Corporate Taxation and Investment in South Africa

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by
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Declaration

I, Mashekwa Maboshe, declare that this thesis is my original work and other sources have been acknowledged through referencing. I also declare that the thesis has not been submitted for the award of a PhD degree at any other university.

Signed by candidate

Signed:

Abstract

This thesis investigates some aspects of corporate taxation and firm-level investment in South Africa. The thesis uses specially constructed and unique datasets to draw insights on the link between corporate tax changes and firm-level investment and as well as the efficiency of capital allocation in South Africa. The thesis comprises a short introductory chapter, three empirical chapters, and a summary chapter.

The first empirical chapter (chapter 2) evaluates the responsiveness of firm-level investment to corporate tax changes over a period of notable corporate tax reforms in South Africa. The study estimates a reduced form neoclassical investment model using a particularly constructed dataset of firms listed on the Johannesburg stock exchange over the period 1999-2012. Generalised methods of moments (GMM) techniques are used to control for various econometric biases. The findings suggest that although the corporate tax reforms reduced the marginal cost of investment, these reductions did not result in a statistically significant increase in firm-level investment. The null effects found in this study are robust to various estimation specifications. Although at variance with the established literature from developed countries, the findings are similar to emerging evidence in other developing country contexts and suggest that other factors may be more important determinants of investment than corporate tax policy.

Chapter 3 explores the possibility that the unresponsiveness of firm-level investment to corporate tax policy may be a result of the presence of financial constraints. According to the financial constraints hypothesis, neoclassical fundamentals may fail to explain investment in the presence of financial constraints. The paper investigates the role of financial constraints in investment using dynamic GMM and endogenous switching regressions methods. The paper finds that financial constraints are an important factor in investment determination. Firms that are more financially constrained rely more on the availability of internal resources to fund investment relative to the less financially constrained firms. The findings suggest that investment policy should consider strategies that reduce informational asymmetries and other capital market inefficiencies. Such strategies would help lower the barriers and costs of external finance, thus improving firm-level investment.

Chapter 4 considers the implications of differential taxation of assets and industries in South Africa. The paper's motivation is that although there are variations in the tax treatment of investments in assets and across industries, little empirical evidence exists on the nature of any investment distortions due to differential tax policies. Using a rare and unexplored industry-level data source from Statistics South Africa, the study constructs a panel of asset shares by industry over the period 2007-2014 and estimates inter-asset tax elasticities to estimate the potential investment distortion or misallocation effects of differential taxation policies. The findings suggest the presence of non-negligible inter-asset distortions due to non-uniform taxation of investments. Investments in a given asset are found to respond to the tax incentives provided for other asset classes. Our findings suggest that current corporate tax policies that offer differentiated and asset or industry-specific investment incentives may be causing distortions and inefficiencies in the allocation of assets among industries.

Dedication

To Tabby and our children, Michelle and Mayamiko.

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List of Abbreviations

ARDL	Auto-Regressive Distributed Lag
CPI	Consumer Price Index
GDP	Gross Domestic Product
GMM	Generalised Method of Moments
ICB	Industry Classification Benchmark
ICT	Information and Computer Technology
JSE	Johannesburg Stock Exchange
MLE	Maximum Likelihood Estimation
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
PRISM	Policy Research in International Services and Manufacturing
RESBANK	Reserve Bank of South Africa
SARS	South African Revenue Service
SIC	Standard industrial Classification
STATSSA	Statistics South Africa
STC	Secondary Tax on Companies
SUR	Seemingly Unrelated Regression
UCC	User-Cost of Capital
UNIDO	United Nations Industrial Organisation
UK	United Kingdom
US	United States

Chapter 1

1. General Introduction

1.1 Introduction

The fundamental role of investment in economic growth and development is incontestable and well documented in both the theoretical and empirical literature (Romer, 1986; Sala-i-martin *et al.*, 2004). Various studies have shown that investment is strongly associated with increased output, productivity, and improved employment (Podrecca and Carmeci, 2001; Hong and Sun, 2011). Following the devastating debt crisis of the 1980s, most developing countries including South Africa implemented a range of corporate tax reforms aimed at improving the investment climate and attracting the much-needed private investment. Some of those corporate tax reforms implemented include reductions in the headline corporate tax rates, tax exemptions, and the provision of generous capital depreciation and accelerated depreciation allowances. The main aim of the corporate tax reforms has been to reduce the marginal costs of investment, thereby incentivizing private investment growth.

Although various countries have implemented some of the standard corporate tax reforms over the last few decades, the economics literature lacks evidence on the effects of these reforms in the context of developing countries[1]. It is therefore not clear whether the reductions in the corporate tax rates have in any way increased investment. It is also less clear whether the differential taxation of assets and industry has had any undesired effects on the patterns of investment. The lack of evidence on these issues is not for lack of effort, but significant data limitations and problems have hampered prospective research in this field. In the case of investigating the firm-level response to corporate tax reforms, very few countries have data with the level of detail required to accurately estimate the elusive tax-adjusted user-cost of capital (UCC) elasticity at the firm level. Even if accurate calculation of the UCC were possible, most developing countries lack frequent changes in corporate tax policy to ensure proper identification. The difficulties of researching inter-asset distortions of corporate taxation

[1] In this thesis, developing countries is broadly defined to include emerging economies.

get more complicated because plant- or industry-level data that has so far been used to estimate the distortions is non-existence in most developing countries, and unreliable at best.

This thesis is motivated by the existing research gaps on the relationship between corporate tax policy and investment and asset allocation in developing countries. Using the South African case study, this thesis contributes to the economics literature by addressing the following research objectives. First, the thesis assesses the responsiveness of firm-level investment to corporate tax policy changes. Second, the thesis considers the role of financial constraints in investment determination among South African firms. Third, the thesis investigates whether the differential taxation of assets and industries leads to any inefficiencies in the allocation of investment in South Africa. These three objectives relate to the main empirical chapters of this thesis.

The first empirical chapter (chapter 2) investigates whether firm-level investment responds to corporate tax incentives. The paper estimates a reduced form neoclassical investment model using an autoregressive distributed lag specification where investment is modelled as dependent on its previous lag as well as the current and past lags of the tax-adjusted user cost of capital and output. The paper uses a specially constructed firm-level panel dataset based on financial statement data extracted from Datastream - an online financial data subscription service offered by Bloomberg. The panel dataset is restricted to non-financial firms listed on the Johannesburg Stock Exchange (JSE) over the period 1999 to 2012. Following the prevailing literature, only the non-financial firms have been considered as these are most likely to undertake fixed capital investment. Estimating the dynamic investment model using both OLS and GMM estimation finds that although the corporate tax policy reforms reduced the marginal cost of investment over time, firm-level investment did not respond to the corporate tax incentives. Although these results deviate from most of the findings in advanced economies, the results are very similar to findings from less developed countries and to one recent study in the USA which found that the large corporate tax cuts of the 2001 reforms did not result in any investment growth. The findings remain robust to changes in the estimation specification that control for potential endogeneity due to issues such as measurement error, reverse causality, and dynamic panel bias. The results suggest that contrary to policy makers expectations, corporate policy incentives may not be an effective policy for stimulating investment formation. Therefore, the continued use of corporate tax incentives in South Africa and other developing countries may constitute unproductive tax expenditures. The corporate tax expenditures may be more productively used if channelled to investments that improve the business environment such as the expansion of transport and energy infrastructure rather than the financing of corporate tax incentives.

The first paper makes the following contributions to the economics literature. First, the study investigates the role of corporate tax policy in investment using a dataset that contains the largest firms and spans a period of notable corporate tax reforms in South Africa. While a similar study (World Bank, 2016) also investigated this issue and found negligible effects of corporate tax changes on investment in South Africa, this study is different as it focuses on the larger corporate firms and spans a longer period with more episodes of reforms compared to the former study. This study is also among the first in the corporate tax-investment literature to consider the likely implications of attrition bias. While attrition bias has often been discussed and considered in other fields of economics where firm panels are used, the corporate tax literature has neglected this important issue. This study tests for the implications of attrition bias in the main investment specifications. This study, therefore, contributes important evidence on the role of corporate tax in investment formation in developing contexts.

The second empirical chapter (Chapter 3) considers the possibility that the insignificant impact of corporate tax on investment found in Chapter 2 may be due to the presence of financial constraints. In the neoclassical investment model estimated in Chapter 2, a key assumption of that model is that capital markets are perfect. However, following the weak performance of neoclassical investment models in some early applications (Eisner and Nadiri, 1968), more recent investment theory has questioned the assumption of perfect markets. In particular, the leading alternative theory of investment has argued that in the real world, capital markets are characterised by imperfect market conditions. In particular, the presence of asymmetric informational problems and agency costs imply that firms would face higher costs of borrowing external funds which may, in turn, constrain firms’ ability to invest in all the required projects (Myers and Majluf, 1984). The financial constraints hypothesis argues that in the presence of financial constraints, investment may no longer respond to the traditional theoretical fundamentals such as corporate tax incentives.

Using the same dataset and similar reduced form investment specification as employed in Chapter 2, Chapter 3 finds empirical evidence in support of the financial constraints hypothesis. In particular, the paper shows that financially constrained firms are about 2 times more reliant on internal resources than financially unconstrained firms. The findings in this paper are remarkably consistent and robust to various econometric problems including the potential problem of likely endogenous sample selection due to the *a priori* sample splitting strategy used in the dominant literature. Chapter 3 makes some clear contributions to literature. In particular, the paper extends the financial constraints literature to the developing country contexts by considering the case of South Africa. The paper also contributes to the literature by using an endogenous sample regression framework that has rarely been used to validate results obtained using the dominant GMM approaches. In addition, Chapter 3 provides an important complement to Chapter 2. Together, these chapters suggest the need for investment policy to simultaneously reduce the use of corporate tax incentives while implementing strategies aimed at reducing informational asymmetries and the high cost of capital to promote firm-level investment.

An important implication of the findings in the first empirical chapter is that the continued use of corporate tax incentives may be unproductive if firm-level investment does not respond to the provision of tax incentives. In fact, the provision of corporate tax incentives may actually be disruptive to the investment allocative process especially if provided non-uniformly across assets and industries. Despite that the tax treatment of investment has varied by asset category and industry, there is very little empirical evidence on the likely investment distortions that differential taxation may cause. Chapter 4 investigates the potential inter-asset distortion effects of differential corporate taxation using an unexplored South African industry-level panel dataset. The chapter first develops an asset-industry panel dataset based on industry-level Annual Financial Statement (AFS) data from Statistics South Africa (StatsSA) and then estimates inter-asset user-cost elasticities by using a translog specification and seemingly unrelated regressions (SUR) approach. Due to some sampling issues noted in the AFS series by StatsSA, we take the findings in Chapter 4 as preliminary. The evidence is however suggestive of non-negligible inter-asset distortions arising from the non-uniform taxation of different assets and industries in South Africa. This Chapter provides the first known inter-asset distortions in fixed capital allocations due to differential taxations in developing countries. The Chapter also contributes rare evidence to the nascent literature on the distortive effects of differential corporate taxation worldwide.

The overall findings in this thesis suggest that South African investment policy should re-consider the role of corporate tax incentives in the presence of financial constraints. Policies that improve the workings and conditions of the capital market should take centre stage in South Africa's investment strategy. Moreover, the suggestive evidence that differential taxation may lead to investment misallocation lends more support to the need to re-consider the entire corporate tax policy incentive package.

1.2 Organisation of the thesis

The rest of this thesis is organised as follows. Chapter 2 investigates the relationship between corporate tax policy and investment using a neoclassical investment framework. The chapter estimates dynamic panel models using a sample of about 196 firms over the period 1999 to 2012. Chapter 3 then follows with an exploration of the likely role of financial constraints in investment in South Africa. The main objective is to explain whether financial constraints are a reason for the failure of the neoclassical investment model in Chapter 2. Chapter 3 uses similar empirical methods as Chapter 2. Chapter 4 uses asset-industry level data and the seemingly unrelated regressions framework to estimate the tax-adjusted inter-asset substitution elasticities. The final chapter is the overall conclusion, which provides a summary of the main findings of the thesis, the policy implications, limitations, and suggestions for future research.

Chapter 2

2. Corporate taxation and firm-level investment

2.1 Introduction

No topic in the investment literature has generated as much debate as the link between corporate tax policy and investment. While traditional theories of corporate investment predict that the long-run impact of corporate tax changes on investment is -1 (Jorgenson, 1963; Hall and Jorgenson, 1967), the findings in the empirical literature remain contentious and inconclusive, even to date. Although a larger proportion of the literature finds evidence in support of the neoclassical benchmark, a growing number of studies cast doubt on the importance of corporate tax policy in investment promotion. Some studies (such as Chirinko, Fazzari and Meyer, 1999; Bond *et al.*, 2003) have found that the sensitivity of investment to corporate tax is much smaller than theoretically predicted. Others (such as Verbič and Črnigoj, 2014; Yagan, 2015; Črnigoj, 2016) do not find any evidence of the impact of corporate tax improvements on investment. The summary evidence on the responsiveness of investment to tax policy is therefore inconclusive.

Much of the empirical evidence has however come from more advanced economies, an observation also made by Bond and Xing (2015). The lack of evidence from developing country contexts is quite striking, given the well-known fact that since the 1990's most developing regions undertook wide-ranging tax reforms as part of the broader IMF and World Bank structural adjustment programmes. In South Africa, significant tax policy reforms have also been ongoing since the early 1990s. Yet only a tiny number of studies on corporate tax policy and investment exist in developing countries.

The lack of empirical evidence on corporate tax and investment in developing countries is largely due to the non-availability of firm-level datasets. Although government-held tax-return records may exist in some countries, most tax databases are unreconciled and thus unusable for research. Moreover, harmonised datasets such as those available in South Africa at SARS do not stretch back far enough to the 1990s when corporate tax reforms were most frequent and significant. These peculiar issues have contributed to a lack of research on corporate taxation and investment in developing countries, potentially resulting in poorly designed and ineffective corporate tax policies.

Given the clear need for more empirical evidence, this study investigates the responsiveness of firm-level investment to corporate tax policy changes in South Africa. The study estimates a neoclassical investment model (Jorgenson, 1963; Hall and Jorgenson, 1967) using company financial statement data for non-financial firms listed on the Johannesburg Stock Exchange (JSE) over the period 1999 to 2012. This period is associated with some notable changes in South Africa's corporate tax policy aimed at reducing companies' marginal costs of capital to promote investment. The paper estimates an auto-regressive distributed lag (ARDL) investment model using the Blundell and Bond (1998) GMM estimator which is robust to econometric problems such as dynamic panel bias, possible reverse causality between investment and tax policy, possible measurement error in the tax variable and firm fixed-effects.

Our findings suggest that despite the observed reductions in the tax-adjusted marginal costs, investment did not respond to corporate tax policy as predicted by traditional investment theories. The findings are similar to those from other developing countries (Črnigoj, 2016; World Bank, 2016). A plausible hypothesis for the null effect of corporate tax policy changes on investment could be the presence of financial constraints in the investment markets. As argued by Fazzari *et al.* (1988), firm investment may no longer respond to fundamentals such as the tax-adjusted marginal costs in the presence of imperfect capital conditions. This hypothesis appears plausible, given that other studies (such as Makina and Wale, 2016; Vengesai and Kwenda, 2018) have found evidence of the presence of financial constraints among firms in South Africa.

This study is among the first in the literature to contribute evidence from a developing country context. The study is also among the first to control for the often-neglected issue of attrition bias in this specific field.

This empirical chapter is organised as follows: the next section presents a review of both the theoretical and empirical literature and highlights the contributions that this paper makes. Section 3 discusses corporate tax reforms in South Africa since the late 1990s. That section discusses the key changes in corporate tax policy and the resulting evolution of the tax-adjusted user cost of capital over the study period. The data and methods are then discussed in section 4 while section 5 presents and discusses the results. The conclusion is presented in section 6.

2.2 Literature Review

The relevant theoretical framework for the study of the relationship between corporate tax and investment is presented in Jorgenson (1963), who provides the first neoclassical theory of investment based on the profit-maximisation behaviour of firms. The basic premise of the theory is that there exists an optimal capital stock for each firm; whereby investment (or divestment) is simply the process of reaching that optimum. Crucially, Jorgenson (1963) characterised an investment model in which investment is explicitly dependent on changes in demand and the rental price of capital or user cost of capital (UCC). In Jorgenson's (1963) theory, the role of corporate tax policy in investment necessarily works through its effects on the UCC, which in turn impacts firm-level investment.

Following the early success of the neoclassical theory (in applications such as Hall and Jorgenson, 1967; Eisner and Nadiri, 1968), Jorgenson (1963)'s theoretical framework has been the standard theoretical framework of investment since the 1960s. The neoclassical approach has however been criticised, particularly for its reduced-form characterisation of the investment adjustment process.

Structural theories such as the Q (Tobin, 1969) and Euler models (Abel, 1980) whose structural equations are derived directly from a dynamic optimisation problem soon emerged as alternative theories. In the Q-theory, the adjustment process is characterised by market information, with a firm's expected life cycle returns of capital captured by the ratio of market value of capital to its replacement costs. In the Euler equation theory, direct quadratic adjustment costs describe the adjustment process. Although not commonly found in the investment-corporate tax field, these structural equation models have been estimated in the broader investment literature. The Q model has been applied in studies such as Hayashi (1982), Hubbard (1998), Audretsch and Elston (2002) and Peters and Taylor (2017) while the Euler has been used such studies as Federici and Parisi (2015) and Cevik and Miryugin (2018).

