significant at 10 percent.

Table 5.6 shows the estimation results total factor productivity - finance model in equation 5.2 with instruments. The results show that there is a negative relationship between firm's total factor productivity and the financial development indicator. A percentage increase in leverage result in about 0.44 per cent decline in total factor productivity, implying that more leveraged firms tend to be less productive. This suggests that debt has detrimental effects on productivity.

**Table 5.6 Total Factor Productivity and Leverage Model Regression Results**

| Dependent Variable: LTFP | FIXED EFFECTS IV |
|---|---|
| leverage_fitted | -0.44*** |
| | (0.07) |
| lsize | -0.07*** |
| | (0.02) |
| ltang | -0.06** |
| | (0.03) |
| lage | 0.16** |
| | (0.06) |
| growth | 0.22*** |
| | (0.03) |
| Constant | -0.30 |
| | (0.32) |
| Industry Dummies | No |
| Observations | 1,386 |
| Number of newid | 295 |
| Overall R-squared | 0.098 |

**Notes**: The dependent variable is logarithm of total factor productivity estimated using Levinsohn and Petrin procedure. Leverage is log of the ratio of total debt to total assets; lsize is logarithm of firm size measured by total assets; ltang is long of tangibility measured by the ratio of fixed assets to total assets;lage is log of age of the firm; growth is annual sales growth measured by log difference; Robust standard errors are reported in brackets. (***): coefficient significant at less than 1 percent; (**): coefficient significant at 5 percent; (*): coefficient significant at 10 percent.

## 5.6 Conclusions

Using the unique panel of companies listed in South Africa during the period 2000–10, the chapter explored the relationship between total factor productivity and financial development. The study followed the two stage methodology. In the first stage, total factor productivity was determined as a residual from the estimation of the production function. The estimation of the production function at the firm level is likely to suffer a number of econometric problems such as simultaneity and selection bias. To address these issues the Levinsohn and Petrin semi-parametric methodology is used because it handles simultaneity and selection bias with minimum data requirement. In the second stage, the total factor productivity model is specified with firm and industry characteristics, and augmented with financial development indicators. Leverage and liquidity are used as the most appropriate indicators of financial development.

The results show that leverage is negatively related to productivity. This indicates that low leveraged firms tend to be more productive compared to the high leveraged. Moreover, liquidity is found to be positively related to firm productivity, suggesting that firms that have sufficient levels of cash available are able to invest in productive projects, such as research and development. The specification also controlled for firm size, age, tangibility, growth and origin. Testing for robustness, the findings hold even after using alternative measure of leverage, which focuses on long term debt and takes into account the global financial crisis. This is also confirmed by the use of the fixed effects instrumental variable which addresses the possible endogeneity between leverage and firm total factor productivity. Overall, the findings support the proposition that total factor productivity channel is valid. This supports the evidence by Nucci et al (2004), Gatti and Love (2008) and Chen and Guariglia (2013).

Finally, the study contributes to the strand of economic literature on finance and economic growth that employs firm level data. To our best knowledge, no other study has presented evidence on the effectiveness of the productivity channel in South Africa using firm level data.

# Chapter Six: Conclusions

## 6.1 Summary of Findings

In order for developing countries to attain the medium term objective of sustainable economic growth the healthy industrial sector is vital. This makes it important to understand the dynamics of firm survival and growth. However, most of the empirical evidence has been on developed countries, with very little attention paid to developing countries because of data limitations. The analysis of the changing firm size distribution requires a panel of firm level data which are generally unavailable in most developing countries. This thesis set out to investigate the relationship between firm growth, survival and total factor productivity in South Africa. It uses the unique firm level panel data covering the period 2000–2010. The thesis has three specific objectives: (1) to investigate the relationship between firm growth and size, (2) to empirically investigate the main drivers of firm's survival among the listed firms in South Africa, and (3) to assess the link between firm finance and total factor productivity.

The thesis contributes to the industrial organisation literature in developing countries. The contributions are threefold. First, it tests the validity of the Law of Proportionate Effects and investigates the factors that explain firm survival using the unique dataset constructed on firms listed in the stock exchange in South Africa. There has been little evidence from developing countries due to the unavailability of appropriate firm level data. Second, by investigating the link between finance and firm productivity the study established the role that financial sector development can play in fostering economic growth. South Africa has relatively sophisticated financial systems, but it has not achieved the robust economic growth as expected. As such, this thesis brings to fore new evidence on the effects of financial sector development on firm total factor productivity. Last, the thesis employs micro econometrics methods such as survival analysis and panel estimators on the firm level data, which have not been extensively used in developing countries.

Chapter three investigated the evolution of size distribution over time and tests the validity of Gibrat's Law in South Africa. Analysing the patterns in non-survival using sales, it is found that takeover is the main cause of death for 2005–10 and the results varied across the size classes, with the highest proportions in the R1-2 billion and R4-5 billion groups. Just under half of all non-survivors in the smallest size category were taken over, implying that the current small firms will never become large firms in future. However, it is not clear whether takeover improves the overall efficiency or reduces potential competition. Large firms may takeover promising small firms to reduce future competition. Using both informal and formal methods to investigate the relationship between firm size and growth, the study found that firm growth among listed companies has not been completely random. Smaller firms have been growing relatively faster than larger firms and, in the small category, it was the very smallest that were growing the fastest. There was some variation across sectors, with LPE not rejected for the primary sector. Thus, the chapter suggests that growth of firms in South Africa is not random as the smallest are the ones registering high growth but the small firms have low survival rates. This is similar to evidence from other BRICS countries such as Ribeiro (2007) for Brazil and Zhang et al (2009) for China.

Chapter four empirically investigated the survival patterns among JSE listed companies and evaluated the main determinants of a firm's survival. The results from using the Kaplan-Meier product limit to investigate the survival patterns in South Africa indicate that, overall, about 50 per cent of the companies listed in the JSE survive up to 10 years. It is noted that comparison of the survival patterns across countries is very difficult due to the differences in sample period, duration and coverage of the sample. The results also show that there are significant differences between the survival functions across the groups within the explanatory variables in all variables except age and origin of the firm. The survival functions for size, age, leverage, profitability and economic sectors groups are significantly different. Estimating the survival model using logit regression model show that large, high profitability and high leverage firms operating in the primary sector are expected to have higher survival chances among the JSE listed companies. This emphasises the importance of firm size and the robust financial sector on firm survival.

Finally, chapter five explored the link between financial development and firm productivity. Productivity plays an important role in firm dynamics. Measuring firm productivity from the Solow residuals and financial development using leverage and liquidity, the findings show that leverage is detrimental to firm productivity. This indicates that that low leverage firms are more productive compared to the high leverage. This suggests that high leveraged firms are concerned with debt reduction than productivity enhancing activities. Moreover, low liquid firms are found to be less productive compared to high liquid firms. High liquid firm are able to invest in productive projects such as research and development. The results are found to be robust to alternative measure of leverage which focuses on long term debt and broad financial development indicators. The long term debt based leverage produced consistent results. The financial development indicators had positive and significant effect on total factor productivity. This reaffirms the existence of a strong influence of finance on total factor productivity. The results suggest that the productivity channel is effective for financial development to influence economic growth in South Africa.

## 6.2 Policy Recommendations

The findings from this thesis provide some valuable policy implications for the South African economy. The finding that the death rate is high among the small firms and size was an important determinant of firm survival raises a number of policy questions. The main cause of firm death was found to be takeover. It is clear that smaller firms are more vulnerable to death and this may have adverse implications for the overall economic growth. As proposed in the National Development Plan, South African government has put more emphasis on small firms as a vehicle towards job creations. The recent up-grading of the department of small enterprises to the level of the ministry bears testimony to that. Despite this, the results imply that while small firms may be able to create jobs, they would not be able to deliver sustainable jobs. Therefore, there is a need to create a balance between small and large firms in job creation. More efforts should be directed towards developing policies that can help small firms to survive longer.

The overall rejection of Gibrat's Law among listed companies in South Africa implies that firm growth has not been completely random. Instead, smaller firms have been growing relatively faster than larger firms and, in the small category, it was the very smallest that were growing the fastest. While there are debates on the merits of the emphasis, the current study advocates for more efforts to be directed towards supporting smaller firms and improving the general business environment. Another implication is that future large firms will never realise that dream. This raises an important question on the motivations of takeovers in South Africa. Are takeovers used as an instrument to eliminate future competition or to enhance the overall efficiency of the industry? The Competition Commission of South Africa is already tasked with ensuring that uncompetitive practices are eliminated. Hence, more support may be warranted.

The finding that large, high profitability and high leverage firms operating in the primary sector are expected to have higher survival chances suggests that the financial sector plays an important role in firm survival. The implication is that the well-functioning financial sector plays an important role in firm survival. As a result, enhancing access to funds particularly for smaller firms may go a long way towards reducing high failure rate.