While these structural theories have a better theoretical appeal over the reduced-form neoclassical investment model, their use in applied work has been criticised. The Q model has for example been criticised for serious problems in the measurement of the q-ratio, and for having very limited applications in contexts outside the stock markets or in situations where financial frictions exit (Hayashi, 1982; Simmler, 2012). The Euler also suffers criticism for being too restrictive (Chirinko, Fazzari and Meyer, 1999; Dwenger, 2014), for imposing empirically implausible quadratic adjustment costs (Doms and Dunne, 1998) and for being too strict in the context of investments under irreversibility (Dixit and Pindyck, 1994). Moreover, the performance of structural equations in empirical applications has been quite disappointing (Oliner, Rudebusch and Sichel, 1995; Bond and Van Reenen, 2007).

To address some of the criticisms of the dominant structural models, contemporary views such as the financial constraints (Myers and Majluf, 1984; Fazzari et al, 1988) and institutional (North, 1991) theories emerged to explain firm investment. In particular, the financial constraints theory argues that in the presence of capital market imperfections, neoclassical fundamentals such as the tax-adjusted marginal cost of capital may fail to explain investment. In the presence of capital market imperfections, the availability of internal finance becomes an important determinant of firm-level investment. Several studies (such as Bond and Meghir,1994; Compello et al, 2010; Gezici et al (2018) lend support to the financial constraints hypothesis.

The institutional theory of investment on the other hand views investment as largely determined by the formal rules that structure economic interactions (North, 1991). According to North (1991), institutions create order, reduce uncertainty, affect the cost of production and exchange, and thus create the economic environment which determines whether firms invest or not. In clarifying the role of institutions, Dollar et al (2005) argue that the investment climate (defined as the institutional, policy, and regulatory environment) "is the link from sowing to reaping." Poor investment climates such as inefficient bureaucracy, corruption, and inadequate physical and financial infrastructure would imply high uncertainty and transaction costs resulting in poor incentives for investment in fixed assets (North, 1991; Dollar et al, 2005). Empirical studies such as Ayyagari et al (2008), Aiello et al (2012) and Ponticelli and Alencar (2016) find evidence in support of the importance of institutions and investment climate in firm-level investment.

Based on the above review of theory, this chapter will use the Jorgenson (1963) and Hall and Jorgenson (1967) neoclassical investment theory as the framework is best suited to study the link between corporate tax policy and investment in South Africa. Notable studies such as Chirinko et. al 1999; Chirinko and Von Kalckreuth, 2003; Dwenger, 2014; and Buettner and Hoenig, 2016) have used this framework to investigate firm-level investment dynamics in advanced economies.

Empirical evidence on the link between corporate tax and investment is vast. Most studies have sought to empirically establish whether the user cost of capital is indeed negative one (-1) as predicted by neoclassical theory (Jorgenson, 1963). The findings in the empirical literature are however far from convergence on the size estimate of the user-cost of capital coefficient. Studies that use industry or aggregate data have generally struggled to find a large user cost elasticity. Using US manufacturing industry data, one of the earliest neoclassical applications (Eisner and Nadiri, 1968) found that the tax-adjusted user cost elasticity only ranged between 0 and -0.33, a range that is far below the theoretical prediction of -1. Subsequent studies based on industry data generally have found relatively low user cost elasticity estimates. For example, studies such as Auerbach and Hassett (1992), Smith (2008) and Bond and Xing (2015) have all reported user cost elasticities of around -0.4 or less.

Concerns about potential bias in the user-cost estimates in aggregate data have been highlighted in the literature. Chirinko et al (1999) and Goolsbee (2004) have argued that the tax effects found in studies based on aggregate data may be biased downwards, due to problems such as measurement error, firm heterogeneity and simultaneity. Moreover, as further pointed out by

Dwenger (2014), aggregate data may suffer limited variation in the parameters used in estimating the user cost of capital, thereby making identification of the user cost parameter difficult. For these reasons, recent studies have generally preferred using more granular data such as firm-level records. Data at the firm level is also deemed as well suited for the study of investment problems given that firms are the natural vehicle through which investment decisions are made. Moreover, firm-level datasets also allow researchers to better control for such econometric concerns as firm fixed effects and endogeneity due to dynamic panel bias among other problems (Chirinko, Fazzari and Meyer, 1999).

Despite the increased availability of micro-datasets, the question about the exact relationship between corporate tax policy and investment is far from consensus. While some early micro studies found evidence of a significant and negative relationship between the user cost of capital and investment, the sizes of the coefficient estimates were quite small. For example, despite controlling for aggregation bias, dynamic bias, and other econometric problems, Chirinko et al (1999) only found a relatively small user cost elasticity of -0.25 using USA manufacturing sector firm data. Other early efforts in using micro-data in the 1990's yield results that are imprecise. For example, Cummins *et. al* (1994) found user-cost elasticity estimates ranging from -0.5 to -1 in their examination of firm-level investment patterns during episodes of tax reform in the USA. Caballero et al (1995) found even a wider range of the long-run user cost elasticities (between -0.01 and -2) using plant-level investment data from the US manufacturing sector.

Since the year 2000, there has been a steady increase in firm-level studies aimed at shedding more light on the size of the user cost of capital. Some studies (such as Dwenger, 2014; Bond and Xing, 2015; Buettner and Hoenig, 2016) have found evidence of elasticity estimates of -1 in line with neoclassical theory. However, the findings in other studies (such as Harhoff and Ramb, 2001b; Chatelain, 2003; Chirinko, Fazzari and Meyer, 2011; Črnigoj, 2016) suggest that user-cost estimates are far below the predicted neoclassical benchmark. In addition, studies that find zero or null effects of corporate tax policy are not uncommon (see for example Chatelain, 2003; Črnigoj and Verbič, 2014; Yagan, 2015).

The empirical evidence on the impact of corporate tax on investment is highly concentrated in advanced economies, with very little evidence from developing regions. Studies that have focused on developing countries and regions are only a handful. For example, Črnigoj (2016) investigates the relationship between corporate tax reforms and investment in Slovenia but found no effect of corporate tax changes in investment. In a study involving Indonesia, Vietnam, Thailand, Malaysia and the Philippines, Cevik and Miryugin (2018) find that moderate corporate tax reforms do not translate into improved investment in the ASEAN region. In South Africa, a recent study based on SARS tax records also finds insignificant effects of corporate tax policy on investment (World Bank, 2016).

The above empirical review has largely focused on studies that assess the responsiveness of investment to changes in the tax-adjusted user cost of capital using the approach in Chirinko et al (1999) and Dwenger (2014) where estimates of the user-cost elasticity are obtained by estimating a neoclassical investment model using dynamic panel techniques such as GMM estimation. While this has been the dominant strategy for estimating the investment effects of corporate tax policy under the Jorgensonian framework, recent papers have begun to use quasi-experimental approaches to estimate the direct effect of corporate tax policy changes on investment. In Germany, Dobbins and Jacob (2016) find that the 2008 corporate tax cuts led to a one-to-one increase in the investment of domestic firms. Following a similar quasi-experimental strategy as Dobbins and Jacob (2016), Ohrn (2018) found that the 2005 corporate tax expenditure programme in the USA led to a 4.7% increase in capital investment for each 1 percentage point reduction in corporate taxes for the beneficiary firms. Liu and Mao (2019) report that the introduction of permanent tax incentives for fixed capital investments over a six-year period from 2004 -2009 in China led to a 38 percent increase in capital investment for the treated firms relative to the control group.

While the emerging evidence from the quasi-experimental strand of literature seems to suggest a general significant impact of corporate tax policy changes on investment, Yagan (2015) however found that that corporate tax reforms of 2003 in the US did not stimulate capita investment, although the reforms evaluated in that study focused on corporate dividend tax cuts.

Based on the above literature review, this study contributes to the literature on the impact of corporate tax and investment in the following ways. First, by using data from a developing country such as South Africa, the study contributes rare evidence in a field overwhelmingly dominated by studies from the USA and Western Europe[2]. Specifically evaluating the interaction of corporate tax policy and investment in a developing country context such as South Africa would help other developing countries in formulating effective corporate tax policies.

Second, by controlling for the effects of likely attrition bias in my findings, this study contributes new insight to the literature on corporate tax and investment. This is important given that the literature has largely ignored the possibility of attrition bias even though it is common for firms to drop out of samples over time.

2.3 Overview of corporate tax reforms and incentives in South Africa

Since the transition to democratic rule in 1994, South Africa's corporate tax policy has undergone significant reviews and reforms, resulting in a relatively efficient and competitive corporate tax system especially in comparison with other regional countries (Davis Tax Committee, 2018). The main objectives of these reforms were to stimulate investment and economic growth in order to address the persistent challenges of unemployment, poverty, and inequality in South Africa (Katz Commission, 1997; Davis Tax Committee, 2018). Some of the significant reforms include several episodes of reductions in the top marginal corporate tax rate from the end of apartheid in 1994 until 2012 and the introduction of the accelerated depreciation allowances especially in the manufacturing sectors in the early 2000s. These changes are reflected in the Income Tax Act 58 of 1962 (Republic of South Africa, 1962) as amended over the years. A specific goal of these reforms was to encourage capital investment in the various assets and sectors of the South African economy.

In addition to the reductions in the headline corporate tax rate since the democratic transition, several other reforms such as the reduction and eventual elimination of the secondary tax on

[2] Although the World Bank supported a similar study in South Africa (World Bank, 2016), that study covered a shorter time frame with fewer episodes of corporate tax policy changes than this study.

companies (STC) have been implemented. The STC was introduced in the income tax code in 1993 to encourage companies to re-invest part of their earnings and to mitigate the decline in tax revenues. As of 1996, the STC rate stood at 12.5% but was reduced to 10% in 2006 and finally abolished in 2012 to re-align the South African dividend tax structure with global norms and practice and to remove the perception of high and unfavourable company taxation regime in South Africa (South African Revenue Service, 2019). As a result, the STC was replaced by the dividend tax – a tax levied on dividends in the hands of the shareholders rather than at the company level. Given the changes in the headline and secondary corporate tax rates over the study period, the combined effective reduction in overall company taxation has reduced over time. Table 2.1 illustrates the trends in corporate tax reductions over the period 1999 to 2012.

Table 2.1: Corporate Tax Rates (1998-2012)

	Corporate income tax	Secondary tax on companies	Effective statutory tax rate*
1998	35%	13%	37.41%
1999	30%	13%	32.59%
2000	30%	13%	32.59%
2001	30%	13%	32.59%
2002	30%	13%	32.59%
2003	30%	13%	32.59%
2004	30%	13%	32.59%
2005	29%	13%	31.63%
2006	29%	13%	31.63%
2007	29%	13%	31.63%
2008	28%	10%	30.18%
2009	28%	10%	30.18%
2010	28%	10%	30.18%
2011	28%	10%	30.18%
2012	28%	0%	28%

*The effective rate is calculated assuming a one third dividend pay-out.

Source: South African tax laws

Other notable investment incentives over the period include the introduction of accelerated depreciation allowances for new plant and machinery in the manufacturing sector at the rate of 40%, 20%, 20%, and 20% in the year 2002 (Republic of South Africa, 1962). The mining sector also saw the introduction of 100% depreciation expensing of new plant and machinery; while schemes that offered an accelerated depreciation schedule of 50%, 30%, 20% were also introduced in the agriculture and renewable energy sectors in the same year (Republic of South Africa, 1962). The South African income tax code also provides for the deductibility of interest expense and operating costs but does not allow for the deduction of dividends and capital expenditures. The deductibility of interest expense has further provided a general investment tax incentive for the firms in South Africa.

In calculating the tax-adjusted user cost of capital in this paper, we take into account the variations in the main headline tax rate, the depreciation allowances, and the interest deductibility of debt. While South Africa has many other tax and non-tax incentives that could be modelled in the user cost estimates, not all the relevant tax incentives can be considered in this study because the financial records used in the study do not contain such details. For instance, under the famous 12i Tax Allowance Investment incentive (12i TAI), companies could receive various cash incentive grants, investment allowances, and learnership allowances for attaining specified investment levels and training criteria. These cash grants and investment allowances are not specifically reported in the financial statements of the companies listed on the JSE and are therefore not incorporated in calculating the user cost of capital used in this paper. To this extent, therefore, our estimate of the user cost of capital and marginal effective tax rates could be considered as lower bound estimates for the real firm-level user costs of capital in cases where firms enjoy further incentives.

2.4 Data and Summary Statistics

2.4.1 Dataset

The main sources of data for this study are the balance sheet and income statements of non-financial companies listed on the South African Johannesburg Stock Exchange (JSE). The data was collected from Datastream - an online financial data subscription service provided by Thomson Reuters (Datastream, 2016). The use of the JSE data in this study has several advantages. First, while data on larger firms may under-represent the smaller ones, larger firms are more likely to be responsive to corporate tax changes because smaller firms are typically exempt from corporate tax payments and therefore only face limited exposure to corporate taxation. Second, the JSE firm panel used here is considerably longer than other currently available alternatives like the company tax returns data from the South African Revenue Service (SARS). Our JSE panel series captures some of the major reforms of the 1990s and early 2000s while in contrast, the SARS tax returns data recently used in similar studies such as World Bank (2016) rely on very limited variation in corporate tax policy changes. Third, we note that due to strict regulatory requirements for JSE listed companies such as having externally audited financial statements, the data in this study is arguably of better quality than other options.

The JSE dataset used in this study is therefore one of the best-suited options to study the relationship between investment and corporate tax policy over a period of actual corporate tax reforms in South Africa. Several other South African studies have used the JSE firm-level data to investigate various investment models (e.g., Ntim, 2013; Makina and Wale, 2016; Vengesai and Kwenda, 2018). Elsewhere, Quader and Taylor (2018) have used listed firm-level data sources from Datastream - the same source as our study - to estimate investment models for the UK. Kumar and Ranjani (2019) and Crisostomo et al (2013) also estimated investment models using firm-level financial data from India's Bombay Stock Exchange and the Sao Paolo Stock Exchange in Brazil, respectively.

This study uses data from non-financial companies listed on the JSE over the period 1999 to 2012. The dataset excludes firms in the banking, insurance, real estate, general financial services, equity and non-equity investment, and health care sectors according to the FTSE/Dow Jones Industry Classification Benchmark (ICB) criteria used in Datastream. The number of firms before conducting any data cleaning and restricting our sample to the relevant panel and variables is 249 firms, representing 3,541 firm-year observations. Observations with missing data on the key variables such as investment, capital stocks, debt, sales, and the user-cost of capital were dropped. Four more observations with very high sales growth rates of over 100% and cash flow ratio above 10 were also dropped as such patterns are deemed highly unusual (Vengesai and Kwenda, 2018). In the final step, I follow the literature (Hovakimian and Titman, 2006; Quader and Taylor, 2018) and winsorize the relevant variables at 1% in both tails to minimise the impact of extreme outliers arising from any extra-ordinary shocks, large mergers and acquisitions, or severe measurement errors. Lastly, all firm-level observations with less than 5 years of consecutive runs are dropped from the data given that the dynamic specifications estimated in this study require a minimum of 5 consecutive observations.

After the data cleaning, the final sample comprised 196 firms operating in 7 different non-financial sectors of the South African economy. The final sample has a minimum of 5 and a maximum of 14 consecutive years of financial data yielding a total of 2,129 firm-year observations. Table 2.2 shows the composition of the sample by industry.

Table 2.2: Sample by Industry Sectors

Industry	No. of obs	%	No. of firms	%
Oil & Gas	9	0.42	1	0.51
Basic Materials	465	21.84	43	21.94
Industrials	720	33.82	71	36.22
Consumer goods	256	12.02	22	11.22
Consumer services	403	18.93	33	16.84
Telecoms	49	2.3	6	3.06
Technology	227	10.66	20	10.2
Total	2,129	100	196	100

Source: Datastream (2016) company database and own calculations, 1999-2012

Given the dynamic nature of the models estimated in the next sections, I also provide a sense of the distribution of the observations by the number of maximum spells (or continuous spells) of consecutive data in our sample. Table 2.3 presents those summary spells while Table 2.4 shows the distribution of observations by year.

Table 2.3: Sample by continuous data spells

Max. spells	No. of obs	%	No. of firms	%
5	100	4.7	15	7.65
6	126	5.92	20	10.2
7	112	5.26	16	8.16
8	160	7.52	19	9.69
9	81	3.8	9	4.59
10	90	4.23	9	4.59
11	55	2.58	5	2.55
12	132	6.2	11	5.61
13	195	9.16	15	7.65
14	1078	50.63	77	39.29
Total	2,129	100	196	100

Source: Datastream (2016) company database and own calculations, 1999-2012

Table 2.4: Sample distribution by year

Year	Obs	%
1999	92	4.32
2000	107	5.03
2001	120	5.64
2002	127	5.97
2003	133	6.25
2004	141	6.62
2005	154	7.23
2006	164	7.7
2007	177	8.31
2008	191	8.97
2009	185	8.69
2010	183	8.6
2011	181	8.5
2012	174	8.17
Total	2129	100

Source: Datastream (2016) company database and own calculations, 1999-2012

Although firm panels generally have attrition, the likely impact of attrition bias has often been neglected in this specific literature on corporate tax and investment. Quader and Tayor (2018) have for example argued that unbalanced firm panels are expected to be free from any potential selection effects and survivor bias in panels that allow for the free entry and exit of firms. Based on such similar assumptions, I note that various studies in the related investment literature such as Buettner and Hoenig (2016), World Bank (2016), Vengesai and Kwenda (2018), and Quader and Taylor (2018) assume away the risk of attrition bias. However, as pointed out by Dwenger (2009; 2014), the reasons for attrition such as cessation of business or mergers, bankruptcy, or falling below listing requirements could be correlated with the decision to invest and therefore likely to cause attrition bias. However, despite the likely attrition bias in unbalanced panels, very little attention has been paid to address this problem. Following Dwenger (2009) and Wooldridge (2002), I test for the likely effects of attrition bias in some specifications of the econometric models in this chapter.

Next, we consider the summary statistics of the key variables required to estimate the investment equations adopted in this paper. The variables are defined according to the standard literature and discussed below.