The results suggest that productivity channel is effective for financial sector development and can promote economic growth in South Africa. While the channel is indirect, empirical literature indicates that productivity growth can lead to sustainable long term economic growth. The policy implication is that more effort should be geared towards financial sector development. However, given that the financial sector in South Africa is already in an advanced stage, the concerns may be in relation to inclusiveness. The negative square of leverage may need further investigation. This investigation would be possible with a larger sample that will allow disaggregation of the panel by leverage levels. In this regard, investigating innovation activities by the South African JSE listed companies and how they link with productivity and financial position will shed more light on the determinants of firm productivity.

## 6.3 Study Limitations and Scope for Future Research

Future research may focus on expanding the sample of firms to cover the non-listed companies. While the current sample represents the largest proportion of the productive sector of the South African economy and to a large extent resembles the structure of the corporate sector, a larger sample may provide some interesting results. Moreover, the increased coverage would allow for aligning the definition of small firms to the South African legislation. The current adopted definition of a small firm is in line with that used in the US and European countries. In the South African context, they may be considered as large firms. The study has shown that takeover seems to be the main cause of death among the listed companies. As a result it may be interesting to investigate the motivations for takeover and acquisitions in South Africa. This would complement the current work and strengthen the type of policy intervention.

The thesis has also raised some issues relating to the innovation activities by the firms which may need further research. The most important channel through which financial development affects productivity is through increased probability for funding innovative projects by firms.

As a result it would be interesting to investigate the innovation activities by the listed companies and link that activity to productivity and financial position (Dabla–Norris et al., 2010). Furthermore, theories in the small firm's literature emphasise the importance of small firms as agents of innovation. The models suggest that small firms are more innovative than large firms. As such, bringing the developing countries experience may contribute to the literature.

In addition, there are other variables that may need to be included in the database to allow for testing of various hypotheses in industrial organisation. The data on a firm's participation in international trade and foreign ownership may be helpful. Firms that are active in international trade are believed to be more productive, grow faster and have better survival chances.

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# A. Appendix for Chapter Two

## Appendix A1: Industrial Classification Benchmark-Industry Structure

| Industry | Sector |
|---|---|
| Oil and Gas | Oil and Gas Producers |
| | Oil Equipment Services and Distribution |
| | Alternative Energy |
| Basic Materials | Chemicals |
| | Forestry and Paper |
| | Industrial Metal and Mining |
| | Mining |
| Industrials | Construction and Materials |
| | Aerospace and Defence |
| | General Industrials |
| | Electronic and Electrical equipment |
| | Industrial Engineering |
| | Industrial Transportation |
| | Support Services |
| Consumer Goods | Automobiles and Parts |
| | Beverages |
| | Food Producers |
| | Household Goods and Home Construction |
| | Leisure Goods |
| | Personal Goods |
| | Tobacco |
| Health Care | Health Care Equipment and Services |
| | Pharmaceuticals and Biotechnology |
| Consumer services | Food and Drug Retailers |
| | General Retailers |
| | Media |
| | Travel and Leisure |
| Telecommunications | Fixed Line Telecommunications |
| | Mobile Telecommunications |
| Utilities | Electricity |
| | Gas, Water and Multi-utilities |
| Financial | Banks |
| | Non-life insurance |
| | Life Insurance |
| | Investments Trusts |
| | Real Estate |
| | Financial Services |
| Technology | Software and Computer services |
| | Technology Hardware and Equipment |

## Appendix A2: Diversification Indicator for SADC countries

| Country | Product I | Product II | Product III | No of Products accounting for 75 per cent | Diversification Index |
|---|---|---|---|---|---|
| Angola | Petroleum oils and oils obtained from bituminous minerals, crude (94,0%) | | | 1 | 1.1 |
| Botswana | Diamonds non-industrial unworked or simply sawn, cleaved or bruted (76,0%) | Diamonds, non-industrial other than unworked./simply sawn/cleaved/bruted (6,5%) | Nickel mattes (6,4%) | 1 | 1.7 |
| Congo, Dem. Rep. | Cathodes and sections of cathodes (39,3%) | Copper ores and concentrates. (22,6%) | Petroleum oils & oils obt. from bituminous minerals, crude (16,2%) | 3 | 4.2 |
| Lesotho | Diamonds, non-industrial, simply sawn/cleaved/bruted (32,2%) | Men's/boys' trousers, bib & brace overalls, breeches & shorts (12,3%) | Synthetic fibres (7,3%) | 13 | 7.6 |
| Madagascar | Nickel (18,5%) | Vanilla (6,8%) | Shrimps & prawns (5,2%) | 26 | 18.6 |
| Malawi | Tobacco, partly/wholly stemmed/stripped (54,5%) | Tea, black (fermented) & partly fermented tea, whether or not flavoured (8,1%) | Cane sugar, raw, in solid form, (7,6%) | 5 | 3.2 |
| Mauritius | Tunas, skipjack & bonito (15,2%) | Cane/beet sugar & chemically pure sucrose (11,9%) | Men's/boys' shirts (excl. knitted or crocheted), of cotton (6,8%) | 36 | 18.9 |
| Mozambique | Aluminium, not alloyed, unwrought (26,7%) | Light oils and preparations (13,4%) | Bituminous coal, whether or not pulverised but not agglomerated (7,3%) | 10 | 9.2 |
| Namibia | Diamonds non-industrial unworked or simply sawn, cleaved or bruted (20,2%) | Fish fillets (7,8%) | Zinc, not alloyed, unwrought (6,1%) | 19 | 15.1 |
| Seychelles | Tunas, skipjack & bonito (56,7%) | Yellowfin tunas (8,4%) | Bigeye tunas (8,2%) | 4 | 2.9 |
| South Africa | Gold (incl. gold plated with platinum), in unwrought forms (excl. powder) (16,6%) | Iron ores & concentrates (excl. roasted iron pyrites), non-agglomerated (9,9%) | Platinum, unwrought/in powder form (8,2%) | 35 | 19.1 |
| Swaziland | Mixtures of odoriferous subs. & mixts. (incl. alcoholic solutions) (25,7%) | Cane sugar, raw, in solid form, not cont. added flavouring/colouring matter ... (16,9%) | Other chemicals products & preparations of the chemical/allied industries(10,5%) | 20 | 9 |
| Tanzania | Tobacco, partly/wholly stemmed/stripped (9,9%) | Gold (incl. gold plated with platinum), in unwrought forms (excl. powder) (7,7%) | Coffee, not roasted, not decaffeinated (5,3%) | 28 | 26.4 |
| Zambia | Cathodes and sections of cathodes (63,6%) | Tobacco, partly/wholly stemmed/stripped (4,3%) | | 5 | 2.4 |
| Zimbabwe | Tobacco, partly/wholly stemmed/stripped (36,3%) | Containing by weight more than 4 % (7,0%) | Precious metal ores & concentrates (6,4%) | 14 | 6.7 |

Source: African Economic Outlook

# B. Appendix for Chapter Three

## Appendix B1: Heckman Maximum Likelihood Estimations

| **Period: 2005-2010** | | | | | | survival2010 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dependent Variable: Log of Sales in 2000** | N | ls2005 | | Constant | | ls2005 | | ls2005sq | | Constant | | athrho | | lnsigma | | Wald(Beta=1) | |
| ALL | 377 | 0.726*** | (0.02) | 4.872*** | (0.39) | -0.761*** | (0.13) | 0.0326*** | (0.00) | 4.838*** | (0.786) | -1.339*** | (0.18) | 0.270*** | (0.05) | 89.88 | 0 |
| SMALL | 105 | 0.458*** | (0.12) | 7.811*** | (1.27) | -0.360 | (0.35) | 0.0179 | (0.02) | 2.164 | (1.513) | -1.582*** | (0.41) | 0.775*** | (0.12) | 17.71 | 0 |
| MEDIUM | 207 | 0.769*** | (0.06) | 4.114*** | (0.90) | 0.649 | (1.70) | -0.0202 | (0.06) | -4.398 | (11.49) | -1.353*** | (0.19) | 0.0110 | (0.06) | 11.96 | 0 |
| LARGE | 65 | 0.955*** | (0.07) | 1.151 | (1.25) | -19.17*** | (0.50) | 0.561*** | (0.02) | 165.0 | (0.0) | 14.10 | (410.4) | -0.791 | (0.10) | 0.35 | 0.55 |
| PRIMARY SECTOR | 57 | 0.958*** | (0.06) | 1.267 | (0.90) | -0.135 | (0.54) | 0.0171 | (0.02) | -0.242 | (3.054) | -0.001 | (0.32) | -0.0954 | (0.10) | 0.47 | 0.49 |
| SECONDARY SECTOR | 128 | 0.764*** | (0.04) | 4.180*** | (0.58) | -1.320*** | (0.35) | 0.0572*** | (0.01) | 8.188*** | (2.049) | -1.061*** | (0.32) | 0.0882 | (0.08) | 30.77 | 0 |
| SERVICES SECTOR | 192 | 0.691*** | (0.04) | 5.529*** | (0.59) | -0.693*** | (0.17) | 0.0286*** | (0.00) | 4.436*** | (1.085) | -1.651*** | (0.25) | 0.408*** | (0.07) | 49.15 | 0 |
| MANUFACTURING | 111 | 0.753*** | (0.04) | 4.256*** | (0.56) | -1.695*** | (0.33) | 0.0725*** | (0.01) | 10.37*** | (1.955) | -1.398** | (0.57) | -0.0623 | (0.09) | 37.63 | 0 |
| BASIC MATERIAL | 55 | 0.956*** | (0.06) | 1.295 | (0.99) | -0.159 | (0.55) | 0.0188 | (0.02) | -0.246 | (3.107) | -0.00160 | (0.32) | -0.0733 | (0.10) | 0.43 | 0.51 |
| INDUSTRIALS | 93 | 0.701*** | (0.05) | 5.052*** | (0.74) | -1.440*** | (0.51) | 0.0644*** | (0.02) | 8.622*** | (2.799) | -1.212*** | (0.31) | 0.163* | (0.09) | 28.48 | 0 |
| CONSUMER GOODS | 34 | 0.928*** | (0.03) | 1.520*** | (0.55) | -1.078 | (0.74) | 0.0517 | (0.03) | 5.738 | (4.243) | 0.320 | (0.50) | -0.600*** | (0.14) | 3.98 | 0.05 |
| CONSUMER SERVICES | ..... | ...... | ..... | ..... | ...... | ...... | ....... | ....... | ....... | ....... | ....... | ....... | ....... | ...... | ...... | ...... | ...... |
| TECHNOLOGY | 29 | 0.791*** | (0.11) | 3.880*** | (1.46) | -4.627** | (2.21) | 0.186** | (0.09) | 28.76** | (13.07) | -1.291 | (1.11) | 0.0450 | (0.26) | 3.2 | 0.07 |
| FINANCIALS | 94 | 0.683*** | (0.06) | 5.640*** | (0.85) | -0.795** | (0.33) | 0.0329** | (0.01) | 4.931** | (2.040) | -2.111*** | (0.48) | 0.552*** | (0.10) | 22.87 | 0 |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

## Appendix B2: Heckman Maximum Likelihood Estimations

| **Period: 2000-2005** | | | | | | survival2005 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dependent Variable: Log of Sales in 2000** | | | | | | | | | | | | | | | | | |
| | N | ls2000 | | Constant | | ls2000 | | ls2000sq | | Constant | | athrho | | lnsigma | | Wald(Beta=1) | |
| ALL | 495 | 0.780*** | (0.03) | 4.374*** | (0.521) | -0.605*** | (0.100) | 0.0261*** | (0.004) | 3.430*** | (0.614) | -1.97*** | (0.146) | 0.647*** | (0.052) | 31.03 | 0 |
| SMALL | 160 | 0.569*** | (0.12) | 4.449*** | (1.215) | 0.222 | (0.404) | -0.0172 | (0.024) | -0.441 | (1.633) | 0.19 | (0.487) | 0.653*** | (0.097) | 12.35 | 0.0 |
| MEDIUM | 281 | 1.152*** | (0.07) | -1.647 | (1.235) | -4.616** | (1.975) | 0.179** | (0.073) | 29.68** | (13.16) | -0.01 | (0.494) | -0.125** | (0.057) | 3.89 | 0.04 |
| LARGE | 54 | 1.156*** | (0.37) | -2.596 | (6.070) | 44.32** | (19.80) | -1.343** | (0.601) | -364.2** | (163.0) | 0.310 | (0.344) | 0.341*** | (0.114) | 0.18 | 0.67 |
| PRIMARY | 64 | 0.619*** | (0.07) | 6.72*** | (1.016) | -0.20*** | (0.04) | 0.01*** | (0.001) | 1.12** | (0.55) | -16.21 | (121.5) | 0.519 | (0.131) | 26.89 | 0.0 |
| SECONDARY | 161 | 0.925*** | (0.07) | 2.306** | (0.981) | -0.687*** | (0.219) | 0.0288*** | (0.009) | 4.123*** | (1.296) | -3.09*** | (0.565) | 0.608*** | (0.0839) | 0.99 | 0.31 |
| SERVICES | 270 | 0.782*** | (0.05) | 4.456*** | (0.743) | -0.851*** | (0.178) | 0.0353*** | (0.007) | 4.967*** | (1.101) | -2.00*** | (0.220) | 0.695*** | (0.0743) | 14.66 | 0.0 |
| MANUFACTURING | 148 | 0.851*** | (0.01) | 3.35 | (0.0) | -0.75*** | (0.0) | 0.03*** | (-0.00) | 4.05 | (0.00) | -15.38 | (30.54) | 0.56*** | 0.0 | 153.33 | 0.0 |
| BASIC MATERIAL | 61 | 0.593*** | (0.07) | 7.04*** | (0.975) | -0.18*** | (0.04) | 0.01*** | (0.00) | (0.92) | (0.59) | -16.81 | (271.2) | 0.52*** | (0.11) | 30.01 | 0.0 |
| INDUSTRIALS | 107 | 0.967*** | (0.09) | 1.790 | (1.263) | -0.788*** | (0.248) | 0.0327*** | (0.0110) | 4.810*** | (1.472) | -3.39*** | (0.838) | 0.595*** | (0.1000) | 0.12 | 0.73 |
| CONSUMER GOODS | 53 | 0.976*** | (0.09) | 0.371 | (1.640) | -1.449 | (1.196) | 0.0648 | (0.0466) | 7.703 | (7.563) | 0.07 | (0.706) | 0.276** | (0.134) | 0.06 | 0.80 |
| CONSUMER SERVICES | ….. | …… | ….. | ….. | …… | …… | ……. | ……. | ……. | ……. | ……. | ……. | ……. | …… | …… | …… | …… |
| TECHNOLOGY | ….. | …… | ….. | ….. | …… | …… | ……. | ……. | ……. | ……. | ……. | ……. | ……. | …… | …… | …… | …… |
| FINANCIALS | 122 | 0.774*** | (0.08) | 4.721*** | (1.101) | -0.708*** | (0.198) | 0.0284*** | (0.00812) | 4.271*** | (1.220) | -2.02*** | (0.338) | 0.878*** | (0.109) | 6.54 | 0.01 |

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

## Appendix B3: Heckman Two Stage Estimations

**Panel 1: 2005-2010**

| **Dependent Variable: Log of Sales in 2005** | ALL | PRIMARY SECTOR | SECONDARY SECTOR | SERVICES SECTOR | BASIC MATERIAL | INDUSTRIALS | CONSUMER GOODS | CONSUMER SERVICES | TECHNOLOGY | FINANCIALS |
|---|---|---|---|---|---|---|---|---|---|---|
| ls2005 | 0.519** | 0.942*** | 0.701*** | 0.516 | 0.940*** | 0.464 | 0.949*** | -17.89 | 0.793*** | 0.633*** |
| | (0.265) | (0.292) | (0.135) | (0.338) | (0.334) | (0.447) | (0.0513) | (2,331) | (0.222) | (0.232) |
| Constant | 9.417* | 1.542 | 5.439** | 10.82 | 1.563 | 9.380 | 1.070 | 483.5 | 4.416 | 8.324* |
| | (5.242) | (4.847) | (2.267) | (7.923) | (5.497) | (7.339) | (0.841) | (59,946) | (2.921) | (4.779) |
| survival2010 | | | | | | | | | | |
| ls2005 | -0.294* | -0.136 | -0.755 | -0.281 | -0.159 | -0.883 | -1.015 | 0.0332 | -3.028 | -0.444 |
| | (0.178) | (0.529) | (0.489) | (0.226) | (0.540) | (0.767) | (0.752) | (0.412) | (2.283) | (0.323) |
| ls2005sq | 0.0169** | 0.0171 | 0.0377* | 0.0142 | 0.0188 | 0.0445 | 0.0487 | 0.00179 | 0.121 | 0.0203 |
| | (0.00745) | (0.0231) | (0.0207) | (0.00932) | (0.0237) | (0.0326) | (0.0319) | (0.0167) | (0.0921) | (0.0133) |
| Mills | | | | | | | | | | |
| Lambda | -5.825 | -0.169 | -2.449 | -7.629 | -0.154 | -5.870 | 0.679 | -457.4 | -2.033 | -5.634 |
| | (4.899) | (2.902) | (2.228) | (8.367) | (3.082) | (7.089) | (0.656) | (57,179) | (2.274) | (5.471) |
| Constant | 1.628 | -0.238 | 4.331 | 1.717 | -0.242 | 4.977 | 5.455 | -0.253 | 19.15 | 2.713 |
| | (1.049) | (2.973) | (2.866) | (1.361) | (3.024) | (4.485) | (4.324) | (2.526) | (14.00) | (1.926) |
| | | | | | | | | | | |
| Wald(Beta=1) | 3.31 | 0.04 | 4.94 | 2.05 | 0.03 | 1.44 | 0.99 | 0 | 0.87 | 2.5 |
| | 0.0688 | 0.8414 | 0.0262 | 0.1523 | 0.857 | 0.2304 | 0.3199 | 0.9935 | 0.3522 | 0.1136 |
| N | 377 | 57 | 128 | 192 | 55 | 93 | 34 | 57 | 29 | 94 |