2.4.2 User cost of capital and other variables

The impact of corporate taxation on investment is traditionally analysed using the tax-adjusted user cost of capital in the tradition of the Jorgenson (1963), and Hall and Jorgenson (1967) neoclassical investment framework. Under neoclassical investment theory and assuming perfect capital markets, the user cost of capital is the channel through which corporate taxes affect investment. The user cost of capital is defined as the minimum return a firm needs on a marginal investment to cover depreciation, taxes, and the opportunity cost of investing in capital (Dwenger, 2009; Liu, 2011). Thus, the user cost is comprehensive, taking into account the investment effects of not only tax policy (e.g statutory tax rates, depreciation and investment allowances, etc) but also the macro-economic factors that impact investment such as inflation and interest rates.

Unlike the "backward-looking" average tax measures based on proportions of tax expenses to profits that have been used previously in the literature (for example Mutti and Grubert, 2004; Desai, Foley and Hines, 2007), Egger et al. (2009) argue that the "forward-looking" user cost of capital is robust to endogeneity in the context of investment models. The user cost of capital is therefore considered the theoretically sound basis for analysing neoclassical investment behaviour (Egger *et al.*, 2009; Nguyen-Thanh and Strupat, 2013).

This paper follows the user cost of capital formulation by Chartelain et al (2003) which is based on the Auerbach et. al (1983)'s model. The model uses the weighted average definition of the user cost of capital where the costs of debt and equity are weighted by their respective shares of the total liabilities of the firm. Typically, company financial statements tend to aggregate fixed assets into broader categories, making it difficult to apply user cost models such as the King and Fullerton (1984) model. The user cost formulation used in this study has been applied in other studies (such as Mojon, Smets and Vermeulen, 2002; Chatelain *et al.*, 2003; Karim and Azman-Saini, 2013; Shokr, Abdul Karim and Zaidi, 2017) that use financial statement data. Following Chartelain et al (2003), the user cost of capital based on company financial statement data can be represented as:

$$UC_{it} = \frac{P_{st}^{I}}{P_{st}} \frac{(1 - \tau_t z_s)}{(1 - \tau_t)} \left[AI_{it} \frac{D_{it}}{D_{it} + E_{it}} (1 - \tau_t) + (LD_t) \left(\frac{E_{it}}{D_{it} + E_{it}} \right) - (1 - \delta_s) \frac{\Delta P_{st+1}^{I}}{P_{st}^{I}} + \delta_s \right] \quad (1)$$

Where p_{st}^{I} and p_{st} are the price of capital goods and final goods (respectively) in sector s at time t. The implicit price series for machinery equipment is used as a proxy for the price of capital goods while the consumer price index is the proxy for the price of final goods. The corporate tax rate is represented by τ. z is the present value of depreciation allowances and is estimated using the approach in World Bank (2015) and industry-level data from Statistics South Africa. AI is the interest rate and is measured using the short-term prime overdraft rate from the South African Reserve Bank. LD is the long-term debt rate and proxies for the opportunity cost of equity and is measured using the 10-year government bond rate from the South African Reserve Bank. The book values of equity, E and debt, D come from financial statement data from Datastream (2016). The industry specific rate of economic, δ_s, is estimated from industry level financial statement data from Statistics South Africa following the approach in World Bank (2015).

The other relevant variables are defined according to the literature. Firm-specific investment $(I_{i,t})$ is calculated as capital expenditure normalized by the previous year's net capital stock $(K_{i,t-1})$. Sales $(S_{i,t})$ is calculated by deflating the nominal sales in the financial statement using the CPI and is used as a proxy for output. The data series for the variable used in this Chapter and Chapter 3 are listed in Table A1 in the appendix. Table 2.5 presents the summary statistics for the key variables used in the investment regression models.

Table 2.5: Descriptive statistics of the key variables

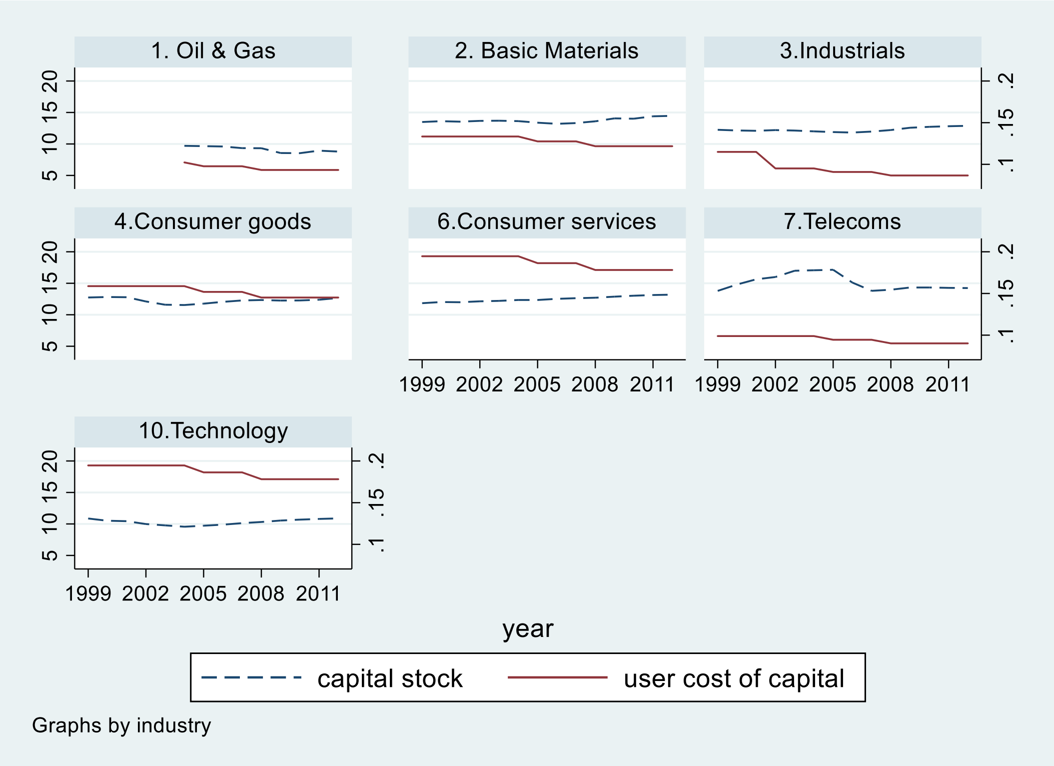
Variable	Mean	Median	Std.Dev	Min	Max
$K_{i,t}$ (R'mil)	3 340	292	9 367	0	72 800
$I_{i,t}/K_{i,t-1}$	0.338	0.227	0.454	0	4.766
$S_{i,t}$ (R'mil)	8 848	1 881	17 000	0	120 000
$\Delta.S_{i,t}/S_{i,t-1}$	0.132	0.063	0.757	-1.000	28.076
$UCC_{i,t}$	0.190	0.196	0.059	-0.074	0.284
$\Delta.UCC_{i,t}/ UCC_{i,t-1}$	0.060	-0.052	0.453	-2.051	2.685

Source: Datastream (2016) company database and own calculations, 1999-2012.

Based on Table 2.5, we first note that the firm-level data are right-skewed as expected. This is reflective of the presence of very large firms on the JSE and therefore justifies the use of capital ratios or logs to scale the model variables as suggested by Chirinko et al (1999). The summary statistics show that the average level of investment for a typical firm, as indicated by the investment-capital ratio ($I_{i,t}/K_{i,t-1}$), is about 34% of net fixed assets. The results are within the range of estimates found in studies such as Crnigoj (2016) and World Bank (2016) who reported net investment rates of 27% and 38% for Slovenia and South Africa, respectively. The average growth rate in real sales was about 13%. A related South African study (World Bank, 2016) however found a higher mean sales growth rate of about 23% using the SARS tax returns data. However, the median growth rates between our study (6.3%) and the World Bank (2016) study (8.3%) are comparable. The mean user cost of capital on the other hand increased by about 6% although the median user cost declined by about 5.2%. While the mean increase may indicate the influence of outliers or influence of the price component of the user cost, the reduction for the median firm reflects the impact of the corporate tax incentives for a typical firm over time. The pattern of movements observed above is similar to what Dwenger (2014) and Crnigoj (2016) have also reported in Germany and Slovenia, respectively.

Figure 2.1 presents the correlation between movements in capital stock and the user cost. The graph shows that gradual reductions in the user cost of capital are broadly correlated with increases in capital stock in various industries over time, although the correlations are not particularly strong. This graph should however be interpreted with caution, given the tiny sample sizes in certain industries (such as the oil and gas sector which has only 1 company).

Figure 2.1: Changes in capital and user cost over time, by industry (1999-2012)



Notes: The graph shows changes in mean log of capital and log of user cost of capital by industry, using the UCC definition based on the tax components only. Figure C1 in the appendices is based on the UCC formulation based on all aggregates.
Source: Datastream (2016) company database and own calculations, 1999-2021.

2.5 Theoretical Model and Empirical Specification

Based on the review of theory, this study uses the neoclassical empirical framework (Jorgenson, 1963; Hall and Jorgenson, 1967; Eisner and Nadiri, 1968) in conceptualising the relationship between corporate tax and investment. Following Eisner and Nadiri (1968), Chirinko, Fazzari and Meyer (1999) and Dwenger (2014), the production function for a firm i at time t can be parameterised with constant elasticity of substitution technology as:

$$F\left(K_{i,t}, L_{i,t}\right) \equiv S_{i,t} = \gamma_t\left[\eta_i K_{i,t}^{-\rho} + (1-\eta_i) L_{i,t}^{-\rho}\right]^{-\frac{\nu}{\rho}} \qquad (2)$$

where $\rho = \left(\frac{1}{\sigma}\right) - 1$, ν represents the degree of the function. η_i and $(1-\eta_i)$ are the firm-specific relative factor shares of capital K and labour L (respectively). γ_t is the year-specific production technology. Taking the first-order conditions and equalising the marginal productivity of capital and marginal cost yields the following equation of optimal capital stock $K^*_{i,t}$:

$$K^*_{i,t} = A_i T_t S^{\beta}_{i,t} UCC^{-\sigma}_{i,t} \quad (3)$$

were $\beta = \sigma + \frac{1-\sigma}{v}$. The optimal level of capital is a function of output (or sales $S_{i,t}$), a firm-specific distribution parameter A_i , technology T_t, as well as the user cost of capital $UCC_{i,t}$. The parameter of interest is the long-term elasticity of capital stock with respect to the $UCC_{i,t}$ is given by $-\sigma$. In a world without frictions and adjustment costs, a firm's current capital stock instantaneously equals the optimal capital level. Thus, the optimal capital stock can be stated as a log-linear function of the log of current sales $S_{i,t}$, the log of the current user cost of capital $UCC_{i,t}$, a firm-specific effect a_i and a deterministic time trend d_t that captures technological progress.

However, in the presence of adjustment costs, firms do not immediately adjust to their optimal targets. To capture the costs of adjustment and uncertainty, the neoclassical approach models capital stock as dependent on its lagged values, as well as both the current and lagged values of sales and user cost of capital (Chirinko, Fazzari and Meyer, 1999). Adding the stochastic error term $\varepsilon_{i,t}$ yields the following equation of current capital stock:

$$k_{i,t} = c + a_i + \sum_{h=1}^{H} \phi_h k_{i,t-h} + \sum_{h=0}^{H} \beta_h s_{i,t-h} - \sum_{h=0}^{H} \sigma_h ucc_{i,t-h} + \sum_{t=1}^{T-1} \tau d_t + \varepsilon_{i,t} \quad (4)$$

The prevailing estimating model proposed by Chirinko et al., (1999) and applied in subsequent studies assumes that investment typically comprises replacement and net components, with replacement capital being proportional to the beginning of period capital. Net capital is defined as the change in stock scaled by the beginning of period capital stock:

$$\Delta k_{i,t} = \frac{I_{i,t}}{K_{i,t-1}} - \delta_i \tag{5}$$

Given that firm-level data typically exhibit large differences in size and are right-skewed, Chirinko et al., (1999) propose specifying the equation for capital in ratios. Thus, the estimating equation can be presented in the following auto-regressive distributed lag form:

$$\frac{I_{i,t}}{K_{i,t-1}} = \delta_i + \sum_{h=1}^{H} \phi_h \frac{I_{i,t}}{K_{i,t-h-1}} + \sum_{h=0}^{H} \beta_h \Delta s_{i,t-h} - \sum_{h=0}^{H} \sigma_h \Delta ucc_{i,t-h} + \Delta \varepsilon_{i,t} \tag{6}$$

Equation (6) is the prevailing estimating equation that the literature uses, and this study also adopts this specification with one lag investment lag and three lags on output and user cost of capital. This specification enables comparison with findings from the broader ARDL based literature (such as Chirinko, Fazzari and Meyer, 1999; Dwenger, 2009; Simmler, 2012; Črnigoj, 2016).

Estimating this model using standard OLS would yield biased and inconsistent estimates due to the likely presence of endogeneity from various sources. As shown by Goolsbee(2000), OLS is considerably biased towards zero due to measurement error in the UCC. Given that this paper uses price aggregates at the national and not firm-level, measurement error is likely present. There is also a possibility of the presence of simultaneity bias between investment and the UCC variable as investment shocks may affect investment which would, in turn, impact interest rates and the UCC (Chirinko, Fazzari and Meyer, 1999; Goolsbee, 2004). Investment may also be contemporaneously determined with output (Dwenger, 2009). These issues in the context of the dynamic nature of the investment equation suggest the use of an instrumental variable estimator.

Although one may make a simplifying assumption of “no unobserved individual effect” and estimate the investment equation using OLS as done by Lang et al (1996), such an assumption would be overly simplistic likely lead to biased estimates in the context of firm-level data. Using the fixed effects estimator would help address the failure of OLS to control for individual effects, however, the fixed effects estimator would still not adequately address the endogeneity that arises in the context of dynamic models. Nickell (1977) argues that with fixed effects, the mean error term would still be correlated with the mean of the lagged dependent variable even when the sample size increases indefinitely.

Although a possible solution to the Nickell bias is the Anderson-Hsiao (1982) (A-H) estimator which reduces dynamic bias by first differencing, the A-H estimator does not take into account all the available moment conditions and has been found to be relatively inefficient. To obtain more efficient estimates, this chapter uses GMM estimators that exploit all available moment conditions thereby solving the problem of weak instruments and yielding more efficient results. In particular, we adopt the system GMM estimator by Blundell and Bond (1998) over the difference GMM estimator (Arellano and Bond, 1991) as the former uses more moment conditions and shown to be more efficient than the latter (Roodman, 2009a). However, given the well-known fact that GMM is not foolproof and sensitive to specifications, caution is taken throughout the thesis to subject all GMM estimates to various specification checks including changing the type of instruments, varying the length of the instruments, and performing diagnostic tests such as the Sargan- Hansen test for the validity of instruments and the Arellano and Bond AR (2) test for second-order serial correlation. The next section presents and discusses the findings of this paper.

2.6 Results and discussion

2.6.1 Main findings

Table 2.6 presents the results of estimating the baseline investment model specified in Equation (6). The first column presents results from the OLS model, while the last two columns present results estimated using the system GMM estimator (by Blundell and Bond, 1998). The OLS results are used as a benchmark, to enable comparison with estimates obtained using the more consistent GMM estimator given the problem of endogenous regressors and dynamic panel bias that OLS fails to address.

Table 2.6: Estimates of user cost of capital and sales

$I_{i,t}/K_{i,t-1}$	OLS (1)	GMM (2)	GMM (3)
$I_{i,t-1}/K_{i,t-2}$	0.253***	0.297***	0.239***
	(0.055)	(0.063)	(0.064)
$\Delta ucc_{i,t}$			
σ_0	0.007	0.016	0.022
	(0.048)	(0.042)	(0.043)
σ_1	-0.063***	-0.039	-0.044*
	(0.023)	(0.027)	(0.024)
σ_2	-0.063**	-0.040*	-0.046**
	(0.024)	(0.023)	(0.021)
σ_3	-0.037	-0.024	-0.025
	(0.022)	(0.022)	(0.021)
SUM(σ)	**-0.156***	**-0.087**	**-0.093**
	(0.088)	(0.090)	(0.076)
$\Delta\beta_{i,t}$			
β_0	0.336***	0.458**	0.464**
	(0.115)	(0.204)	(0.199)
β_1	0.161***	0.119**	0.149***
	(0.048)	(0.051)	(0.046)
β_2	0.016	-0.006	0.004
	(0.052)	(0.060)	(0.062)
β_3	-0.007	-0.033	-0.043
	(0.043)	(0.060)	(0.066)
SUM(β)	**0.506***	**0.539***	**0.574***
	(0.139)	(0.209)	(0.228)
Observations	1,083	1,083	1,083
No. of firms	174	174	174
No. of instruments	-	124	161
AR(1) (p-value)		0.011	0.012
AR(2) (p-value)		0.626	0.745
Sargan-Hansen (p-value)		0.318	0.270

Notes:
Dependant variable: Investment, scaled by the replacement cost of the beginning of period capital stock ($I_{i,t}/K_{i,t-1}$). *S*UM(σ) and *S*UM(*β*) denote the long run coefficient of the user cost of capital and output respectively, calculated as described in the text. Standard errors in parentheses. Significance levels are denoted as: *** p<0.01, ** p<0.05, * p<0.1. Column (1) is estimated using pooled OLS with cluster-robust standard errors. Columns (2) and (3) are estimated using the system GMM estimator with robust standard errors. The instruments for the estimated equations are the lags of the regressors. All regressions include industry-year effects.
Source: Datastream (2016) company database and own calculations, 1999-2012.

Turning to our variable of interest, Table 2.6 shows that although the user cost of capital coefficients fall within the anticipated range and have the desired direction (-0.16 to -0.09), corporate tax policy did not impact capital investment in South Africa in the period under study. The user cost coefficients remain insignificant under both the OLS and GMM models[3]. However, as is well known, the OLS estimates are potentially endogenous in the context of dynamic panels. Using GMM to control for dynamic panel bias, our coefficient estimates become even smaller in comparison with the OLS estimates[4]. The GMM coefficient size estimate of about -0.1 (as shown in Columns (2) and (3)), represents only one-tenth of the theoretical UCC coefficient size of negative one (-1).