**Panel 2: 2000-2005**

| **Dependent Variable: Log of Sales in 2000** | ALL | PRIMARY SECTOR | SECONDARY SECTOR | SERVICES SECTOR | BASIC MATERIAL | INDUSTRIALS | CONSUMER GOODS | CONSUMER SERVICES | TECHNOLOGY | FINANCIALS |
|---|---|---|---|---|---|---|---|---|---|---|
| ls2000 | 0.783*** | 0.149 | 0.999*** | 0.853*** | -0.236 | 0.960*** | 0.975*** | 1.633 | -4.296 | 0.817*** |
| | (0.0754) | (1.667) | (0.0812) | (0.0603) | (4.011) | (0.230) | (0.0959) | (1.918) | (69.80) | (0.0993) |
| Constant | 4.982*** | 19.79 | 0.828 | 3.157*** | 28.51 | 2.433 | 0.413 | -14.21 | 103.1 | 4.462** |
| | (1.623) | (42.76) | (1.527) | (1.201) | (100.2) | (4.990) | (1.555) | (43.55) | (1,376) | (1.832) |
| survival2005 | | | | | | | | | | |
| ls2000 | -0.452*** | -0.0854 | -0.803* | -0.700*** | -0.0343 | -0.604 | -1.386 | -0.231 | 0.144 | -0.703** |
| | (0.148) | (0.247) | (0.422) | (0.244) | (0.252) | (0.530) | (1.006) | (0.623) | (1.042) | (0.305) |
| ls2000sq | 0.0224*** | 0.00727 | 0.0365** | 0.0320*** | 0.00537 | 0.0275 | 0.0625 | 0.0137 | 0.00117 | 0.0314** |
| | (0.00628) | (0.0113) | (0.0172) | (0.0101) | (0.0116) | (0.0216) | (0.0400) | (0.0241) | (0.0422) | (0.0130) |
| Mills | | | | | | | | | | |
| Lambda | -2.717** | -13.45 | -0.965 | -1.288 | -19.71 | -2.625 | 0.0596 | 8.618 | -48.89 | -2.624* |
| | (1.181) | (36.85) | (0.991) | (0.850) | (82.03) | (3.677) | (0.838) | (25.98) | (671.5) | (1.533) |
| Constant | 2.193** | 0.178 | 4.364* | 3.691** | -0.150 | 3.396 | 7.288 | 0.734 | -1.887 | 3.834** |
| | (0.869) | (1.319) | (2.576) | (1.447) | (1.344) | (3.235) | (6.247) | (3.983) | (6.375) | (1.748) |
| | | | | | | | | | | |
| Wald(Beta=1) | 8.27 | 0.26 | 0 | 5.98 | 0.09 | 0.03 | 0.07 | 0.11 | 0.01 | 3.41 |
| | 0.004 | 0.6097 | 0.9872 | 0.0145 | 0.7581 | 0.863 | 0.793 | 0.7415 | 0.9395 | 0.0649 |
| N | 495 | 64 | 161 | 270 | 61 | 107 | 53 | 82 | 50 | 122 |

. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1._

# Appendix B4: Heckman Two Stage Estimations

| **Panel 1: 2005-2010** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Dependent Variable: Log of Sales in 2005** | ALL | PRIMARY SECTOR | SECONDARY SECTOR | SERVICES SECTOR | BASIC MATERIAL | INDUSTRIALS | CONSUMER GOODS | CONSUMER SERVICES | TECHNOLOGY | FINANCIALS |
| ls2005 | 0.601*** | 0.911*** | 0.721*** | 0.592* | 0.898*** | 0.556 | 0.950*** | 0.830*** | 0.861*** | 0.679*** |
| | (0.205) | (0.220) | (0.119) | (0.319) | (0.259) | (0.352) | (0.0444) | (0.0846) | (0.116) | (0.120) |
| lage | -0.245 | 0.0491 | 0.0270 | -0.683 | 0.0481 | -0.0137 | -0.128 | -0.656 | -0.788** | -0.00654 |
| | (0.334) | (0.194) | (0.247) | (1.004) | (0.195) | (0.642) | (0.119) | (1.287) | (0.363) | (0.328) |
| Constant | 8.817* | 1.830 | 4.960*** | 12.05 | 2.050 | 7.897 | 1.570*** | 5.781 | 5.078*** | 6.406*** |
| | (4.563) | (3.271) | (1.564) | (10.16) | (3.917) | (5.149) | (0.577) | (5.953) | (1.432) | (2.167) |
| survival2010 | | | | | | | | | | |
| ls2005 | -0.274 | -0.0616 | -0.894* | -0.227 | -0.0812 | -0.967 | -1.365* | -0.00355 | -4.052 | -0.439 |
| | (0.181) | (0.566) | (0.530) | (0.232) | (0.573) | (0.868) | (0.802) | (0.425) | (2.803) | (0.343) |
| ls2005sq | 0.0156** | 0.0145 | 0.0458** | 0.0113 | 0.0157 | 0.0477 | 0.0681* | 0.000337 | 0.159 | 0.0205 |
| | (0.00761) | (0.0245) | (0.0227) | (0.00964) | (0.0249) | (0.0366) | (0.0351) | (0.0173) | (0.115) | (0.0143) |
| lage | 0.320 | 0.701 | 0.203 | 0.337 | 0.611 | 0.404 | -7.909 | -1.108 | 4.436 | 0.779 |
| | (0.325) | (1.677) | (0.644) | (0.416) | (1.683) | (0.697) | (5.848) | (2.172) | (2.925) | (0.490) |
| lagesq | -0.0472 | -0.137 | -0.0859 | -0.0378 | -0.119 | -0.0925 | 1.024 | 0.292 | -0.725 | -0.153* |
| | (0.0567) | (0.259) | (0.113) | (0.0734) | (0.261) | (0.129) | (0.782) | (0.348) | (0.471) | (0.0910) |
| Mills | | | | | | | | | | |
| Lambda | -5.129 | -0.397 | -2.106 | -8.117 | -0.482 | -4.879 | 0.468 | -1.086 | -0.921 | -3.006 |
| | (4.239) | (2.213) | (1.579) | (9.971) | (2.447) | (5.427) | (0.356) | (3.894) | (0.690) | (2.082) |
| Constant | 1.114 | -1.383 | 5.082 | 0.917 | -1.280 | 5.264 | 21.17* | 0.918 | 19.57 | 1.835 |
| | (1.166) | (3.524) | (3.215) | (1.545) | (3.562) | (5.176) | (11.99) | (3.825) | (17.03) | (2.205) |
| Wald(Beta=1) | 3.79 | 0.16 | 5.44 | 1.64 | 0.16 | 1.58 | 1.28 | 4.06 | 1.45 | 7.17 |
| | 0.0516 | 0.6873 | 0.0197 | 0.2004 | 0.6927 | 0.2082 | 0.2573 | 0.0438 | 0.2288 | 0.0074 |
| N | 354 | 53 | 120 | 181 | 51 | 87 | 32 | 54 | 26 | 91 |

| **Panel 2: 2000-2005** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Dependent Variable: Log of Sales in 2000** | ALL | PRIMARY SECTOR | SECONDARY SECTOR | SERVICES SECTOR | BASIC MATERIAL | INDUSTRIALS | CONSUMER GOODS | CONSUMER SERVICES | TECHNOLOGY | FINANCIALS |
| ls2000 | 0.791*** | 0.224 | 0.995*** | 0.859*** | -0.0833 | 0.957*** | 0.955*** | 1.217*** | 1.854 | 0.831*** |
| | (0.0557) | (1.623) | (0.0826) | (0.0563) | (3.943) | (0.183) | (0.102) | (0.317) | (2.858) | (0.108) |
| lage | 0.184 | -0.268 | 0.256 | 0.0456 | -0.0915 | 0.498 | 0.108 | 0.930 | -2.187 | -0.202 |
| | (0.122) | (2.450) | (0.194) | (0.161) | (3.239) | (0.426) | (0.267) | (0.823) | (5.138) | (0.387) |
| Constant | 3.705*** | 19.02 | -0.502 | 2.645** | 25.07 | -0.190 | 0.357 | -7.922 | -9.526 | 5.038** |
| | (1.123) | (46.08) | (1.074) | (1.194) | (101.4) | (2.203) | (1.468) | (7.967) | (35.16) | (2.511) |
| survival2005 | | | | | | | | | | |
| ls2000 | -0.495*** | -0.0490 | -0.925** | -0.787*** | -0.00121 | -0.729 | -1.457 | -0.478 | -0.0849 | -0.686** |
| | (0.152) | (0.250) | (0.438) | (0.258) | (0.254) | (0.559) | (1.022) | (0.690) | (1.054) | (0.314) |
| ls2000sq | 0.0247*** | 0.00557 | 0.0439** | 0.0359*** | 0.00388 | 0.0354 | 0.0663 | 0.0245 | 0.0149 | 0.0303** |
| | (0.00651) | (0.0114) | (0.0180) | (0.0108) | (0.0117) | (0.0230) | (0.0409) | (0.0271) | (0.0430) | (0.0134) |
| lage | -0.732 | 0.527 | -1.420 | -0.721 | 0.369 | -0.743 | -2.256 | -1.773 | -1.410 | -0.0161 |
| | (0.518) | (1.653) | (0.977) | (0.731) | (1.667) | (1.305) | (1.526) | (1.645) | (1.921) | (0.991) |
| lagesq | 0.109 | -0.0725 | 0.164 | 0.127 | -0.0534 | 0.0538 | 0.312 | 0.326 | 0.149 | 0.0169 |
| | (0.0801) | (0.244) | (0.147) | (0.116) | (0.245) | (0.198) | (0.227) | (0.256) | (0.303) | (0.160) |
| Lambda | -1.879** | -12.41 | -0.177 | -0.890 | -17.10 | -1.042 | -0.0616 | 3.350 | 6.370 | -2.845 |
| | (0.753) | (37.90) | (0.674) | (0.709) | (82.99) | (1.698) | (0.722) | (3.320) | (16.55) | (1.798) |
| Constant | 3.504*** | -0.875 | 7.546** | 5.088*** | -0.889 | 5.545 | 11.41* | 4.238 | 1.409 | 3.684* |
| | (1.171) | (3.129) | (3.069) | (1.769) | (3.171) | (3.887) | (6.834) | (4.517) | (6.554) | (2.196) |
| Wald(Beta=1) | 14.05 | 0.23 | 0 | 6.23 | 0.08 | 0.05 | 0.19 | 0.47 | 0.09 | 2.48 |
| | 0.0002 | 0.6326 | 0.9528 | 0.0125 | 0.7835 | 0.8155 | 0.6619 | 0.4937 | 7651 | 0.1156 |
| N | 483 | 63 | 159 | 261 | 60 | 105 | 53 | 81 | 48 | 116 |

. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1._

## Appendix B5: OLS Results with Deflated Prices

| | **Dependent Variable:** | **Continuing Companies,2005-2010** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Log of sales in 2010_n** | **ls2005_n** | | **Constant** | | **N** | **R-squared** | **Wald(beta=1)** | |
| (1) | ALL | 0.805*** | (0.0242) | 2.277*** | (0.227) | 288 | 0.795 | 65.4 | 0.00 |
| (2) | SMALL | 0.468*** | (0.109) | 4.107*** | (0.628) | 70 | 0.214 | 23.9 | 0.00 |
| (3) | MEDIUM | 0.832*** | (0.0594) | 1.900*** | (0.557) | 157 | 0.559 | 7.9 | 0.00 |
| (4) | LARGE | 0.958*** | (0.0670) | 0.712 | (0.831) | 61 | 0.776 | 0.4 | 0.53 |
| (5) | PRIMARY SECTOR | 0.958*** | (0.0547) | 0.760 | (0.558) | 46 | 0.875 | 0.58 | 0.44 |
| (6) | SECONDARY SECTOR | 0.809*** | (0.0381) | 2.228*** | (0.355) | 107 | 0.811 | 25 | 0.00 |
| (7) | SERVICES SECTOR | 0.759*** | (0.0372) | 2.682*** | (0.342) | 135 | 0.758 | 41 | 0.00 |
| (8) | MANUFACTURING SECTOR | 0.811*** | (0.0336) | 2.162*** | (0.324) | 94 | 0.864 | 31.6 | 0.00 |
| (9) | BASIC MATERIAL | 0.956*** | (0.0599) | 0.780 | (0.610) | 44 | 0.859 | 0.53 | 0.46 |
| (10) | INDUSTRIALS | 0.753*** | (0.0518) | 2.797*** | (0.475) | 79 | 0.732 | 22.79 | 0.00 |
| (11) | CONSUMER GOOODS | 0.921*** | (0.0373) | 1.006** | (0.369) | 27 | 0.961 | 4.5 | 0.04 |
| (12) | CONSUMER SERVICES | 0.786*** | (0.0691) | 2.421*** | (0.686) | 40 | 0.773 | 9.63 | 0.00 |
| (13) | TECHNOLOGY | 0.788*** | (0.106) | 2.299** | (0.886) | 20 | 0.754 | 4 | 0.06 |
| (14) | FINANCIALS | 0.721*** | (0.0568) | 2.891*** | (0.496) | 64 | 0.722 | 24.23 | 0.00 |

| | **Dependent Variable:** | **Continuing Companies,2000-2005** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Log of sales in 2010_n** | ls2000_n | | Constant | | N | R-squared | Wald(beta=1) | |
| (1) | ALL | 0.906*** | (0.0321) | 0.972*** | (0.295) | 279 | 0.742 | 8.55 | 0.00 |
| (2) | SMALL | 0.582*** | (0.119) | 2.723*** | (0.710) | 82 | 0.231 | 12.41 | 0.00 |
| (3) | MEDIUM | 1.153*** | (0.0630) | -1.320** | (0.602) | 153 | 0.689 | 5.89 | 0.00 |
| (4) | LARGE | 1.121*** | (0.376) | -1.667 | (4.661) | 44 | 0.175 | 0.1 | 0.7 |
| (5) | PRIMARY SECTOR | 0.740*** | (0.0607) | 2.915*** | (0.585) | 40 | 0.796 | 18.36 | 0.00 |
| (6) | SECONDARY SECTOR | 1.045*** | (0.0608) | -0.461 | (0.571) | 94 | 0.762 | 0.56 | 0.46 |
| (7) | SERVICES SECTOR | 0.902*** | (0.0450) | 1.000** | (0.403) | 145 | 0.738 | 4.72 | 0.03 |
| (8) | MANUFACTURING SECTOR | 0.923*** | (0.0572) | 0.777 | (0.540) | 83 | 0.763 | 1.83 | 0.18 |
| (9) | BASIC MATERIAL | 0.726*** | (0.0660) | 3.008*** | (0.636) | 38 | 0.770 | 17.23 | 0.00 |
| (10) | INDUSTRIALS | 1.101*** | (0.0806) | -0.890 | (0.742) | 64 | 0.750 | 1.56 | 0.21 |
| (11) | CONSUMER GOODS | 0.973*** | (0.0945) | 0.127 | (0.928) | 29 | 0.797 | 0.08 | 0.77 |
| (12) | CONSUMER SERVICES | 1.036*** | (0.0790) | -0.262 | (0.773) | 45 | 0.800 | 0.21 | 0.65 |
| (13) | TECHNOLOGY | 0.700*** | (0.137) | 2.462** | (1.188) | 25 | 0.532 | 4.78 | 0.03 |
| (14) | FINANCIALS | 0.874*** | (0.0701) | 1.239** | (0.592) | 67 | 0.705 | 3.22 | 0.07 |

The table shows the OLS estimates for testing Law of Proportionate Effects for the period 2005–2010 and 2000–2005. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1._n indicates constant prices.

# C. Appendix for Chapter Four

**Appendix C1: Descriptive Statistics**

| Variable | N | Mean | Median | sd | variance | skewness | kurtosis | min | max |
|---|---|---|---|---|---|---|---|---|---|
| Survival Dummy | 716 | 0.49 | 0 | 0.500 | 0.25 | 0.03 | 1.00 | 0 | 1 |
| Size | 697 | 1.69 | 2 | 0.631 | 0.39 | 0.33 | 2.32 | 1 | 3 |
| Age | 703 | 2.27 | 3 | 0.898 | 0.80 | -0.57 | 1.48 | 1 | 3 |
| Profitability | 661 | 1.49 | 1 | 0.50 | 0.25 | 0.00 | 1.00 | 1 | 2 |
| Leverage | 655 | 1.49 | 1 | 0.50 | 0.25 | 0.00 | 1.00 | 1 | 2 |
| Economic Sectors | 716 | 2.33 | 3 | 0.759 | 0.57 | -0.63 | 1.99 | 1 | 3 |
| Origin | 716 | 0.71 | 1 | 0.454 | 0.20 | -0.93 | 1.86 | 0 | 1 |