The results above are similar to other studies that find an insignificant effect of corporate tax policy on investment. For instance, a recent World Bank supported study found a small and insignificant user cost coefficient (of -0.13) in large manufacturing sector firms in South Africa (World Bank, 2016). Similarly, Verbič and Črnigoj (2014) and Crnigoj (2016) also found that the user cost of capital among Slovenian firms was overall small (-0.08) and insignificant. Yagan (2015), focussing on the dividend component of corporate tax policy also found a zero effect of corporate tax policy changes on investment in the USA. Our findings may be due to factors such as potential measurement error in the user cost of capital, limited variation in the user cost of capital, or the investment dampening effects of the 2008/9 financial crisis. We explore and discuss these issues further in section 2.6.2.

The other results in Table 2.6 show that sales (or output) has a positive and significant coefficient as expected. In particular, for every 10% increase in output, capital investment rises by between 5 - 6%. The results are quite precisely estimated across all the specifications and fall within the range of coefficient estimates found in studies that have used the ARDL and DL specifications (see for example Chirinko et al., 1999; Dwenger, 2009; 2014; and Simmler, 2012).

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[3] Across all models in Table 2.6, the wald tests reject the null hypothesis that UCC coefficient is equal to -1 and fail to reject the null of zero coefficients (p-value = 0.000 across all models). These tests confirm that UCC is indeed statistically insignificant.

[4] This is suggestive of the bias correction due to GMM even though the results remain insignificant. The findings of insignificant effects of UCC on investment persist even when the length of the instrument lags is varied from 2 -5 (Column 2) to 2-7 years (Column 3) as shown in Appendices A2 and A3.

Before discussing the implications of the findings in this paper, it is important to review the adequacy of the estimated model and validity of the estimation techniques and instruments used. First, is the baseline model in Equation (6) indeed a dynamic series? To answer this, we focus on the coefficients of the lagged investment variable in the first row of Table 2.6. As can be seen, the investment lag is significant and persistent in all the specifications. In particular, the results indicate that past investment explains about 24% to 30% of current investment. The coefficient sizes of the lagged investment variable are also consistent with the notion of dynamic stability (Bond, 2002) in all the specifications. Taken together, these results suggest that specifying the baseline investment model as a dynamic or autoregressive is reasonable and allays any concerns of bias due to model misspecification.

Next, we consider a few diagnostic tests, given that dynamic GMM estimators are only consistent and efficient in the absence of serial correlation in the transformed error terms and when instruments are valid. Arellano and Bond (1991) and Blundell and Bond (1998) suggest running the Sargan-Hansen tests of over-identifying restrictions to check for the validity of the instruments; and running the Arellano-Bond test to check for second-order serial correlation in the transformed lag. These diagnostic tests are inbuild in the xtabond2 Stata module (Roodman, 2009a, 2015) and reported in all the dynamic estimations in this study. As can be seen in Table 2.6, the AR (2) test (with the p-values at 0.626 and 0.745, respectively) fails to reject the null hypothesis of no second-order serial correlation. The Sargan-Hansen test (with the p-values of 0.318 and 0.270, respectively) also fails to reject the null hypothesis that the instruments are valid. These two diagnostic tests suggest that the estimated dynamic GMM specifications are reliable.

Furthermore, it is well known that dynamic GMM estimations can be sensitive to changes in specification, especially if the underlying model is misspecified. To check the stability of the baseline results in Table 2.6, I follow the suggestions in Roodman (2009a) and re-run the estimations by varying specifications such as the length of the instrument lags, using different instruments, and changing estimation procedures (two-and one-step; and comparing the system-versus difference-GMM estimations). The results remain largely stable. The finding that tax policy does not impact capital investments is consistent, as the user cost of capital coefficient remains insignificant in all the alternative models specified. In addition, the alternative specifications confirm the persistence of investment and the impact of output on investment in all the specifications. The results of the above alternative specifications are presented in Tables A2, A3, and A4 in the appendix.

2.6.2 Robustness checks

The results presented so far may be sensitive to factors such as attrition, the effects of the 2008/2009 financial crisis, and even potential measurement error in the user cost of capital. To assess whether the results remain stable after controlling for some of the likely biases, a few checks are performed. First, given that this study uses an unbalanced panel, attrition may be a problem if firms leave the sample in a non-random way. Unobservable factors that affect attrition may also be correlated with the decision and level of investment. Not accounting for attrition in the investment equations may therefore lead to endogenous estimates. Surprisingly, despite the risk of potentially endogenous estimates, most studies in this specific investment-tax literature do not account for the potential bias due to non-random attrition. A quick review of about a dozen relevant studies that focus on the nexus between investment and user cost indicates that only Dwenger (2009;2014) has discussed and tested for the likely impacts of attrition the estimations[5]. All the other studies beginning with the seminal paper by Chirinko et al (1999) appear largely pre-occupied with only estimating the user cost coefficient. The issue of attrition appears quite distant, even amongst other notable studies such as Bond *et al.*, (2003), Almeida and Campello (2007) and Baum *et al.*, (2011) that have focussed on the financial (as opposed to the neoclassical) determinants of investment.

One justification for overlooking the dynamics of exit may be found in Quader and Taylor (2018), who argue that allowing for the entry and exit of firms over time potentially "frees" the sample from any selection effects and survivor bias. Although this argument may hold, it is nevertheless prudent to test for the presence and likely bias due to attrition whenever possible. This study implements a three-step attrition test procedure outlined in Wooldridge (2002) and applied by Dwenger (2014). In the first step, the probability of dropping out of the sample is predicted based on predictors such as the profit margin, changes in real sales, and firm size as proxied by total assets. I then calculate the inverse mills ratio (IMR) in the second step and

[5] Table A5 in the appendix shows a list of the relevant studies reviewed.

finally include the IMR in estimating the main investment equation. To obtain consistent standard errors, the standard errors are bootstrapped. The results of estimating the main investment model controlling for attrition bias are contained in the Appendices in Table A6 (Panel A).

Secondly, selection bias due to the entry of new firms may be a concern. New entrants may be typically structurally different from established surviving firms. Moreover, new entrants would not have prior-period records, thereby posing difficulties especially on the measurement of variables with lags. In the case of listed firms, however, companies may exist long before they are listed and could thus be operationally similar to existing firms in some respects at the time of listing. Due to the absence of information on the nature of entries, I cannot directly control for new entrants. Nonetheless, to see whether the full sample estimates are likely influenced by new entries, I compare the full sample results with the estimates from a sub-sample of survivor firms only. Those results are reported in the Appendices in Table A6 (panel B).

The test for attrition reveals an insignificant inverse mills ratio. This suggests that non-random attrition is not an issue in this dataset. The estimates in this study are therefore not biased by the presence of attrition in the data. These findings are in line with Dwenger (2009; 2014) who found that attrition did not bias results in a similar study in Germany. The results in Table A6 also indicate no differences between the full sample and restricted regression for survivor firms, suggesting that my estimates are not significantly influenced by the entry of new firms on the stock exchange.

Next, I consider the likelihood that the null effect of tax policy on investment in my study may simply be due to the impact of the 2008/2009 financial crisis. Given that my sample spans the period 1999-2012, there is a possibility that the observed unresponsiveness of investment to corporate tax changes may simply be due to the investment dampening effect of the 2008/2009 financial crisis. To investigate this possibility, I re-estimate the base model in Equation (6) for the period 1999-2008 just before the full impact of the crisis materialised. If the full sample (1999-2012) estimates were simply a reflection of the dampening effects of the financial crisis, I expect that the pre-crisis sample estimation to yield a significant tax coefficient if corporate tax reforms influenced capital investment. Table A7 in the Appendix shows the results of this estimation.

As can be seen in Table A7, our estimates of the investment model before the 2008/2009 financial crisis show that South African corporate firms did not increase their investments in response to changes in corporate tax reforms. These findings suggest that the corporate tax is simply not the channel through which investment accumulates in South Africa.

Lastly, I consider the possibility that the null effects found in this paper may simply be due to measurement error in the user cost of capital estimate used here. As shown by Goolsbee (2004), measurement error could bias the user cost of capital towards zero. Given that several components of the user cost of capital in Equation (1) are only available at the industry or national level, measurement error could be an issue in this study. For instance, I used aggregate producer prices of machinery equipment and the aggregate CPI as proxies for the firm-specific investment goods price and firm-specific output prices as required in Equation (1). To rule out the possibility that the effect of the user cost of capital could be annulled by the influence of the industry aggregates, I re-estimate the baseline model purely focusing on the tax components of the UCC specified as $(1 - \tau_t z_s)/\,(1 - \tau_t)$[6]. The results reported in Table A8 in the appendix do not dispute the overall conclusion that corporate tax policy does not influence investment in South Africa.

2.7 Discussion

Our finding that investment does not significantly respond to tax incentives in the neoclassical framework are similar to other studies in Slovenia (Verbič and Črnigoj, 2014; Črnigoj, 2016) and in South Africa (World Bank, 2016). More generally, the findings belong to a broader category of studies that have questioned the importance of corporate tax policy in investment determination (Fazzari *et al.*, 1988; Chirinko, Fazzari and Meyer, 1999; Harhoff and Ramb, 2001a; Yagan, 2015). Fazzari et al (1988) have argued that in the presence of liquidity constraints, investment may no longer respond to neoclassical fundamentals such as corporate

[6] Bond and Xing (2015) similarly restrict their UCC specification to the tax component. This specification however lacks within firm variation in the user cost.

tax changes. The separability between investment and financing structure no longer holds under imperfect capital market conditions, resulting in capital investment responding to the availability of internal finance rather than to tax policy.

The null effect of corporate tax found in this paper may suggest evidence of the presence of financial constraints among South African firms. Recent studies provide evidence of the presence of significant financial constraints and the importance of leverage among South African firms (Makina and Wale, 2016; Vengesai and Kwenda, 2018). Evidence from World Bank surveys also suggests that corporate taxes are not the biggest concern for most firms, but that a lack of access to affordable finance is a key constraint to firm performance (Mthimkhulu and Aziakpono, 2015; World Bank, 2015). The presence of financial imperfections in South Africa is therefore likely to be a reason for the insignificant impact of corporate tax policy on investment in South Africa.

Besides the presence of financial constraints, other factors may contribute to the null effect of corporate tax policy on investment. First, not all the tax incentives have been modelled in this study. As already discussed, some incentives under the Department of Trade and Industry's 12i Tax Allowance Incentive could not be incorporated in the UCC computation due to a lack of data. To the extent that such incentives cause significant reductions in marginal taxes, their positive effects are not captured in this study. Second, there is also a possibility that the overall corporate tax reform package may not be material enough to translate into significant investment impacts. As found in Cevik and Miryugin (2018), firm investment may not respond to corporate tax changes in circumstances where corporate reforms are only piece-meal and negligible. Third, there is a possibility that the non-response of investment to corporate tax policy could simply be due to the practice of profit-shifting by JSE companies with links to multinational corporations. Using South African tax data, Wier (2020) recently found evidence of tax-shifting of profits to low-tax jurisdictions by large South African corporations. In particular, the study found that related party invoice pricing was about 8% higher than pricing at arm's length - translating to a transfer pricing loss estimated at 0.5% of corporate tax payments (Wier, 2020). To the extent that profit shifting is significant and perverse, corporate tax incentives may not result in capital investment in South Africa but instead, tax incentives could be used to subsidise investment and profit generation in other jurisdictions.

This paper therefore calls for more studies that explore the responsiveness of investment to all corporate tax including those directly and preferentially administered by the South African Department of Trade and Industry. We also call for studies that investigate whether threshold effects exist in respect to the depth of corporate tax changes and investment in South Africa; and finally, we also call for more research on whether the illegal practice of profit shifting negates the effects of corporate tax incentives on investment formation in South Africa.

2.8 Conclusion

This paper considered the impact of corporate tax changes on capital investment among South African listed firms. The study used company balance sheet and financial statement data of non-financial companies listed on the Johannesburg stock exchange. The study exploits rare variations in the marginal statutory tax rates and capital depreciation allowance provisions to estimate the user cost of capital elasticity. We find that while the changes in corporate tax policy successfully lowered the marginal cost of investment, the reductions did not translate into significant increases in capital investments. The results therefore suggest that capital investment policy in South Africa must look beyond corporate tax policy. Focusing reform efforts on improving efficiency in the financial markets could help firms lower their marginal costs and expand investments. These recommendations are supported by investor perceptions from a recent World Bank survey in which financial and infrastructural deficiencies were identified as some of the greatest constraints to investment and growth in South Africa.

However, as hypothesised by Fazzari *et al* (1988), the null effect of corporate tax reductions on firm investment could be suggestive of the presence of imperfect capital conditions in the South African capital markets. If this were the case, then part of the reason for the failure of the user cost of capital channel in explaining investment in South Africa could be the presence of financial frictions. The next chapter (Chapter 3) explores the role of financial constraints in firm-level investment formation in South Africa.

Chapter 3

3. Do financial constraints affect firm-level investment?

3.1 Introduction

This chapter follows directly from the previous one, where I found that despite notable changes to corporate tax policy aimed at stimulating investment in South Africa, firm-level investment remained unresponsive to tax incentives. According to the predictions of the neoclassical investment model (Jorgenson, 1963) used in the previous Chapter, corporate tax incentives are expected to impact investments by altering the tax-adjusted marginal cost of capital. Following the post-Jorgenson investment literature, a plausible reason for the failure of the user cost channel in explaining investment in the previous chapter is the presence of financial constraints.

A crucial assumption of neoclassical investment theory is that internal and external finance are perfect substitutes. Consequently, profit maximising firms can undertake all profitable investment projects without constraints in the availability of internal or external resources. The validity of the assumption of perfect substitutability of internal and external finance has however been questioned (Eisner and Nadiri, 1968). Myers and Majluf (1984) have argued that real-world capital markets are characterised by imperfect conditions such as information asymmetry and agency costs, which impose a wedge between the costs of internal and external funds. In such scenarios, firms' investment decisions may no longer respond to neoclassical fundamentals, but financial factors such as the availability of internal finance (Fazzari *et al.*, 1988). This chapter tests this hypothesis using the same dataset and similar methodological framework as Chapter 2.

Following the work by Fazzari *et al.*, (1988), several empirical studies have emerged to investigate the link between investment and financial constraints (see for example Bond and Meghir, 1994; Bond et al, 2003; Almeida and Campello, 2007; Quader and Taylor, 2018). The literature generally suggests that financial constraints are important in firms' investment decisions. In particular, the availability of internal finance has been found to be crucial for fixed capital investment in financially constrained firms even in advanced economies.

There are however some important gaps in the literature. First, there is an ongoing discussion about the effectiveness of the sample splitting strategy used in the prevailing literature. The dominant identification strategy for the presence of financial constraints follows the work of Fazzari *et al.*, (1988) and involves estimating a financial constraints investment model over two groups of firms: one deemed to be financially constrained and the other thought to be financially unconstrained. Evidence for the presence of financial constraints is established if the responsiveness of investment to financial constraints variables is higher among the constrained firm than those that are unconstrained. This is under the assumption that relatively more constrained firms would rely more on internal resources than firms considered to be less financially constrained. The classification criteria typically use variables believed to reflect varying degrees of asymmetric information and agency costs. Thus, firms that have relatively higher asymmetric information and agency costs would be deemed to face relatively higher costs of external finance, and thus be included in the financially constrained group (and vice versa for those deemed to have relatively less informational and agency cost problems).

Different sample splitting criteria have been used in the literature. Examples include; dividend pay-out (Fazzari *et al.*, 1988; Gilchrist and Himmelberg, 1995; Denis and Sibilkov, 2010), firm-size (Almeida, Campello and Weisbach, 2004; Almeida and Campello, 2007; Črnigoj and Verbič, 2014) and group affiliations (Hoshi, Kashyap and Scharfstein, 1991; Chirinko and Schaller, 1995; Lensink, Van der Molen and Gangopadhyay, 2003).

A problem with the commonly used sample splitting strategy is that classification can be quite sensitive to the choice of splitting indicator and threshold values (Hovakimian and Titman, 2006). Furthermore, the *a priori* sample splitting strategy may cause endogenous sample selection if the sample classification criterion is correlated with the investment decision process (Hobdari et al, 2009). In the context of panel data, another problem that emerges is that the *a priori* partitioning of firms may cause static misclassification (Hu and Schiantarelli,1998), whereby the classification of firms remains static over the entire sample even when firm's financial constraints status may change with time. Hu and Schiantarelli (1998) further argue that even where care is taken to allow firms to exogenously change regimes from one period to another, the risk of dynamic misclassification and bias would persist.

The above sample classification issues remain unresolved, with little agreement on how to best classify firms as financially constrained or not. In addition to this problem, the financial constraints literature lacks sufficient evidence from developing country contexts. Most of the literature is disproportionately focused on advanced economies (Fazzari, Hubbard and Petersen, 1988; Hoshi, Kashyap and Scharfstein, 1991; Bond *et al.*, 2003; Almeida and Campello, 2007; Baum, Schäfer and Talavera, 2011). This is rather surprising, given that most developing countries are arguably more severely financially constrained than those in advanced regions (Edjigu and Sim, 2019). To the extent that the impact of financial frictions in capital markets in advanced economies is different from that in developing countries, developing country investment strategies may be poorly designed and ineffective in achieving the much-needed investment.

This study investigates the role of financial constraints in investment formation among South African firms. The study adopts the dominant single factor sample classification criteria to identify the role of financial constraints in South African corporate firms. The study uses GMM estimation to address some of the endogeneity concerns that arise in dynamic investment models. This study makes the following contributions to the literature. First, by focusing on South Africa, the study provides evidence on the link between financial constraints and investments in a developing country context. This helps close the evidence gap in the literature on financial constraints in developing countries. Secondly, by finding consistent results across various sample splitting criteria using various estimation techniques (OLS, GMM, endogenous switching regression), this study contributes robust evidence of the presence of financial problems even among large firms in developing contexts.