**Appendix C2: Logistic Results**

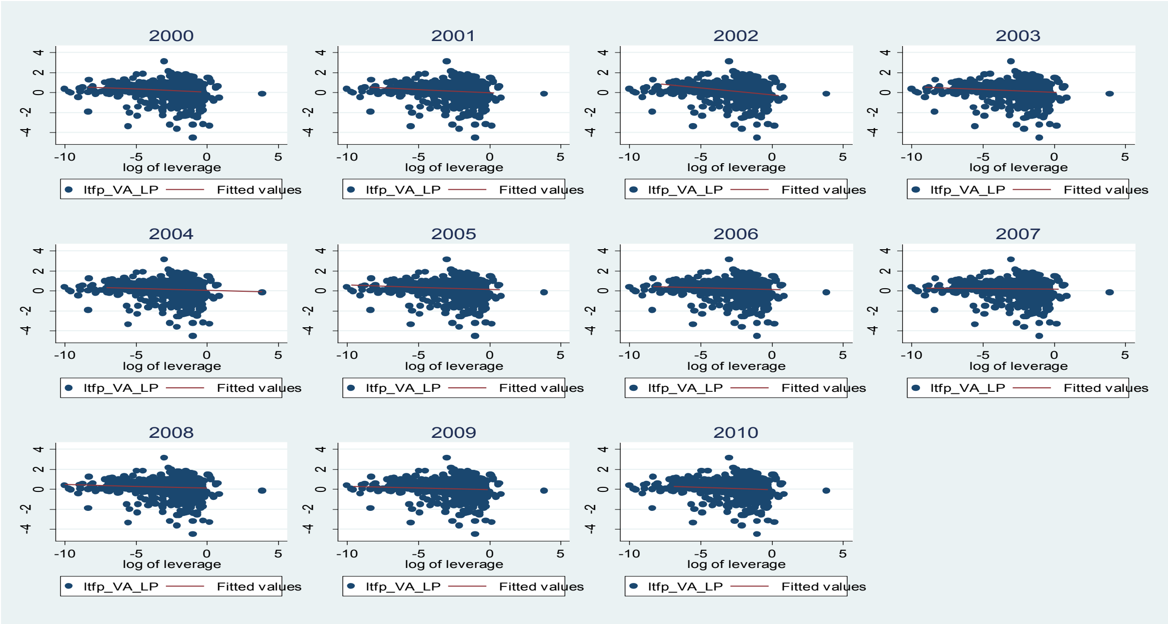
| Dependent Variable: Failure | (1) Overall | (2) Pre Crisis |
|---|---|---|
| Firm Size | -0.134** | -0.102* |
| | (0.0538) | (0.0552) |
| Firm Age | -0.0165 | 0.0521 |
| | (0.0872) | (0.0911) |
| Profitability | -0.0395 | -0.129 |
| | (0.107) | (0.111) |
| Leverage | -0.117* | -0.141** |
| | (0.0678) | (0.0679) |
| Secondary sector | 0.195 | 0.251 |
| | (0.333) | (0.343) |
| Tertiary sector | 0.509 | 0.734** |
| | (0.338) | (0.348) |
| Origin | -0.283 | 0.200 |
| | (0.282) | (0.287) |
| Constant | 1.249 | -0.330 |
| | (0.800) | (0.807) |
| Log Likelihood | -269.1192 | -259.5978 |
| LR chi2(7) | 19.72(0.00) | 15.62(0.02) |
| Pseudo R2 | 0.0353 | 0.292 |
| Observations | 403 | 392 |

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

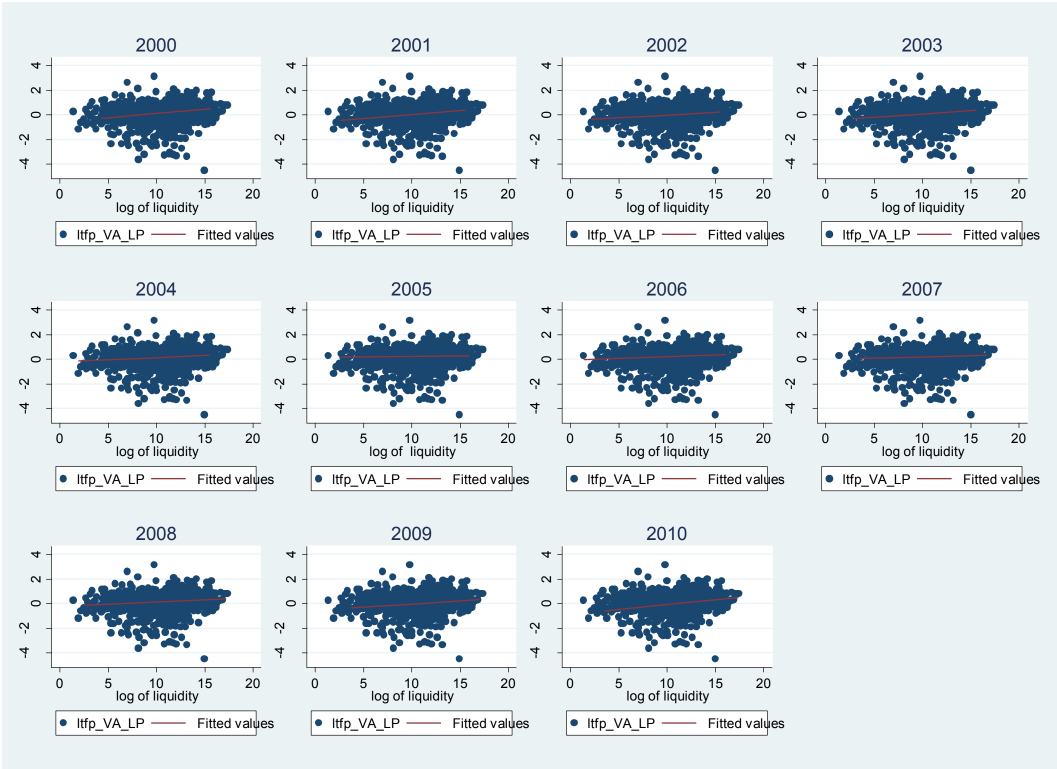
**Notes**: The Dependent variable is equal to unity if a firm died during the period and zero if it is found alive at the end of the period. Firm size is the logarithm of sales: leverage is log of the ratio of total debt to total assets.; Profitability is the log of the profit. Firm age is log of age of the firm;

# D. Appendix for Chapter Five

## Appendix D1: TFP and Log of Leverage per year




## Appendix D2: TFP and Log of Liquidity per year



**Appendix D3: OLS Results for Production Functions**

| **Dependent Variable: LTFP** | **(1) OLS** | **(2) OLS** |
|---|---|---|
| lcapital | 0.594*** | 0.611*** |
| | (0.0300) | (0.0314) |
| llabour | 0.406*** | 0.392*** |
| | (0.0321) | (0.0327) |
| Constant | -0.225 | -0.368** |
| | (0.144) | (0.170) |
| Industry Dummies | No | Yes |
| Observations | 2,275 | 2,275 |
| R-squared | 0.931 | 0.933 |

**Notes**: The dependent variable is log of value added. Robust standard errors are reported in brackets. (***): coefficient significant at less than 1 percent; (**): coefficient significant at 5 percent; (*): coefficient significant at 10 percent.

**Appendix D4: Total Factor Productivity and Finance Results**

| Dependent Variable: LTFP | (1) OLS | (2) OLS | (3) OLS |
|---|---|---|---|
| leverage | -0.157*** | -0.162*** | |
| | (0.0454) | (0.0437) | |
| leverage_sq | -0.0154*** | -0.0157*** | |
| | (0.00544) | (0.00535) | |
| liquidity | 0.0156 | | 0.0380*** |
| | (0.0138) | | (0.0126) |
| lsize | 0.0328* | 0.0510*** | 0.0104 |
| | (0.0193) | (0.0124) | (0.0180) |
| ltang | -0.0255 | -0.0287 | -0.0255 |
| | (0.0299) | (0.0302) | (0.0288) |
| lage | -0.0154 | -0.0128 | -0.0194 |
| | (0.0247) | (0.0248) | (0.0244) |
| growth | 0.0541 | 0.0584 | 0.0788* |
| | (0.0420) | (0.0419) | (0.0421) |
| origin | 0.0632 | 0.0557 | 0.110 |
| | (0.167) | (0.167) | (0.151) |
| Constant | -0.900*** | -0.998*** | -0.608** |
| | (0.293) | (0.270) | (0.262) |
| Industry Dummies | Yes | Yes | Yes |
| Observations | 1,761 | 1,781 | 1,948 |
| R-squared | 0.094 | 0.095 | 0.071 |

**Notes**: The dependent variable is log of total factor productivity estimated using Levinsohn and Petrin procedure. leverage is log of the ratio of total debt to total assets.; liquidity is log of the ratio of liquid assets to total assets; lsize is log of firm size measured by total assets; ltang is long of tangibility measured by the ratio of fixed assets to total assets; lage is log of age of the firm; growth is annual sales growth measured by log difference; origin is the dummy for the origin of the firm.; Robust standard errors are reported in brackets. (***): coefficient significant at less than 1 percent; (**): coefficient significant at 5 percent; (*): coefficient significant at 10 percent.

**Appendix D5: Total Factor Productivity and Finance Results**

| **Dependent Variable: LTFP** | **(1) FIXED EFFECT** | **(2) FIXED EFFECTS** | **(3) FIXED EFFECTS** | **(4) RANDOM EFFECTS** | **(5) RANDOM EFFECTS** | **(6) RANDOM EFFECTS** |
|---|---|---|---|---|---|---|
| leverage | -0.183*** | -0.189*** | | -0.181*** | -0.188*** | |
| | (0.0305) | (0.0298) | | (0.0276) | (0.0270) | |
| leverage_sq | -0.0176*** | -0.0181*** | | -0.0175*** | -0.0179*** | |
| | (0.00383) | (0.00378) | | (0.00352) | (0.00349) | |
| liquidity | 0.0144 | | 0.0336*** | 0.0210* | | 0.0399*** |
| | (0.0118) | | (0.0117) | (0.0107) | | (0.0105) |
| lsize | -0.0937*** | -0.0781*** | -0.109*** | -0.0114 | 0.0113 | -0.0294* |
| | (0.0222) | (0.0188) | (0.0214) | (0.0162) | (0.0112) | (0.0157) |
| ltang | -0.207*** | -0.209*** | -0.169*** | -0.0942*** | -0.0997*** | -0.0792*** |
| | (0.0283) | (0.0276) | (0.0240) | (0.0195) | (0.0192) | (0.0178) |
| lage | 0.0385 | 0.0367 | 0.0653 | -1.31e-06 | 0.00242 | 0.00802 |
| | (0.0583) | (0.0570) | (0.0570) | (0.0230) | (0.0229) | (0.0236) |
| growth | 0.0619*** | 0.0661*** | 0.0838*** | 0.0554*** | 0.0608*** | 0.0727*** |
| | (0.0197) | (0.0194) | (0.0191) | (0.0189) | (0.0187) | (0.0185) |
| origin | | | | 0.195 | 0.186 | 0.209 |
| | | | | (0.124) | (0.124) | (0.130) |
| Constant | 0.546** | 0.480** | 0.786*** | -0.613*** | -0.719*** | -0.322 |
| | (0.248) | (0.242) | (0.241) | (0.204) | (0.196) | (0.201) |
| Industry Dummy | No | No | No | Yes | Yes | Yes |
| Observations | 1,761 | 1,781 | 1,948 | 1,761 | 1,781 | 1,948 |
| R-squared | 0.100 | 0.098 | 0.064 | 0.098 | 0.076 | 0.041 |
| Number of newid | 332 | 333 | 352 | 332 | 333 | 352 |

**Notes**: The dependent variable is log of total factor productivity estimated using Levinsohn and Petrin procedure. leverage is log of the ratio of total debt to total assets.; liquidity is log of the ratio of liquid assets to total assets; lsize is log of firm size measured by total assets; ltang is long of tangibility measured by the ratio of fixed assets to total assets; lage is log of age of the firm; growth is annual sales growth measured by log difference; origin is the dummy for the origin of the firm.; Robust standard errors are reported in brackets. (***): coefficient significant at less than 1 percent; (**): coefficient significant at 5 percent; (*): coefficient significant at 10 percent.

**Appendix D6: Total Factor Productivity and Finance Results: Two -Way Fixed Effects**

| **Dependent Variable: LTFP** | **(1) FIXED EFFECTS** | **(2) FIXED EFFECTS** | **(3) FIXED EFFECTS** |
|---|---|---|---|
| leverage | -0.176*** | -0.181*** | |
| | (0.0305) | (0.0298) | |
| leverage_sq | -0.0171*** | -0.0175*** | |
| | (0.00383) | (0.00378) | |
| liquidity | 0.0140 | | 0.0321*** |
| | (0.0118) | | (0.0117) |
| lsize | -0.123*** | -0.109*** | -0.123*** |
| | (0.0261) | (0.0234) | (0.0248) |
| ltang | -0.198*** | -0.200*** | -0.159*** |
| | (0.0283) | (0.0276) | (0.0240) |
| lage | -0.00623 | -0.00895 | 0.0447 |
| | (0.0647) | (0.0631) | (0.0644) |
| growth | 0.0558*** | 0.0603*** | 0.0730*** |
| | (0.0199) | (0.0196) | (0.0193) |
| Constant | 1.065*** | 1.020*** | 1.039*** |
| | (0.358) | (0.353) | (0.347) |
| Time Dummies | Yes | Yes | Yes |
| Observations | 1,761 | 1,781 | 1,948 |
| R-squared | 0.115 | 0.114 | 0.080 |
| Number of newid | 332 | 333 | 352 |

**Notes**: The dependent variable is log of total factor productivity estimated using Levinsohn and Petrin procedure. leverage is log of the ratio of total debt to total assets.; liquidity is log of the ratio of liquid assets to total assets; lsize is log of firm size measured by total assets; ltang is long of tangibility measured by the ratio of fixed assets to total assets; lage is log of age of the firm; growth is annual sales growth measured by log difference; origin is the dummy for the origin of the firm.; Robust standard errors are reported in brackets. (***): coefficient significant at less than 1 percent; (**): coefficient significant at 5 percent; (*): coefficient significant at 10 percent.

**Appendix D7: OLS Total Factor Productivity and Finance Results: Lagged Dependent Variable**

| **Dependent Variables** | **(1) OLS** | **(2) OLS** | **(3) OLS** |
|---|---|---|---|
| ltfp(-1) | 0.569*** | 0.568*** | 0.621*** |
| | (0.0499) | (0.0493) | (0.0473) |
| leverage | -0.0972*** | -0.0968*** | |
| | (0.0356) | (0.0343) | |
| leverage_sq | -0.00964** | -0.00965** | |
| | (0.00405) | (0.00400) | |
| liquidity | -0.00164 | | 0.00890 |
| | (0.0104) | | (0.00896) |
| lsize | 0.0165 | 0.0149** | 0.00330 |
| | (0.0120) | (0.00670) | (0.0104) |
| ltang | -0.0216 | -0.0221 | -0.0281 |
| | (0.0220) | (0.0220) | (0.0188) |
| lage | 0.0194 | 0.0181 | 0.0186 |
| | (0.0157) | (0.0153) | (0.0147) |
| growth | 0.110 | 0.110 | 0.127* |
| | (0.0759) | (0.0759) | (0.0719) |
| origin | -0.0152 | -0.0138 | 0.0146 |
| | (0.0655) | (0.0657) | (0.0540) |
| Constant | -0.438*** | -0.429*** | -0.247** |
| | (0.147) | (0.127) | (0.115) |
| Industry Dummies | Yes | Yes | Yes |
| Observations | 1,577 | 1,591 | 1,742 |
| R-squared | 0.345 | 0.346 | 0.357 |

**Notes**: The dependent variable is log of total factor productivity estimated using Levinsohn and Petrin procedure. leverage is log of the ratio of total debt to total assets.; liquidity is log of the ratio of liquid assets to total assets; lsize is log of firm size measured by total assets; ltang is long of tangibility measured by the ratio of fixed assets to total assets; lage is log of age of the firm; growth is annual sales growth measured by log difference; origin is the dummy for the origin of the firm.; Robust standard errors are reported in brackets. (***): coefficient significant at less than 1 percent; (**): coefficient significant at 5 percent; (*): coefficient significant at 10 percent.

**Appendix D8: Total Factor Productivity and Finance Results: Lagged Dependent Variable**

| Dependent Variables:LTFP | (1) FIXED EFFECTS | (2) FIXED EFFECTS | (3) FIXED EFFECTS | (4) RANDOM EFFECTS | (5) RANDOM EFFECTS | (6) RANDOM EFFECTS |
|---|---|---|---|---|---|---|
| ltfp(-1) | 0.144*** | 0.143*** | 0.217*** | 0.266*** | 0.263*** | 0.338*** |
| | (0.0273) | (0.0271) | (0.0266) | (0.0254) | (0.0252) | (0.0247) |
| leverage | -0.147*** | -0.147*** | | -0.147*** | -0.147*** | |
| | (0.0311) | (0.0304) | | (0.0278) | (0.0273) | |
| leverage_sq | -0.0134*** | -0.0135*** | | -0.0137*** | -0.0137*** | |
| | (0.00402) | (0.00398) | | (0.00358) | (0.00355) | |
| liquidity | -0.00124 | | 0.0152 | 0.00104 | | 0.0160 |
| | (0.0119) | | (0.0116) | (0.0109) | | (0.0105) |
| lsize | -0.0799*** | -0.0800*** | -0.108*** | -0.00451 | -0.00425 | -0.0262* |
| | (0.0223) | (0.0191) | (0.0211) | (0.0161) | (0.0113) | (0.0154) |
| ltang | -0.191*** | -0.188*** | -0.160*** | -0.0851*** | -0.0862*** | -0.0878*** |
| | (0.0287) | (0.0282) | (0.0236) | (0.0192) | (0.0190) | (0.0175) |
| lage | 0.0589 | 0.0570 | 0.108* | 0.0273 | 0.0265 | 0.0381* |
| | (0.0577) | (0.0573) | (0.0559) | (0.0223) | (0.0224) | (0.0223) |
| growth | 0.0825*** | 0.0821*** | 0.0978*** | 0.0787*** | 0.0791*** | 0.0948*** |
| | (0.0253) | (0.0248) | (0.0238) | (0.0246) | (0.0243) | (0.0233) |
| origin | | | | 0.150 | 0.153 | 0.171 |
| | | | | (0.119) | (0.119) | (0.121) |
| Constant | 0.547** | 0.544** | 0.848*** | -0.474** | -0.466** | -0.154 |
| | (0.250) | (0.244) | (0.241) | (0.201) | (0.195) | (0.194) |
| Industry Dummy | No | No | No | Yes | Yes | Yes |
| Observations | 1,577 | 1,591 | 1,742 | 1,577 | 1,591 | 1,742 |
| R-squared | 0.108 | 0.107 | 0.105 | 0.241 | 0.239 | 0.274 |
| Number of newid | 310 | 311 | 326 | 310 | 311 | 326 |

**Notes**: The dependent variable is log of total factor productivity estimated using Levinsohn and Petrin procedure. leverage is log of the ratio of total debt to total assets.; liquidity is log of the ratio of liquid assets to total assets; lsize is log of firm size measured by total assets; ltang is long of tangibility measured by the ratio of fixed assets to total assets; lage is log of age of the firm; growth is annual sales growth measured by log difference; origin is the dummy for the origin of the firm.; Robust standard errors are reported in brackets. (***): coefficient significant at less than 1 percent; (**): coefficient significant at 5 percent; (*): coefficient significant at 10 percent.