3.2 Literature Review

The relevant theoretical framework for contextualising the relationship between financial restrictions and investment is provided by Modigliani and Miller (1958) and Myers and Majluf (1984). Under the assumption of no information asymmetries and agency costs, Modigliani and Miller (1958) postulate that financial structure is irrelevant to real decisions. The market value of a firm therefore only depends on the expected net income flows from potential investments and not on financial structure. Under this view, a firm will undertake all positive net present value projects it desires without limitations because internal and external funding are perfect substitutes. The irrelevance theory has however been criticised for its unrealistic assumption about perfect conditions. As observed by Hubbard (1998), financial markets are in many cases characterised by incomplete and asymmetric information between the firms and lenders of capital funds.

Following the shortcomings of the Modigliani-Miller (1958) theorem, Myers and Majluf's (1984) pecking order emerged as the relevant theory in explaining the role of financial constraints in firm investment. According to Myers and Majluf (1984), firms could have information about prospective investment projects that investors may not. Accordingly, the presence of informational asymmetries and contract enforcement problems could result in agency costs that differ according to the source of finance, leading to a pecking order in the preference of capital sources. Myers (1977) and Myers and Majluf (1984) show that if external funders are less well informed about the value of a firm relative to firm insiders, capital providers would demand a higher premium to offset possible losses arising from financing “lemons” (or projects with hidden risks) due to adverse selection. Therefore, as predicted by the pecking order theory, firms will prefer to finance investment projects using internal funds as the priority source of funds. External debt is only preferred when internal financing is insufficient or constrained, while equity financing is the last resort (Myers and Majluf, 1984).

Building upon the above theoretical insights (Myers, 1977; Myers and Majluf, 1984), Fazzari *et al.* (1988) were the first to empirically estimate the impact of capital imperfections in traditional investment models. Fazzari *et al.* (1988) pre-suppose that in the presence of financial constraints, the cost of external finance is substantially higher than the opportunity cost of internal finance, and therefore financially constrained firms would rely more on lower-cost internal financing for investments. Accordingly, the responsiveness of investment to financial factors would indicate the degree to which firms face information and agency costs. More financially constrained firms would have a higher sensitivity of investment to the availability of internal finance relative to the less constrained firms. In testing this hypothesis, Fazzari *et al.* (1988) use US firm-level data and classify firms as financially constrained or not using dividend pay-out ratio. The study assumes that firms with lower dividend ratios are more likely to be financially constrained relative to firms with higher dividend ratios. Further, the study adopts cash flow as a better proxy of internal finance over net profits. Estimating both the structural (Q model) and neoclassical (accelerator) investment models over the two sub-samples, Fazzari *et al.* (1988) found that investment-cash flow sensitivity was not only higher in the low dividend-paying firms, but also increased with the increasing financial constraints (Fazzari et al, 1988).

The identification strategy in Fazzari *et al.* (1988) has since prevailed in the financial constraints literature, with various studies confirming the presence of financial constraints using differing sample separation criteria. Using the firm size or age, for example, studies such as Devereux and Schiantarelli (1990), Budina *et al.* (2000) and Črnigoj and Verbič (2014) find that investment in younger or smaller firms is more constrained and dependent on internal finance compared to relatively more operationally mature or larger firms. As explained in the literature, younger and smaller firms are likely to have informational problems such as poor revenue records or low collateral assets. These informational problems are likely to result in high external finance costs thereby constraining the ability of smaller and younger firms to invest (Schiantarelli, 1996; Kumar and Ranjani, 2018). Group affiliation has also been a commonly used sample classification criteria, under the assumption that firm membership to a business group helps reduce informational and contract enforcement problems, group affiliation is expected to improve affiliates' access to external finance (Schiantarelli, 1996). Studies that use business groups (for example Hoshi et al, 1991; Lensink et al, 2003) find that group affiliates have lower financial constraints compared to stand-alone firms.

Another commonly used single classification criteria used is dividend-pay out. Almeida and Campello (2007) and Denis and Sibilkov (2010) find that low dividend-paying firms, which are most likely financially constrained, have higher investment-cash flow sensitivities than firms that make higher dividend pay-outs. Evidence for financial constraints has also been found in studies that have used other less common sample grouping variables such as stock issuance (Bond and Meghir, 1994; Crisóstomo et al, 2014) and capital intensity (Kalatzis et al, 2008).

Although several studies have found evidence of financial constraints using sample splitting approaches similar to Fazzari *et al* (1988), other studies have questioned the adequacy of the dominant classification approach. Using the same sample of firms as that in Fazzari *et al* (1988), Kaplan and Zingales (1997) find evidence in contrast with the findings in Fazzari *et al* (1988). In particular, they find that when the sample-splitting criterion is based on firm's operating performance and managers' assessments of financial need, the investment cashflow sensitivity of companies deemed to the financially constrained is lower than that of financially unconstrained firms. Kaplan and Zingales (1997) argue that under certain circumstances, the investment-cash flow sensitivity may increase as financing constraints are relaxed. For example, low constraint firms with more liquid assets may report a higher investment sensitivity simply because of the leverage effect and not necessarily due to financial constraints (Kaplan and Zingales, 2000). Although Fazzari et al (2000) subsequently defended their 1997 seminal work by pointing out the likely subjectivity bias in Kaplan and Zingales (1997), an important point had been highlighted. In particular, the Fazzari-Kaplan exchange showed that the investment-cash flow coefficient could be sensitive to classification criteria.

Another strand of literature has sort to use direct measures of constraints in a bid to find effective classification criteria. Typically, these methods involve directly obtaining company finance managers' assessments of financial constraints and impacts on business outcomes. One advantage of direct measures is that they side-step the interpretational problems inherent in proxy measures such as cash flow (Savignac, 2008). Using data from interviews with company CFOs from the US, Europe, and Asia, Campello *et al*, (2010) find that the majority of the financially constrained firms bypassed attractive investment opportunities due to the inability to borrow externally. Moreover, financially constrained firms also used more cash flows and relied more on asset sales to fund operations (Campello et al, 2010). Savignac (2008) also finds significant evidence of the existence and impact of financial constraints on innovative capabilities among French firms. Other studies (such as Ayyagari et al, 2008; Edjigu and Sim, 2019) have also used direct measures of financial constraints and established their impacts in developing regions. Perception-based studies have however criticised for being unreliable in most cases and potentially affected by classification bias problems (Fazzari et al, 2000).

The third strand of literature has used indices to classify firms based on firm characteristics or variables that predict financial constraints. For instance, Cleary (1999) used US firm data to construct a multivariate classification index of factors such as debt ratio, sales growth, net income margin and others thought to determine financial constraint status. Using that index, Cleary (1999) found that in contrast with several prior studies, the sensitivity of investment to cash flow was higher in less constrained firms than in more constrained firms. However, using a differently defined multi-variate index, Lamont et al (2001) do not find any difference in the impact of financial constraints on firm performance. Subsequent studies such as Musso and Schiavo (2008) have used synthetic indices based on seven indicators deemed most closely associated with financial constraints. That study found evidence in support of Fazzari et al's (2000) hypothesis that investment reacts more to cash flow in financially constrained firms. The findings in Musso and Schiavo (2008) were subsequently supported by Hadlock and Pierce (2010) who carefully defined multiple financial classification schemes based on firm-level qualitative data. Based on their results, Hadlock and Pierce (2010) criticise the classification index used in Kaplan and Zingales (1997) as ineffective and propose simply using firm size and age as the sole basis for classifying financial constraints in subsequent studies. Mulier et al (2016) who subsequently use a simple index that emphasises the role of firm size and age in predicting financial constraints find results in support of the proposition in Hadlock and Pierce (2010) that simple measures could be effective in characterising financial constraints.

Given the observed sensitivity of results to classification criteria in single or multivariate-index criteria, Hu and Schiantarelli (1998) have used endogenous switching regression techniques to address the problems and biases inherent in ex-ante sample separation. One problem with traditional ex-ante partitioning is that classification is prone to static misclassification, whereby the classification of firms remains frozen over the entire sample even when the firm's financial constraint status changes (Hu and Schiantarelli, 1998). The risk of misclassification and bias would persist in the dynamic sense, even if care was taken to allow firms to exogenously change regimes from one period to another (Hu and Schiantarelli, 1998). More importantly, ex-ante separation of firms may cause endogenous sample selection problems if the partition indicator is correlated with the investment decision process (Hausman and Wise, 1977; Hobdari et al 2009). To overcome these biases, endogenous switching regression models with unknown sample separation have been applied by a few studies in the financial constraints literature. In these models, both the probability of belonging to a given regime and the investment determination process are simultaneously determined, thereby side-stepping the problem of ex-ante classification bias. Applying the endogenous switching model on US manufacturing firms, Hu and Schiantarelli (1998) find evidence of relatively higher investment-cash flow sensitivity among financially constrained firms. Subsequent studies have used the endogenous switching regression methods in the US (Hovakimian and Titman, 2006; Almeida and Campello, 2007) and Estonia (Hobdari et al, 2009) and find evidence similar to Hu and Schiantarelli (1998). The findings from this nascent literature support the notion that even after controlling for potential endogeneity due to sample selection, financial constraints are important in investment decisions.

While the above literature suggests evidence for the importance of financial constraints in investment decisions, gaps remain. First, most of the empirical evidence is disproportionally concentrated in advanced economies, with most of the evidence coming from the US (Fazzari *et al.*, 1988; Hu and Schiantarelli, 1998; Almeida and Campello, 2007; Denis and Sibilkov, 2010; Ağca and Mozumdar, 2017) or Western Europe (Bond *et al.*, 2003; Carpenter and Guariglia, 2008; Bertoni, Colombo and Croce, 2010; Mulier, Schoors and Merlevede, 2016; Quader and Taylor, 2018). A relatively smaller number of studies has come from transitional Eastern European countries (Budina, Garretsen and De Jong, 2000; Črnigoj and Verbič, 2014; Schwarz and Pospíšil, 2018) and are largely motivated by the need to understand the extent to which the formerly communist economies still face capital markets constraints. Little evidence has come from developing economies such as China, Brazil, or India (Poncet et al, 2010; Bassetto and Kalatzis, 2011; Kumar and Ranjani, 2018). Moreover, the evidence from these significantly larger and structurally different economies may not be directly applicable to the South African context.

Although a few studies have investigated financial constraints in the sub-Saharan context (Ayyagari, Demirgüç-Kunt and Maksimovic, 2008; Fowowe, 2017; Edjigu and Sim, 2019), this Chapter fails to draw much inference from those studies because all are cross-country studies and none specifically focuses on the impact of financial constraints on investment. Moreover, these studies likely suffer from endogeneity problems arising from perception bias due to the use of firm managers' self-reports of constraints (Fazzari et al, 2000). Furthermore, while only two studies have been found on the topic of financial constraints in South Africa (Kwenda, 2015; Makina and Wale, 2016), these studies use tiny sample sizes and could therefore only be considered as exploratory at best. Moreover, the studies do not address the issues of financial constraints on capital investment.

The second gap relates to the problem of *apriori* sample classification. As already discussed, results in the financial constraints literature are sensitive to the choice of sample splitting criteria in some cases. In addition, *apriori* sample separation criteria could be endogenous. Despite concerns about endogenous sample bias, very few studies have addressed this issue in the literature.

This study therefore extends the financial constraints literature by using the South African context, thereby contributing reliable evidence on the topic in the context of a large developing country. The study also adds to the literature by using various classification criteria to assess the consistency of the findings to alternative sample splitting criteria using the dominant approach. This study also controls for the potential endogenous sample bias by estimating an endogenous switching regression.

3.3 Empirical Framework

3.3.1 Estimating model

The financial constraints literature has followed the empirical framework of Fazzari et al, (1988) where financial constraints are estimated and established using either the reduced form neoclassical investment model or Tobin's Q. An important concern in the literature is that the observed sensitivity of investment to cash flow may simply be due to omitted future profitability variables rather than the real impact of financial constraints on investment. To allay these concerns, Fazzari et al, (1988) control for the future profitability of company stocks in their estimation by including the Tobin's Q ratio in their investment regression. With future profitability controlled for, one could then interpret a positive difference in the investment-cash flow coefficients between the constrained and unconstrained firms as evidence of financial constraints. Although structural models (like the Q or Euler) have the advantage that they are directly derived from the firm's dynamic optimisation problem (Bond and Van Reenen, 2007), the use of average Q in the empirical studies as a proxy of the unobservable Q has been criticised. Erickson and Whited (2000) and Cummins et al, (2006) have shown that measurement error in average Q may be transmitted to the cash flow coefficient, thereby making it difficult to isolate the effects of financial constraints from future market opportunities.

To avoid the measurement error complications inherent in Q models, reduced form neoclassical investment models are commonly used in the financial constraints literature. In these models, the log of the first differences of sales ratios or the ratio of changes in real sales to capital has been used as proxies for expected future profitability in place of the problematic Q ratio. Fazzari et al, (1988) have shown that output-based expected demand proxies outperform Tobin's Q in most cases. Furthermore, tax variables are often excluded from financial constraints models to avoid the bias inherent in including insignificant variables[7]. Based on empirical specifications in the literature (such as Fazzari *et al.,* 1988; Budina, Garretsen and De Jong, 2000; Hobdari, Jones and Mygind, 2009; Mulier, Schoors and Merlevede, 2016), this study uses the following reduced form investment-financial constraints investment model:

[7] The literature has argued against the explicit inclusion of capital cost variables given that interest rates (and therefore the UCC) appears to only affect investment in an indirect ways that could be captured by broader macroeconomic factors (Bernanke and Gertler, 1995; Kalatzis, Azzoni and Achcar, 2008)

$$\frac{I_{i,t}}{K_{i,t-1}} = \delta_0 + \delta_1 \frac{I_{i,t-1}}{K_{i,t-2}} + \delta_2 \Delta s_{i,t-h} + \delta_3 \frac{CF_{i,t}}{K_{i,t-1}} + \varepsilon_{i,t} \quad (1)$$

were the dependant variable, $\frac{I_{i,t}}{K_{i,t-1}}$, is measured by the values of reported capital expenditure divided by the replacement value of capital stock. The replacement value of capital is measured using the perpetual inventory method as applied in Bond and Xing (2015). Investment is modelled as dependent on its past lag, sales growth, and cash flow. Sales growth is measured as the first difference of the natural log of real sales. The neoclassical (reduced form equation) financial constraints literature has used sales growth as a standard proxy for expected future demand or profitability (Budina, Garretsen and De Jong, 2000; Bassetto and Kalatzis, 2011). Cash flow, $CF_{i,t}$, is measured as the sum of net earnings before extraordinary items and depreciation scaled by the lag of fixed capital stock (following Dwenger, 2014). All the empirical estimations in this paper include industry-time effects.

3.3.2 Sample splitting strategy

Identifying the presence of financial constraints requires estimating equation (1) over separate samples of financially constrained and unconstrained firms and comparing differences in the investment-cashflow coefficients. Identifying a good sample splitting variable that best reflects the degree of informational asymmetries and thus financial constraints among firms is therefore important. This is particularly so given that previous research (Hu and Schiantarelli, 1998; Guariglia, 2008) has pointed out that results could be sensitive to the choice of partition variable. Given these concerns, this paper pays attention to the choice of sample splitting variable and refers to the literature to identify indicators that are likely correlated with the degree of financial constraints for the South African case. After a review of the literature, firm size and dividend pay-out ratio are selected as the main sample splitting criteria. We briefly consider the justification for the choice of firm size and dividend pay-out ratio below.

The size of a firm (proxied by the number of employees, total sales, total asset, or market valuation, etc) has been one of the most frequently used sample separation criteria in the literature. Most studies argue that small-sized firms are more likely to face informational asymmetry problems, higher external finance premiums and therefore more likely to be constrained than larger firms (Budina, Garretsen and De Jong, 2000; Simmler, 2012). Although one may argue that listed firms are by default big in size, studies that utilise stock exchange data (Crisóstomo, Iturriaga and González, 2014; Quader and Taylor, 2018) still find substantial variation in firm size, and the associated liquidity constraint risks. Similar patterns are observed among South African listed firms. In particular, Makina and Wale (2016) show that smaller South African listed companies face systematically higher asymmetric information costs compared to larger firms. I therefore expect firm size to be a useful indicator for financial constraints (and thus a relevant sample classification variable) in the South African context. This study uses the natural log of sales as the indicator of firm size following Quader and Taylor (2018). Further, we use the industry-year median sales values to create the relevant sub-groups.

This study also uses dividend pay-out ratio as the alternative second sample splitting criteria. Various studies have argued that low dividend pay-out may be symptomatic of firm-level liquidity constraints and bankruptcy risk (Fazzari *et al.*, 1988; Bond and Meghir, 1994a). This is important, especially for listed firms where dividend pay-outs serve as an important signal of profitability to the shareholders and the market. Relatively low or no dividend pay-outs could therefore be a useful proxy for financial constraints even in South Africa. Dividend pay-out is defined as the ratio of dividend payments made to income before profits (Quader and Taylor, 2018). To check for the sensitivity of the results to alternative sample splitting criteria, alternative definitions of both firm size and dividend pay-out ratio are considered. Furthermore, other sample definition criteria are such as leverage is considered. The literature suggests that leverage may be ambiguous: high debt levels may indicate that a firm is liquidity constraints, on the other hand, high debt may also indicate that a firm is vibrant and able to contract debt levels and therefore potentially unconstrained (Budina, Garretsen and De Jong, 2000; Črnigoj, 2016).