## Appendix D9: Total Factor Productivity and Finance Results: Global Financial Crisis

| Dependent variable<br>LTFP | (1)<br>OLS | (2)<br>OLS | (3)<br>OLS | (4)<br>OLS | (5)<br>LSDV | (6)<br>LSDV | (7)<br>LSDV | (8)<br>LSDV |
|---|---|---|---|---|---|---|---|---|
| leverage | -0.157*** | -0.156*** | -0.160*** | -0.157*** | -0.177*** | -0.179*** | -0.178*** | -0.176*** |
| | (0.0455) | (0.0447) | (0.0474) | (0.0453) | (0.0370) | (0.0363) | (0.0374) | (0.0367) |
| leverage_sq | -0.0154*** | -0.0150*** | -0.0153*** | -0.0155*** | -0.0171*** | -0.0169*** | -0.0171*** | -0.0172*** |
| | (0.00544) | (0.00536) | (0.00544) | (0.00545) | (0.00454) | (0.00455) | (0.00456) | (0.00455) |
| liquidity | 0.0138 | 0.0132 | 0.0144 | 0.00351 | 0.0199 | 0.0193 | 0.0200 | 0.0117 |
| | (0.0137) | (0.0137) | (0.0135) | (0.0140) | (0.0124) | (0.0126) | (0.0124) | (0.0129) |
| ltang | -0.0274 | -0.0238 | -0.0271 | -0.0287 | -0.0926** | -0.0864* | -0.0924** | -0.0926** |
| | (0.0296) | (0.0288) | (0.0296) | (0.0294) | (0.0463) | (0.0443) | (0.0462) | (0.0464) |
| lsize | 0.0376* | 0.0377* | 0.0368* | 0.0386** | 0.00194 | -0.00436 | 0.00182 | 0.00325 |
| | (0.0193) | (0.0193) | (0.0193) | (0.0192) | (0.0196) | (0.0200) | (0.0196) | (0.0195) |
| lage | -0.0203 | -0.0180 | -0.0202 | -0.0236 | 0.00142 | 0.00483 | 0.00142 | -0.00138 |
| | (0.0245) | (0.0245) | (0.0245) | (0.0245) | (0.0256) | (0.0256) | (0.0257) | (0.0259) |
| growth | 0.0503 | -0.00375 | 0.0496 | 0.0493 | 0.0406 | -0.00699 | 0.0405 | 0.0386 |
| | (0.0411) | (0.0374) | (0.0407) | (0.0405) | (0.0409) | (0.0359) | (0.0408) | (0.0401) |
| origin | 0.0641 | 0.0758 | 0.0640 | 0.0696 | 0.176 | 0.221 | 0.176 | 0.179 |
| | (0.166) | (0.170) | (0.167) | (0.167) | (0.190) | (0.193) | (0.191) | (0.192) |
| **crisis** | **-0.0917*** ** | **-0.135*** ** | **-0.0648** | **-0.433*** ** | **-0.127*** ** | **-0.147*** ** | **-0.121** ** | **-0.422*** ** |
| | **(0.0292)** | **(0.0353)** | **(0.0606)** | **(0.150)** | **(0.0374)** | **(0.0385)** | **(0.0531)** | **(0.128)** |
| *Interactions* | | | | | | | | |
| growth_crisis | | 0.286*** | | | | 0.296*** | | |
| | | (0.0967) | | | | (0.0752) | | |
| levcrisis | | | 0.0123 | | | | 0.00265 | |
| | | | (0.0249) | | | | (0.0167) | |
| liquidcrisis | | | | 0.0295** | | | | 0.0249*** |
| | | | | (0.0120) | | | | (0.00932) |
| Constant | -0.904*** | -0.903*** | -0.908*** | -0.798*** | -0.709** | -0.645** | -0.711** | -0.630** |
| | (0.292) | (0.295) | (0.293) | (0.299) | (0.302) | (0.300) | (0.303) | (0.307) |
| Time Dummies | No | No | No | No | Yes | Yes | Yes | Yes |
| Industry Dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 1,761 | 1,761 | 1,761 | 1,761 | 1,761 | 1,761 | 1,761 | 1,761 |
| R-squared | 0.101 | 0.113 | 0.101 | 0.105 | 0.088 | 0.114 | 0.088 | 0.093 |
| Number of newid | n/a | n/a | n/a | n/a | 332 | 332 | 332 | 332 |

Notes: The dependent variable is total factor productivity estimated using Levinsohn and Petrin procedure leverage is log of the ratio of total debt to total assets; .liquidity is log of the ratio of liquid assets to total assets;lsize is log of firm size measured by total assets, ltang is long of tangibility measured by the ratio of fixed assets to total assets, lage is log of age of the firm, growth is annual sales growth measured by log difference, origin is the dummy for the origin of the firm.Robust standard errors are reported in brackets. (***): coefficient significant at less than 1 percent; (**): coefficient significant at 5 percent; (*): coefficient significant at 10 percent.

**Appendix D10: Total Factor Productivity and Financial Development Results**

| Dependent Variable: LTFP | (1) OLS | (2) OLS | (3) FIXED EFFECTS | (4) FIXED EFFECTS | (5) RANDOM EFFECTS | (6) RANDOM EFFECTS |
|---|---|---|---|---|---|---|
| lprivate_credit | | 0.159 | | 0.368*** | | 0.172* |
| | | (0.145) | | (0.0978) | | (0.0909) |
| lstock_market | 0.112** | | 0.0876** | | 0.0843** | |
| | (0.0550) | | (0.0387) | | (0.0379) | |
| lsize | 0.0530*** | 0.0520*** | -0.0783*** | -0.0947*** | 0.0118 | 0.00778 |
| | (0.0126) | (0.0127) | (0.0181) | (0.0187) | (0.0112) | (0.0115) |
| ltang | -0.0356 | -0.0352 | -0.174*** | -0.175*** | -0.0881*** | -0.0892*** |
| | (0.0287) | (0.0288) | (0.0235) | (0.0234) | (0.0174) | (0.0175) |
| lage | -0.0137 | -0.0133 | 0.0457 | 0.0225 | 0.00948 | 0.0103 |
| | (0.0244) | (0.0245) | (0.0565) | (0.0568) | (0.0233) | (0.0235) |
| growth | 0.0801* | 0.0813* | 0.0891*** | 0.0875*** | 0.0784*** | 0.0786*** |
| | (0.0414) | (0.0418) | (0.0189) | (0.0188) | (0.0184) | (0.0184) |
| origin | 0.0909 | 0.0925 | | | 0.189 | 0.193 |
| | (0.149) | (0.150) | | | (0.129) | (0.130) |
| Constant | -1.387*** | -1.571** | 0.323 | -0.739* | -0.903*** | -1.262*** |
| | (0.384) | (0.735) | (0.287) | (0.448) | (0.272) | (0.460) |
| Industry Dummy | Yes | Yes | No | No | Yes | Yes |
| Observations | 1,968 | 1,968 | 1,968 | 1,968 | 1,968 | 1,968 |
| R-squared | 0.068 | 0.067 | 0.061 | 0.066 | 0.036 | 0.039 |
| Number of newid | n/a | n/a | 353 | 353 | 353 | 353 |

Notes: The dependent variable is total factor productivity estimated using Levinsohn and Petrin procedure, lprivate_credit is the ratio of private sector credit to GDP, lstock_market is the ratio of stock market capitalisation to GDP, lsize is log of firm size measured by total assets, ltang is long of tangibility measured by the ratio of fixed assets to total assets, lage is log of age of the firm, growth is annual sales growth measured by log difference, origin is the dummy for the origin of the firm. Robust standard errors are reported in brackets. (***): coefficient significant at less than 1 percent; (**): coefficient significant at 5 percent; (*): coefficient significant at 10 percent.,