3.4 Data and summary statistics

This study uses the same firm-level dataset of South African listed companies previously used in the preceding chapter (Chapter 2). The dataset spans the period 1999 to 2012 and contains the relevant investment, output, and cash flow variables needed to estimate a standard reduced form financial constraints model. The dataset also contains a rich set of variables such as total assets, dividend pay-outs, leverage, market valuations, and others that provide a useful basis for the robustness analysis of our results. Table 3.1 provides summary statistics of the main variables used in the analysis. The summary statistics are shown for the full sample and by financial constraint status (as proxied by firm size and dividend pay-out behaviour).

Table 3.1 shows the mean investment-capital ratio of around 0.34, which is well within the reasonable range reported in the literature (Crisóstomo et. al, 2014; Kumar and Ranjani, 2018). The investment cash flow ratio is higher among the relatively smaller firms compared to the larger firms. This trend is expected given that small-sized firms are more likely to be in the phase of expanding their capital base. On the other hand, ceteris paribus, lower dividend-paying firms are likely to face financial challenges and therefore likely to have a lower investment rate compared to the more-liquid higher-dividend paying firms. Sales increased at an annual average of about 6% in line with some reported trends in the literature (Mulier, Schoors and Merlevede, 2016). Sales grew faster in smaller firms relative to larger firms and among higher-dividend paying than lower-dividend paying firms. Both these sales growth patterns (by firm size and by dividend pay-out capacity) are largely as expected. Turning to cash flow, the average cash flow to capital ratio is 0.73 and within the typical range reported in the literate (Bassetto and Kalatzis, 2011). Cash flow also varies by firm groups, with relatively larger cash flow to capital levels observed among the smaller firms. The literature has interpreted larger cash-flow holdings as evidence of liquidity problems, such that financially constrained firms would build cash reserves when cash flows are positive in anticipation of having to draw down the reserves in tough times (Allayannis and Mozumdar, 2004). Table 3.1 presents the rest of the detailed statistics.

Table 3.1: Summary Statistics

	Full sample			FC (Size)			FU (Size)			FC (Dividend)			FU (Dividend)		
	Mean	Median	Std. Dev	Mean	Median	Std. Dev	Mean	Median	Std. Dev	Mean	Median	Std. Dev	Mean	Median	Std. Dev
Investment	0.338	0.227	0.454	0.393	0.212	0.600	0.292	0.237	0.267	0.384	0.219	0.590	0.303	0.236	0.297
Change in sales	0.058	0.059	0.327	0.043	0.049	0.425	0.071	0.063	0.203	0.068	0.064	0.410	0.049	0.057	0.248
Cash flows	0.729	0.424	0.899	0.732	0.339	1.067	0.728	0.453	0.820	0.719	0.344	1.056	0.735	0.457	0.789
Observations	2027			946			1073			907			1112		

Notes: FC and FU represent firm groups that are financially constrained and unconstrained (respectively). The sampling splitting criteria used are firm size (natural log of real sales) and dividend payout ratio. The number of observations refers to counts of the investment variables in the sample.

Source: Datastream (2016) company database and own calculations, 1999-2012.

3.5 Results and discussion

This section tests for the presence of financial constraints. This is done by estimating the financial constraints investment model in equation (1) separately for each group. Following the standard approach in the literature, the presence of financial constraints is established if the investment-cashflow coefficient is significantly larger for the constrained group while either insignificant or significantly lower in the unconstrained group (Fazzari, Hubbard and Petersen, 1988; Almeida and Campello, 2007; Hobdari, Jones and Mygind, 2009; Mulier, Schoors and Merlevede, 2016). Given the problems of measuring unobservable future profitability, the empirical literature assumes a non-zero cashflow coefficient for unconstrained firms to capture any residual future profitability not fully controlled for (Hobdari, Jones and Mygind, 2009; Quader and Taylor, 2018); or to capture the reality that there could be no perfectly unconstrained firm. Allowing for the above possibility still calls for the investment-cashflow coefficient in unconstrained firms to be significantly higher than that in the relatively less constrained firms.

Our analysis begins with the estimation of equation (1) using OLS as the benchmark estimation model. The results are presented in Table 3.2 and are reported according to the sample splitting criteria (firm size and dividend-payout) adopted in this study. Column (1) shows the regression estimates based on the full sample. Columns (2) and (3) present estimates based on firm size as the sample splitting criteria while Columns (4) and (5) show estimates based on dividend pay-outs as the sample partitioning criteria.

Table 3.2: OLS estimation of financial constraints

	(1) Full sample	(2) Small firms	(3) Larger firms	(4) Low dividend ratio firms	(5) High dividend ratio firms
Lagged investment	0.295***	0.234***	0.334***	0.275***	0.285***
	(0.028)	(0.051)	(0.027)	(0.040)	(0.039)
Change in sales	0.272***	0.259**	0.274***	0.282**	0.196***
	(0.086)	(0.109)	(0.054)	(0.131)	(0.048)
Cash flow	0.135***	0.263***	0.065***	0.207***	0.071***
	(0.034)	(0.074)	(0.015)	(0.062)	(0.023)
Constant	0.085***	0.146**	0.083***	0.124**	0.100***
	(0.027)	(0.069)	(0.014)	(0.059)	(0.015)
Observations	1,229	350	879	453	776
R-squared	0.386	0.424	0.470	0.440	0.343

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1 denotes the significance at the 1%, 5% and 10% level respectively. All regressions include sets of time dummies.
Source: Datastream (2016) company database and own calculations, 1999-2012.

The results in Table 3.2 suggest that across all the samples, current investment is influenced by its past levels, expected future profitability, and internal finance. The significance of the lag of investment lends support to the expectation that investment is dynamic, and that our model is appropriately specified. The relationship between investment and output is positive, suggesting that firms' investment reacts to expected future profitability as expected.

Focusing on the variable of interest, the significant cash flow coefficient in column (1) suggests the presence of imperfect market conditions in the South African capital markets. The positive sensitivity of the investment to cash flow indicates that some firms in the overall sample face difficulties in accessing external finance and rely on internal resources to fund investments. However, to effectively confirm the presence of financial constraints, the cash flow effects on investment need to be isolated by financial constraints status. Columns (2) and (3) show the investment-cash flow coefficient estimates when financial constraint status is proxied by firm size. The results show that smaller-sized firms have a much larger coefficient (of 0.263) compared to the coefficient in firms (0.065). The wald test rejects the null hypothesis of the equality of the coefficients ($\chi(1) = 7.06$, *p-value*=0.008) thus confirming that the difference is statistically significant. The difference is also economically significant, given that the sensitivity of investment to the availability of internal finance cash flow is almost 4 times higher in smaller-sized firms than the larger firms.

A concern in the financial constraints literature is that findings can be sensitive to sampling criteria (Guariglia, 2008). Columns (4) and (5) use the dividend payout ratio to check the sensitivity of the findings to alternative sample splitting criteria. The results show that low dividend-paying firms have a significantly higher investment cashflow sensitivity (of 0.207) compared to low dividend-paying firms (whose coefficient is only 0.071). The coefficient differences are statistically different ($\chi(1) = 4.39$, *p-value*=0.036). These results support the argument that lower dividend-paying firms are likely liquidity and financially constrained and therefore more dependent on internal financing for investments than firms than higher dividends payers. The results above suggest that financial constraints are an important determinant of investment in South Africa. These results are confirmed even when alternative sample splitting criteria are used. See Table B1 in the appendices for results obtained using total assets, the number of employees, market value of companies, and leverage as alternative criteria for classifying financial constraints.

The OLS results in Table 3.2 could be biased for various reasons. First, the proxies for the unobservable financial constraints and future expected profitability could contain non-negligible measurement error. Second, the OLS would give biased estimates of the coefficient of lagged investment in the presence of individual-specific effects (Bond, 2002). Even when within (or fixed-effect) estimator is applied, the bias persists (Nickell, 1977; Bond, 2002). These issues suggest the need to use GMM estimation techniques to address endogeneity in the context of short, dynamic and possibly endogenous panels. The usual choice of GMM estimator is between the difference (Arellano and Bond, 1991) or system (Blundell and Bond, 1998) GMM. The empirical literature has generally used the more efficient system GMM estimator which uses more instruments. The Blundell and Bond (1998) estimator is however prone to the risk of instrument proliferation and invalid estimates due to the generation of too many instruments (Roodman, 2009b).

The estimation of equation (1) using GMM may increase the risk of invalid estimates when the full sample is partitioned by financial constraints. I thereby limit the number of instruments used by restricting the lags used and by collapsing the instruments to ensure that the number of instruments does not exceed the number of firms in the various specifications. Both the difference and system GMM are estimated to gain a sense of the responsiveness of the results to estimation specifications. I use the two-step procedure that has prevailed in the literature due to its appealing asymptotic efficiency properties (Roodman, 2009b). Table 3.3 shows the results of estimating equation (1) using various system GMM specifications. The results confirm the earlier findings based on OLS. In particular, we still find that investment in smaller firms or low dividend-paying firms responds more to the availability of internal resources than in larger and higher dividend-paying firms. Strikingly, the results are remarkably close to those obtained using OLS in terms of the size of the cash flow coefficients. These findings confirm that financially constrained firms rely more on internal resources to finance investment than less constrained firms. The results remain robust to the alternative two -and one-step GMM procedures for estimating the standard errors. Furthermore, despite the problem of applying GMM to small samples, both the Arellano and Bond (1991) AR(2) serial correlation test and the Sargan-Hansen test suggest that all the models in Table 3.3 do not suffer the problem of serial correlation or invalid instruments. The finding that investment responds more to the availability of internal funds among more constrained firms is robust even to the use of the difference GMM (see Table B2 in Appendix B). Although the difference GMM specification is not the preferred specification for the reasons mentioned above, cash flow is remarkably always significant in constrained firms and always insignificant among financially healthy firms. The estimations do not however find significant effects of output growth or the lag of investment and may therefore suggest sensitivity of the estimates to instrument specification. Our preferred results are therefore the system GMM estimates which are consistent with theory and the OLS results already discussed.

Table 3.3: GMM estimates: Sensitivity of investment to cashflow

	Small Firms	Larger firms	Small Firms	Larger firms	Low dividend ratio firms	High dividend ratio firms	Low dividend ratio firms	High dividend ratio firms
	2-step estimator		1-step estimator		2-step estimator		1-step estimator	
Lagged investment	0.436***	0.284***	0.436***	0.281***	0.422***	0.252***	0.415***	0.247***
	(0.111)	(0.062)	(0.111)	(0.063)	(0.100)	(0.055)	(0.100)	(0.051)
Change in sales	0.292	0.531***	0.290	0.526***	0.089	0.411***	0.091	0.474***
	(0.180)	(0.118)	(0.189)	(0.139)	(0.090)	(0.146)	(0.092)	(0.174)
Cash flow	0.160**	0.085***	0.160***	0.090***	0.190***	0.098**	0.191***	0.107***
	(0.063)	(0.031)	(0.057)	(0.031)	(0.064)	(0.043)	(0.061)	(0.039)
Constant	-0.030	0.036	-0.028	0.029	0.106	0.025	0.098	0.028
	(0.093)	(0.036)	(0.089)	(0.040)	(0.087)	(0.036)	(0.081)	(0.040)
Observations	350	879	350	879	453	776	453	776
Number of firms	72	96	72	96	108	117	108	117
No. of instruments	69	69	69	69	69	69	69	69
AR(1) (p-value)	0.052	0.004	0.060	0.003	0.055	0.013	0.040	0.001
AR(2) (p-value)	0.261	0.281	0.237	0.280	0.348	0.709	0.324	0.704
Sargan-Hansen (p-value)	0.740	0.481	0.740	0.481	0.243	0.613	0.243	0.613

Notes: The dependent variable is investment to capital ratio ($I_{i,t}/K_{i,t-1}$). All regressions are estimated using the two-and one-step system GMM estimator (Blundell and Bond, 1998) and all specifications include industry-time effects. The instruments used are the second lags of investment, change in sales and cash flow. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 denote the significance levels.
Source: Datastream (2016) company database and own calculations, 1999-2012.

Before turning to the discussion of the results, we consider the possibility that the sample partitioning criteria used so far may be correlated with the investment determination process and could therefore be endogenous. To see how robust our findings are to potential selection problems, this study applies an endogenous switching regression model (Maddala, 1986; Lokshin and Sajaia, 2004). The endogenous switch approach can cluster firms efficiently, based on observed differences in firm characteristics while simultaneously estimating the investment models for each group. The methodological details of the switching regression approach are presented in Appendix B2. The estimates of the switching regression model are shown in Table 3.4 with panel A showing estimates of the investment equation while panel B presents estimates of the selection equation. The equations in Panel A and B are estimated jointly by maximum likelihood estimation (Maddala, 1986; Lokshin and Sajaia, 2004).

Two endogenous switching regression models are estimated. The first (in columns 1 and 2) is based on firm size as the proxy for financial constraints while the second model is based on dividend pay-out behaviour. As previously discussed, we expect that smaller (or low-dividend paying) firms are likely more financially constrained than their larger (or higher-dividend paying) firms. We therefore expect that if financial constraints exist among South African firms, then the coefficient of the cash flow variable among the more constrained firms will be significantly larger than the coefficient of the cash flow variable among the less constrained firms. The results in Table 3.4 are very similar to the previously estimated findings obtained using both OLS and GMM.

The results show that investment depends on its lag, future expected demand, and internal finance. Importantly, we note that similar to previous estimations using both the OLS and GMM estimators, more constrained firms continue to show greater reliance on internal availability of funds for investment compared to the less constrained firms. In particular, the investment-cast flow sensitivity is about 4 times larger for the financially constrained firms (0.272) compared to the relatively less constrained firms (0.065) when firm size is used as a proxy for financial constraints. Similar results are obtained when dividend pay-out is used as a proxy for financial constraints. The cash flow coefficient among the low-dividend payers is more than 2.5 times larger (0.203) than that in higher dividend pay-out firms (0.071).

Turning to the selection equations (panel B), our estimates suggest that firm size is a significant determinant of the probability of financial constraints in both models. The probability of being financially constrained reduces with increasing firm size and cash flow in both selection models while higher long-term debt levels are associated with reductions in the probability of being financially constrained in model 1 - the reverse holds for model 2. Higher profitability, as expected, is associated with a lower probability of being financially constrained in model 2 (although the relationship is insignificant in model 1).

The likelihood ratio tests in both model 1 and model 2 support the hypothesis of the likely presence of endogenous sample selection. Our selection model in panel (B) should however be treated with caution because variables like age which could be correlated with the probability of financial constraints are unobserved in this paper. To the extent that age is correlated with financial constraint status, the selection model and overall endogenous switching framework could be biased due to omitted variable problem. The lack of variable for the age of a firm could however be mitigated by the fact firm size may pick up some of the effects of age. Nonetheless, the striking similarity and consistency of the findings between the endogenous switch model on one hand and OLS and our preferred GMM estimates, on the other hand, lends credible support to the presence of financial constraints in this Chapter.

Table 3.4: Maximum Likelihood Endogenous Switching Regression Model Results

	Model 1 Smaller firms (1)	 Larger firms (2)	Model 2 Low dividend paying firms (3)	 High dividend paying firms (4)
Panel A: Investment equations:				
Lagged investment	0.227***	0.333***	0.273***	0.179***
	(0.044)	(0.020)	(0.037)	(0.019)
Change in sales	0.271***	0.273***	0.287***	0.142***
	(0.054)	(0.028)	(0.053)	(0.028)
Cash flow	0.272***	0.065***	0.203***	0.071***
	(0.024)	(0.007)	(0.019)	(0.009)
Constant	0.191***	0.080***	0.118**	0.043***
	(0.049)	(0.012)	(0.050)	(0.011)
Panel B: Selection Equations:				
Firm size	-1.235***		-0.080***	
	(0.066)		(0.019)	
Profit-sales ratio	0.377		-0.141**	
	(0.388)		(0.065)	
Cash flow	-0.149**		-0.141***	
	(0.063)		(0.040)	
Long term leverage	-1.020***		0.390**	
	(0.360)		(0.169)	
Constant	18.127***		1.024***	
	(0.988)		(0.281)	
Observations	1,226		1,226	
LR Test: *Chi(2)*	12.45	*Chi(2)*	104.72	
P-value	(0.002)	*P-value*	(0.000)	

Notes: Panel A represents the standard investment equation previously estimated. Panel B represents the selection equation of the probability of firm constraints. The investment coefficients and probabilities of selection are jointly estimated using the endogenous switching MLE regression. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 denote significance levels. The likelihood ratio tests in model 1 supports the hypothesis of the likely presence of endogenous sample selection in the model based on sample size while the alternative specification in model 2 does not.

Source: Datastream (2016) company database and own calculations, 1999-2012.

Overall, the evidence of the presence of significant financial constraints among JSE listed firms in South Africa is quite robust. Several studies that use similar estimation strategies in different settings find evidence of the presence of financial constraints. Our findings are quite comparable to results from studies in other large developing countries such as India and China (Poncet, Steingress and Vandenbussche, 2010; Kumar and Ranjani, 2018). Strikingly, the coefficient size estimate of the responsiveness of investment to cash flow (of around 0.23) for financially constrained firms in India (Kumar and Ranjani, 2018) suggests that Indian firms face just about the same level of financial constraints as their South African counterparts (with coefficient estimates ranging from 0.16 to 0.27 as shown in Tables 3.3 and 3.4). However, in comparison to the cash flow coefficient estimates (of between 0.11 to 0.13) obtained from China (Poncet et al, 2010), our findings indicate that South African firms face relatively higher financial constraints than their Chinese counterparts.

The comparative evidence from more advanced countries such as the USA, Sweden, Finland and Belgium, and the Czech Republic (Almeida and Campello, 2007; Mulier, Schoors and Merlevede, 2016; Schwarz and Pospíšil, 2018) shows that firms in developed countries experience substantially lower financial constraints than their counterparts in developing countries and South Africa in particular. These coefficient size estimate for financially constrained firms is roughly 0.09 for the USA (Almeida and Campello, 2007); 0.04, 0.05 and 0.08 for Sweden, Finland, and Belgium (respectively) (Mulier, Schoors and Merlevede, 2016); and about 0.10 for the Czech Republic (Schwarz and Pospíšil, 2018). The above coefficient estimates imply that the level of financial constraints in the USA, Sweden, Finland, Belgium and the Czech Republic are only about 40%, 20%, 25% 40%, and 50% (respectively) of the level of the financial burden that South African firms face.

The empirical comparison above clearly shows that South African firms experience far much higher financial constraints than firms in advanced economies. This finding may explain why corporate tax policy is relatively more effective in stimulating investment in developed economies such as the USA or Germany while similar tax policy incentives in poorer countries are found to be ineffective. This chapter therefore lends credence to the hypothesis that the insignificant impact of corporate tax on investment in the previous chapter could be a result of the presence of substantial financial constraints among South Africa's firms.

3.6 Conclusion

This study proceeded from the previous chapter where results indicated that despite notable changes in corporate tax policy in South Africa, firm-level investment did not respond to changes in the tax-adjusted user cost of capital. A plausible reason for the poor response of firm investment in neoclassical models is the failure of the assumption of perfect capital markets in the real world. According to the financial constraints hypothesis which emerged to explain the poor performance of neoclassical investment models in some early applications, firm investment decisions in the presence of imperfect capital markets may no longer respond to the neoclassical fundamentals, but to other factors such as the availability of internal finance.

This Chapter tested the role of financial constraints as an alternative determinant of investment in South Africa. Using a firm-level dataset with about 1,266 firm-year observations over the period 1999-2012, we find evidence in support of the presence of financial constraints among South African non-financial firms. In particular, the findings suggest that financially constrained firms rely more on the availability of internal resources to fund investment compared to firms that are less financially constrained. The findings remain robust to changes in sample splitting criteria and estimation techniques controlling for various potential econometric concerns such as dynamic panel or endogenous sample splitting bias.

In light of the findings that firm-level investment did not respond to corporate tax policy in the previous Chapter, our findings imply that South Africa's investment strategy must re-consider the use and design of tax incentives. If investment is hardly driven by tax incentives, the government likely incurs significant tax revenue losses by the continued provision of tax incentives. The foregone tax revenues could arguably be invested in transport and energy infrastructure to strengthen South Africa's investment climate. Second, given the presence of financial constraints, investment policy should consider strategies that reduce capital market inefficiencies and improve liquidity to support firms' investment needs.

Chapter 4

4. Differential corporate taxation and inter-asset allocation distortions

4.1 Introduction

While the importance of corporate tax incentives in capital accumulation and economic growth has been widely researched in the corporate tax literature (Chirinko, Fazzari and Meyer, 1999; Vartia, 2008; Bond and Xing, 2015), there is little empirical evidence on the inter-asset distortion effect of the corporate income tax. In most countries, tax policy employs a range of provisions such as accelerated depreciation, investment allowances, and at times, reductions in the top marginal tax rates to attract and direct investment in specific capital assets and industries. Consequently, substantial differences in the effective tax rate of different capital assets and industries within the same country could exist, with non-trivial implications for the allocation of new capital investment. In particular, differential taxation of various investment assets may alter the structure of business investment, and to that extent, distort capital investments (Fatica, 2013).

Whereas empirical studies such as King and Fullerton (1984) and Auerbach (1996) have highlighted substantial differences in the effective tax burden faced by different asset categories due to different tax treatment, there is very little research on the possible link between differential asset taxation and inter-asset distortions. Nearly all studies that have been done on this topic have been conducted in the USA and were designed around the major US tax reforms of the 1980s. Consequently, there have not been very recent studies that tackle this topic even within the USA, possibly due to the absence of large-scale sweeping reforms since the major reforms of 1986. Elsewhere, there is almost no study conducted on this topic, with Fatica (2013) who investigates the likely inter-asset distortions of differential corporate taxation in Europe being the only exception.

Although a very limited number of studies on corporate tax in developing regions such as Africa exist, most focus on the link between corporate tax and investment (World Bank, 2016). Studies on the efficiency implications of differential corporate tax are certainly non-existent in developing countries, including South Africa. The lack of evidence on this topic is very surprising given the continued use of differential taxation is largely associated with various distortions. Besides the potential inter-asset and productivity distortions, differential taxation could significantly increase corporate tax revenue losses and tax administration costs. Moreover, non-uniform taxation may also lead to unsustainable investment from speculative and footloose investors. The use of differential taxation could therefore be at variance with various national policies on sustainable, efficient, and effective investment.

This chapter contributes new empirical evidence on the inter-asset distortion effects of the corporate tax using South Africa as a case study. The study uses an unexplored dataset of industry panels with data on asset-level investment patterns over the period 2007 to 2014. Using this dataset, we compute asset shares and user-costs of capital and estimate both the own and cross-asset substitution elasticities. Given the issues surrounding the industry-level Annual Financial Statistics (AFS) series from Statistics South Africa (StatsSA), the findings that differential taxation distorts investment allocation could be taken as exploratory and as a foundation for further debate and research on the efficiency of differential taxation in South African and other developing countries.

4.2 Related empirical studies

The empirical literature on the economic distortions of corporate taxation is very limited and has generally not advanced since the last major tax reforms in the USA in the 1980s and in developing countries around the 1990s. Most efforts to study distortions of differential taxation are therefore quite outdated and have focused on the US economy.

The few existing studies could however be organised around three main strands. The first set of studies attempts to highlight the impact of differential taxation on capital asset distortions indirectly by calculating tax-induced differences in the marginal cost of investment in different assets and industries. Evidence for the existence of asset allocation distortion is established when large asset-specific marginal cost differences attributed to tax policy changes are found. This identification strategy has been used in studies (such as Auerbach, Aaron and Hall, 1983; King and Fullerton, 1984; Auerbach and Hassett, 1991; Mackie, 2002) who find significant tax-induced variations and distortions in the asset level user-cost of capital and marginal effective tax rates in the US economy. Auerbach et. al (1983) for instance finds that the social cost of misallocation of capital arising from differential taxation stood at 3.19 percent of total capital stock in the US in 1981. Mackie (2002) also finds that differential taxation in the US tends to favour investment in equipment assets while disadvantaging non-residential structures.

The second strand has used general equilibrium approaches to study the capital misallocation and welfare costs of differential taxation, particularly in the earlier studies. Various studies (such as Auerbach, 1989; Fullerton and Henderson, 1989a, 1989b; Jorgenson, 1996) have found evidence of asset distortions and welfare losses due to differential corporate taxation. In evaluating the welfare implications of the US corporate tax reforms, Auerbach (1989) showed that increasing overall corporate taxes would result in a welfare loss similar in magnitude to the welfare gain that would result from implementing uniform corporate taxation. Focusing on the same USA reform efforts of the 1980s, Fullerton and Henderson (1989a) found that inter-asset distortions were larger than inter-industry distortions, thereby showing that the level of aggregation matters when assessing the effects of tax policy changes. Fullerton and Henderson

(1989a) also found that due to distortions caused by non-uniform taxation, the US suffered welfare costs estimated at around 0.18 percent of gross national income (GNI).

The last strand of literature attempts to directly estimate the inter-asset distortions of the corporate income tax (Liu, 2011; Fatica, 2013). These studies have adopted empirical methods from the productivity literature (Berndt and Wood, 1975, 1979) to study the responsiveness of asset-level investment to their own- and cross-asset tax incentives. The studies exploit the rich substitution properties of the trans-logarithmic function specification (Berndt and Christensen, 1973; Christensen, Jorgenson and Lau, 1973) to estimate investment cost-share functions using the seemingly unrelated regression (SUR) estimation technique. Although the application of the translog function and estimation of substitution possibilities is new in the corporate tax literature, these methods have been used extensively in other sectors such as technology, energy, forestry, and agriculture (Morrison, 1997; Saal and Parker, 2000; Nagubadi *et al.*, 2004; Serletis, Timilsina and Vasetsky, 2010).

Two relatively recent applications have estimated translog investment share functions in the US (Liu, 2011) and the OECD (Fatica, 2013). The study by Liu (2011) used industry-asset panel data over the period 1962 to 1997 and investigates the responsiveness of investments in assets (such as structures, computer equipment (ICT), plant and machinery, and transportation equipment) to a given assets' tax incentives and the tax incentives of other assets. That study found evidence of sizeable inter-asset distortions due to differential taxation among some assets although in some cases the elasticities of substitution involving ICT assets were found to be unexpectedly high. Fatica (2013) who uses a similar approach and industry data obtained from 11 OECD countries find results in support of significant inter-asset distortions.

While Fatica (2013) and Liu (2011) bring much-needed evidence of the potential distortionary effects of differential taxation on asset allocation using recent data, the use of industry-level data may be problematic. First, I argue that industry-level data may not appropriately characterise the asset investment process as such decisions are undertaken at the firm level. Second, in some very specialist industries with few players like computer technology, biotechnology, etc, the industry estimates could be driven by a single dominating firm or a few outliers[8]. Some of the unexpectedly large asset elasticities found in Liu could simply be due to the influence of dominant firms in sectors such as ICT. For the above reasons, asset-specific information at the firm level would be the best dataset for the investigation of inter-asset distortions.

Due to various limitations, this study is unable to obtain a South African asset-specific firm-level dataset. At present, industry-level data is the only option available to test the hypothesis of inter-asset misallocation due to non-uniform taxation. Owing to the significance of the research question, this study proceeds to use industry-level data to offer suggestive evidence of the likely implication of differential taxation in investment allocation. To the best of our knowledge, this study becomes the first to investigate inter-asset distortions of corporate taxation in a developing country context. The study also joins a very limited set of studies (Liu, 2011; Fatica, 2013) that directly estimate the inter-asset distortion effects of differential corporate taxation by estimating the own and cross-tax elasticities of asset investment.

4.3 Empirical Framework and model specification

This section closely follows the methodological presentations in Fatica (2013) and Liu (2011), the two studies that have extended the translog function to the corporate tax literature. The transcendental logarithmic (translog) cost function allows for a rich pattern of substitution between input pairs and could thus be used to model the investment distortion effects of corporate taxation. The general form of the long run translog cost function can be specified as:

[8] These insights were obtained following discussions at UNIDO-PRISM global value chains workshop held at the School of Economics, University of Cape Town, 18th-19th September, 2019.

$$
\begin{aligned}
lnC = \alpha_0 + \alpha_Q lnQ \\
&+ \sum_i \alpha_i lnP_i + \frac{1}{2}\gamma QQ(lnQ)^2 + \sum_i \gamma Q_i lnQ_i lnP_i \\
&+ \frac{1}{2}\sum_i \sum_j \beta_{ij} lnP_i lnP_i + \beta_t Time + \frac{1}{2}\beta_T Time^2 \\
&+ \beta_{TQ} TimelnQ + \sum_{i=1}^{n} \beta_{Tj} TimelnP_i + \beta_I Industry \\
&+ \frac{1}{2}\beta_I Industry^2 + \beta_{IQ} IndustrylnQ + \sum_{i=1}^{n} \beta_{Ii} IndustrylnP_i \\
&+ \varepsilon
\end{aligned} \tag{2}
$$

where P_i is the after-tax price of input *i*, *Q* is the industry level output and *TIME* and INDUSTRY are the time and industry dummies. The β_{ij}'s are the parameters of interest. By the shepherd's lemma, the set of input cost-minimising share equations are derived by differentiating the cost function in Equation (2) with respect to the log of the price of input *i*:

$$
S_i = \frac{\delta lnC}{\delta lnP_i} = \frac{(X_i P_i)}{C} = \alpha_i + \gamma Q_i lnQ + \sum_j \beta_{ij} lnP_i + \beta_{Ti} Time + \beta_{Ii} Industry \tag{3}
$$

Where S_i is the cost share of input *i*. All cost shares sum to one and the cost function is homogenous of degree one in price by definition. These conditions suggest that the following restrictions must hold for well-behaved investment shares:

$$
\begin{gathered}
\sum_i \alpha_i = 1 \\
\sum_i \gamma Q_i = 0, \qquad and \\
\sum_i \beta_{ij} = \sum_i \beta_{ij} = 0
\end{gathered} \tag{4}
$$

Applying this system of equations (Equations 3 and 4) to the data demands that the error terms in the investment functions be defined. However, although the errors terms could be assumed independent across observations, the investment equation errors are likely correlated within each industry. This calls for the joint estimation of the system of equations in order to obtain efficient estimates. This paper applies Zellners' (1962) seemingly unrelated regression method to estimate the investment share equations. Empirically, we specify investment share equations for industrial structures, computer equipment, plant and machinery, and transportation equipment. However, the adding up property of the investment shares implies a singular variance matrix, because only N_{k-1} shares equations are linearly independent. This problem is easily solved by dropping one investment share equation. The Maximum likelihood estimation of the parameters of the investment equation is invariant to the choice of excluded equation (Barten, 1969). We therefore arbitrarily drop the transportation share equation and divide the UCC (and price) of every other asset by the UCC (or price) of transportation equipment. This yields the following investment share equation system that is estimated using the SUR method:

$$S_{ikt} = \alpha_i + \sum_j \beta_{ij} ln\left(\frac{UCC_{ikt}}{UCC_{trans,kt}}\right) + \sum_j \beta_{ij} ln\left(\frac{P_{ikt}}{P_{trans,kt}}\right) + \eta_k + \varepsilon_{ikt} \quad (5)$$

where S_{ikt} is the share of asset i in industry k at time t. The user-cost and the relative price of each asset i in industry k at time t are the dependent variables in this estimation model. The model also includes some time and industry dummies to control for any technological changes and industry-specific effects.

4.4 Data and variables

4.4.1 Dataset

This paper exploits detailed industry-level financial statement data published in the disaggregated annual financial statistics (AFS) reports by Statistics South Africa. The detailed data comprises consolidated industry-level income statements, balance sheets, and fixed asset information of various industries in South Africa. The data is presented at all the standard industrial classification (SIC) levels but excludes mining due to varying and complex applications of tax incentives in those sectors. We use data at the SIC 4-digit level as this has the most sub-group industries and observations over the period. At the SIC 4-digit level, data is available for 8 years period from 2007 to 2014 and covers at least 200 industrial groupings (see Table C4 in the Appendix for the industry definitions). However, as the tabulation of these codes would produce excessive output, I simply provide the distribution of industries at the SIC 1-digit level which provides a concise summary. Table 4.1 shows that the majority of the observations come from the manufacturing and services sectors.

Table 4.1: Distribution of the Observations at the SIC -1digit level

Industry (SIC 1-digit)	Freq.	Percent	Cum.
Manufacturing	472	44.32	44.32
Electricity	8	0.75	45.07
Construction	59	5.54	50.61
Trade	180	16.9	67.51
Transport	63	5.92	73.43
Financial	170	15.96	89.39
Services	113	10.61	100
Total	1,065	100	

Notes: Own estimates based on the AFS datasets from StatsSA

An important problem already highlighted with industry data is that some sectors (such as biotechnology) could be dominated by single large monopoly firms that drive all the results in that sector. Perhaps the most important data challenge is that the AFS series from Statistics South Africa does not follow a consistent sample of firms in a specific industry, and some industrial classification may not be sampled in subsequent waves. For this specific study, these data challenges imply that our findings can only be taken as explorative[9] evidence. Future study efforts could therefore use this as a foundation and reference for more fine-grained analysis should when datasets become available.

[9] Despite the noted problems in the AFS, other studies such as World Bank (2015) have used this same industry panel dataset to calculate costs of capital.

4.4.2 User-cost of capital and asset shares

Based on the AFS data described above, we now turn to the calculation of the user-cost of capital and investment share variables and other parameters relevant in this study. This paper uses the King and Fullerton (1984) methodology of calculating the user-cost of capital (UCC) given that assets are disaggregated into standard categories in the AFS dataset. The UCC methodology used in this Chapter is therefore different from that in Chapter 2 (Chatelain *et al.*, 2003). In particular, the approach here offers more variation due to disaggregated asset composition. For each given asset, variation in the UCC is derived from changes in the headlines corporate tax rate, changes in tax depreciation, variations in the accumulated depreciation over time as well as changes due to the influence of macroeconomic parameters such as inflation and government bonds and treasury bill rates as proxies for the long- and short-term interest rates, respectively. The derivation of the UCC using the King and Fullerton (1984) approach is detailed. Refer to Appendix C1 and C2 for more information on the derivation of the model and calculation of the parameters of interest. The asset-level UCC for asset *i* in industry *k* at time *t* can be presented as:

$$UCC_{ikt} = \frac{(r_{kt} - \pi_t + \delta_i)(1 - \tau_t z_{ikt})}{(1 - \tau_t)} \tag{1}$$

Where r is the industry-specific interest rate, π is the inflation rate and δ is the asset-specific depreciation rate. τ is the corporate tax rate while z is the asset-specific accumulated tax depreciation allowance rate. The paper follows the UCC estimation approach presented in an earlier study done by the World Bank (2015) for South Africa[10]. The data used in constructing the user-cost of capital comes from various sources. The nominal interest rate (r) is calculated using the inter-bank prime lending rate and the 10-year yield government bond rate (as proxies for the cost of debt and equity, respectively). These rates were obtained from the South African Reserve Bank. The CPI data from StatsSA is used to capture inflation. The effective statutory tax rates used in calculating the asset-industry user-cost of capital is the average of the headline corporate tax rate and the secondary tax rates. The evolution of these series (interest rates,

[10] The paper uses approaches and assumptions that are generally applied in World Bank assessments of effective corporate taxation in developing countries.

inflation, and corporate tax rates) is shown in Figure C1 in Appendix C. Data such as the asset level economic depreciation rates and tax depreciation rates were obtained from the World Bank study on marginal effective tax rates in referenced earlier (World Bank, 2015). The above study is particularly relevant given that it uses the same context and similar data as this study.

Table 4.2 presents the summary distribution of the UCC and the present value of depreciation allowances (z) associated with the different capital investments.

Table 4.2: Mean and Standard Deviation of UCC and z

Tax Parameters	2007-2008	2009-2010	2011-2012	2013-2014
UCC: Structures	8.77	12.71	11.25	9.93
	(2.28)	(2.94)	(2.64)	(2.26)
UCC: Computer	31.62	43.38	40.48	41.74
	(9.94)	(10.93)	(11.11)	(10.81)
UCC: Transport	24.41	28.71	26.94	25.82
	(3.20)	(3.31)	(3.49)	(3.46)
UCC: Plant	17.84	21.82	20.52	19.58
	(0.98)	(1.68)	(1.55)	(1.48)
z : Structures	0.45	0.52	0.54	0.53
	(0.01)	(0.02)	(0.03)	(0.02)
z : Computer	0.81	0.84	0.85	0.85
	(0.01)	(0.01)	(0.01)	(0.01)
z : Transport	0.80	0.83	0.84	0.83
	(0.01)	(0.02)	(0.02)	(0.02)
z : Plant	0.82	0.83	0.85	0.84
	(0.02)	(0.03)	(0.02)	(0.02)

Notes: *UCC* and *z* are the user cost of capital and the present value of depreciation allowance for each given asset, respectively. The means and standard deviations of the selected tax parameters have been winsorized at the 1 and 99 percent of their empirical distributions. Standard deviation in parentheses.

Table 4.2 shows that plant and machinery equipment and non-residential structures have the lowest user costs of capital. The lower user cost of capital for plant and machinery equipment is a result of the more generous depreciation allowances offered for capital investments in South Africa. In particular, the accelerated depreciation allowances available in industries such as manufacturing, agriculture, and mining sectors would contribute to lowering the user cost of capital. The lower user cost of capital for investment in structures could be a result of mainly the relatively longer depreciation tax lives for structures. The higher cost of capital for computing equipment could be a result of the lack of significant tax depreciation incentives for ICT assets.

Before we turn to the rest of the summary statistics, we define the dependant variable as the share of investment in asset *i* relative to the annual addition to gross fixed assets in industry *k* at time *t*. The StatsSA industry-level dataset classifies assets by nature of use according to standard accounting practice. In this paper, the fixed asset categories used are; i) plant and machinery ii) transportation equipment iii) non-residential structures, and iv) computer and ICT equipment[11]. The PPI series used are proxies for the asset prices were obtained from Statistics South Africa.

4.4.3 Descriptive statistics

Table 4.3 presents summary statistics for the key variables used in the regression analysis. The mean, standard deviation as well as the 25th, 50th, and 75th percentiles are presented for the investment shares, cost of capital, and price indices for the four asset categories.

[11] We exclude land and capital work-in-progress from the asset categories because the former is typically fixed for most industries and the latter is difficult to allocate to a specific asset category. The balance sheets also include intangible fixed assets such as the value of intellectual property rights and copyrights. These are also excluded because our focus in fixed depreciable tangible assets.

Table 4.3: Summary Statistics

	Mean	Std. Dev	25%	50%	75%	N
Plant Equipment						
Investment Share	0.53	0.24	0.35	0.56	0.73	1065
COC (%)	20.21	1.880	18.96	20.33	21.28	1065
Real price index	101.6	9.020	94.23	97.01	107.1	1065
Structures						
Investment Share	0.130	0.160	0.0200	0.0700	0.180	1065
COC (%)	10.88	2.830	8.490	10.08	13.05	1065
Real price index	93.41	4.820	88.22	94.42	97.13	1065
Computer and ICT Equipment						
Investment Share	0.09	0.14	0.02	0.04	0.09	1065
COC (%)	40.54	11.31	28.82	44.57	51.23	1065
Real price index	100.5	5.560	94.81	98.77	102.0	1065
Transportation Equipment						
Investment Share	0.250	0.210	0.0900	0.190	0.360	1065
COC (%)	26.69	3.640	22.98	28.28	29.45	1065
Real price index	103.9	7.720	98.32	98.99	110.7	1065

Notes: Summary statistics given for all industries in South Africa. Investment share is defined as the rand investment in a given asset over the total capital investment in a given industry. COC is the user cost of capital expressed in percentages. Real prices are proxied by the PPI for the respective asset.
Source: AFS (2007-2014), Statistics South Africa

As can be seen in Table 4.3, machinery equipment has the largest share of investment (53%), while ICT equipment has the smallest share (9%). Investment in non-residential structures constitutes about 13% of the total investment share while transportation equipment stands at 25%. The cost of capital is most favourable for machinery and plant equipment and structures because those categories have lower user cost of capital rates. This could reflect the more generous depreciation allowances available for machinery equipment categories relative to ICT or transport equipment categories. We observe no unusual trends in the real prices indices and the investment shares.

4.5 Results

4.5.1 OLS and SUR estimates

This section presents the results of estimating equation (5), first starting with OLS as the benchmark model and then using SUR estimation in a subsequent specification. Table 4.4 reports the coefficient estimates of the system of equations obtained under various model specifications. Columns 1 and 2 show results from a pooled OLS regression under the assumption of no contemporaneous correlation between the error terms. Column (1) does not control for time and industry effects while Column (2) takes those effects fully into account. Column (3) includes the time and industry effects also but estimates the results using the seemingly unrelated regression model under the assumption of plausible cross-equation correlation of the error terms.

Table 4.4: Seemingly Unrelated Regression Estimates

		(1)	(2)	(3)
Equation for Structures	$UCCstruc$	0.01	-0.13*	-0.12**
		(0.03)	(0.07)	(0.06)
	$UCCcomp$	0.07***	-0.49***	-0.45***
		(0.02)	(0.16)	(0.14)
	$UCCTrans$	-0.23***	0.32***	0.29***
		(0.03)	(0.12)	(0.10)
Equation for Computers	$UCCstruc$	0.07***	-0.49***	-0.45***
		(0.02)	(0.16)	(0.14)
	$UCCcomp$	0.15***	-1.78***	-1.62***
		(0.02)	(0.53)	(0.48)
	$UCCTrans$	-0.05***	0.90***	0.88***
		(0.02)	(0.32)	(0.31)
Equation for Transport	$UCCstruc$	-0.23***	0.32***	0.29***
		(0.03)	(0.12)	(0.10)
	$UCCcomp$	-0.05***	0.90***	0.88***
		(0.02)	(0.32)	(0.31)
	$UCCTrans$	0.12**	-0.61	-0.77
		(0.05)	(0.52)	(0.50)
N		1,065	1,065	1,065

Notes: Standard errors in parenthesis. * indicates significance at 0.10 level, ** indicates significance at 0.05 level, *** indicates significance at 0.01 level.
Source: AFS (2007-2014), Statistics South Africa.

The coefficient estimates in Table 4.4 are not for direct interpretation and certainly not informative of the size of the effect of user-cost elasticities on investments. We merely use these estimates as parameter inputs in the estimation of the relevant substitution elasticities that this study aims to show. Nonetheless, we briefly comment on how the general results change across different specifications and suggest the preferred estimates for use as inputs into calculating the tax-adjusted UCC elasticities in the next section. As can be seen, the results are largely similar, and most coefficients on user-cost in the investment share equations are statistically significant. However, we note that OLS estimates that control for technological trends and industry effects (Column 2) yield more efficient estimates than those in Column (1) where technology and industry effects are not included. The OLS estimates may however be inefficient, due to the likelihood that the share investment equations within each industry may be correlated with the error term. Therefore, we use Zellners' (1962) SUR method to obtain efficient estimates. Column (3) presents the SUR estimates which are quite similar to the OLS estimates in Column (2). The Breuch-Pagan Langrage multiplier test for the independence of the disturbances across equations (with a chi-square (3) value of 198.55 and p-value of 0.000) suggests strong evidence of the contemporaneous correlation between the error terms. The SUR model estimates in Column (3) are therefore our preferred parameter inputs into the calculation of the elasticities in the next stage[12]. For ease of reference, the SUR estimates (in column 3) including the imputed parameter estimates initially omitted (as already discussed) are presented in Table 4.5 below.

Table 4.5: Summary of SUR parameter estimates

	Coefficient	Std. Error	95% Confidence Interval	
$\beta_{struc,struc}$	-0.120	0.061	-0.239	0.000
$\beta_{struc,comp}$	-0.448	0.144	-0.730	-0.166
$\beta_{struc,trans}$	0.291	0.100	0.095	0.487
$\beta_{comp,comp}$	-1.625	0.484	-2.574	-0.675
$\beta_{comp,trans}$	0.882	0.311	0.273	1.491
$\beta_{trans,trans}$	-0.773	0.495	-1.743	0.197
$\beta_{plant,struc}$	0.276	0.210	-0.135	0.688
$\beta_{plant,comp}$	1.190	0.627	-0.038	2.419
$\beta_{plant,trans}$	-0.400	0.525	-1.430	0.629
$\beta_{plant,plant}$	-1.066	1.023	-3.072	0.939

Notes: The parameter estimates related to the plant equation are imputed using regression estimates from the SUR model. All other parameters are simply summarized from column (3) of Table 4.4.
Source: AFS (2007-2014), Statistics South Africa

[12] Attempts to control for the likely endogeneity of our estimates using IV-SUR with investment growth opportunities and liquidity as standard instruments led to inconsistent and insignificant coefficients. IV estimation is therefore not pursued further in this study due to the data problems noted earlier. However, by using the SUR, we control for the problems of contemporaneous correlation of the error terms.

4.5.2 The UCC elasticities

Next, we estimate the elasticities of investment demand which can be used to establish the responsiveness of UCC elasticities of investment. We use the parameter estimates in Table 4.5 to calculate both the own- and cross-UCC elasticities of investment demand for the different asset categories. The own-UCC demand elasticities show the responsiveness of investment demand to corporate tax incentives for a given asset. But our interest is the cross-UCC demand elasticities which show the responsiveness of investments to other asset types. The cross and own tax elasticities of demand calculated under the assumption of fixed capital investment can be derived as (Uzawa, 1962; Liu, 2011):

$$\xi_{ij} = \frac{\hat{\beta}_{ij} + S_i S_j}{S_i} \forall\, i \neq j;\; \xi_{ij} = \frac{\hat{\beta}_{ii} + {S_i}^2}{S_i} \forall\, i \qquad (6)$$

Where S_i and S_j are the investment shares for asset *i* and *j* respectively. The $\widehat{\beta' s}$ are the estimated coefficients on the log of cost of capital. The associated variance of the demand elasticities are then calculated using the delta method (Pindyck, 1979; Dwenger, 2009):

$$V(\xi_{ij}) = \left(\frac{1}{S_i}\right)^2 * V(\hat{\beta}_{ij}) \forall\, i, j \qquad (7)$$

The estimated own-COC and cross-COC elasticities of investment demand are shown in Table 4.6.

Table 4.6: Own- and Cross-UCC elasticities

	Structures	Computer Equipment	Transportation Equipment	Plant & Machinery Equipment
input shares	12.81%	8.74%	25.16%	53.30%
Factor i	ξ_i, *struc*	ξ_i, *comp*	ξ_i, *trans*	ξ_i, *plant*
Structures	-1.807***	-3.409***	2.525***	2.691
	(0.476)	(1.123)	(0.782)	(1.640)
Computer	-4.999***	-19.510***	10.350***	14.159**
	(1.647)	(5.546)	(3.556)	(7.176)
Transportation	1.286***	3.594***	-3.821*	-1.058
	(0.398)	(1.235)	(1.968)	(2.088
Plant &	0.647	2.32**	-.500	-2.468
Machinery	(0.394)	(1.176)	(0.986)	(1.920)

Notes: Standard errors in parenthesis. * indicates significance at 0.10 level, ** indicates significance at 0.05 level, *** indicates significance at 0.01 level.
Source: AFS (2007-2014), Statistics South Africa

4.5.3 Findings and discussion

While this paper is mainly concerned with an assessment of inter-asset distortions, we begin our analysis with a brief discussion of the responsiveness of investments with respect to their own corporate tax policy incentives. This helps put our findings in context and enables generalized comparisons with similar studies. First, we note that as predicted by theory, the own-UCC elasticities are all negative, except for the coefficient on plant and machinery equipment which is insignificant. The absolute values of the coefficients are greater than 1, indicating that investment demands for all assets are elastic. Results show that the own investment elasticity for non-residential structures is -1.80, transportation equipment has an elasticity of -3.82 while computer equipment has a very high elasticity of -19.50 which is unreasonable. Nonetheless, the demand elasticities of structures are generally comparable with findings in the very small literature that uses disaggregated data. For example, Liu (2011) also finds that the own-user cost of capital for non-residential structures in the United States is elastic, with elasticity estimates of about -1.29. Our elasticity estimate of -3.82 for transportation equipment is substantially different from Liu (2011) and Fatica (2013) who find insignificant elasticity estimates in the US and the OECD, respectively. Like other studies which attempt to disaggregate the capital elasticities, we find that computer equipment is highly elastic in South Africa. The huge elasticity estimate of -19.50 could be largely driven by the relatively tiny share of computer equipment in aggregate capital investment. The inverse relationship between demand elasticities and investment share is apparent (as can be seen in Equations 6 and 7 above). Therefore, where investment shares vary widely as is the case in this study, the resulting elasticity estimates are likely to vary widely as well, with assets with smaller shares being relatively more sensitive to changes in the user costs of capital than assets with relatively larger investment shares.

On whether differential taxation induces inter-asset effects, this paper finds evidence of distortions across different assets. The cross-tax elasticities show a significant degree of substitutability between most assets. We find that Transportation equipment and structures; transportation equipment and computer equipment; and plant equipment and computer equipment are substitutes. On the other hand, we observe tax complementarity between computer equipment and structures. While economic theory does not predict how transportation, plant, computer equipment, and structures should be interrelated, it is not inconceivable that computer equipment and structures could be complements, particularly if one considers that modern industrial structures are often equipped with sophisticated computer networks and security systems. It is therefore highly likely that industrial structures and computer equipment complement each other in most industrial sectors. The finding that plant equipment and computer equipment are substitutes is also plausible if one considers that traditional mechanical plants are increasingly being replaced with computerised systems like robotic artificial intelligence systems that can control production, especially in manufacturing. However, the finding that transportation equipment is a substitute for either industrial structures or computer structures does not seem intuitive or reasonable, and quite unlikely to hold in reality in many sectors.

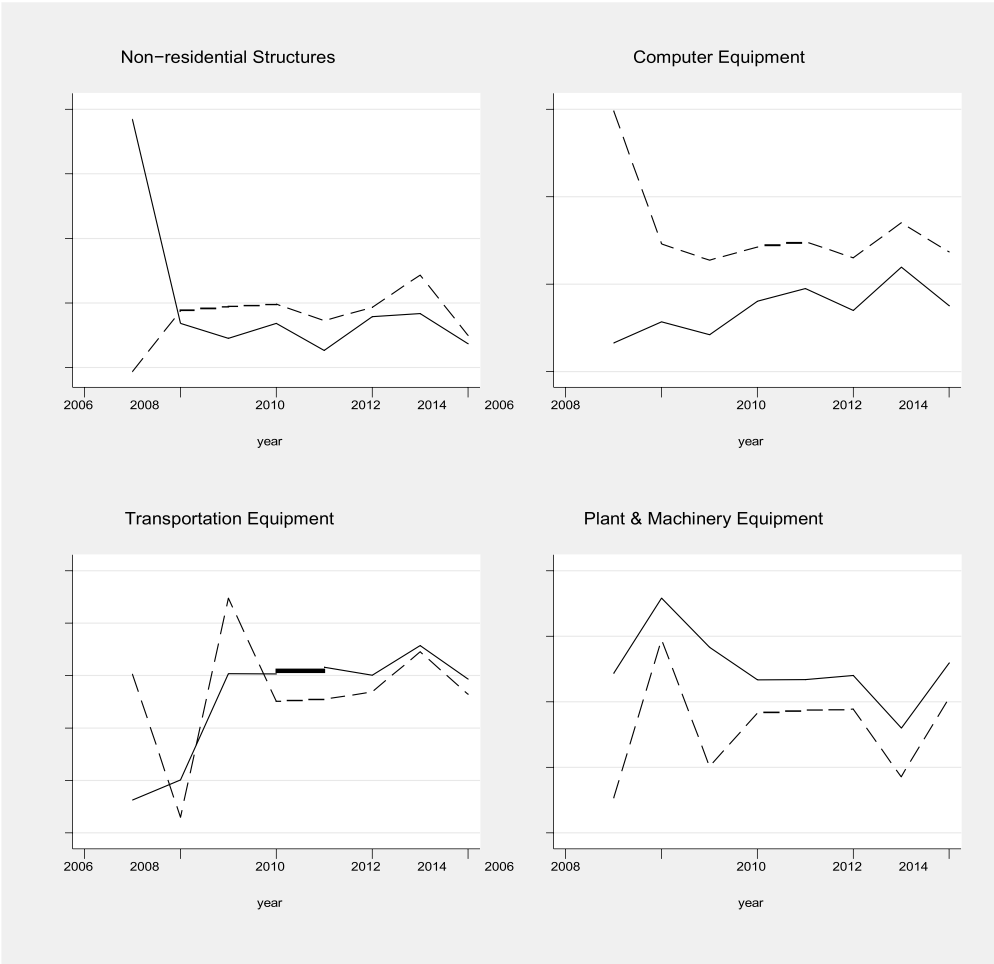
Of the 12 cross-elasticity estimates, 8 are statistically different from zero - indicating the presence of inter-asset distortions. Some asset-level investments could therefore be responding to the tax incentives intended for other assets. We find that a 1 percent change in the user cost of computing equipment leads to on average a 3.4 percent decrease in investment in non-residential structures. Conversely, a 1 percent increase in the user cost of structures leads to a 4.9 percent decrease in investment in computer equipment. While we find that structures and computer equipment are complementary inputs, studies such as Fatica (2013) finds that the two inputs are tax-substitutes, though Liu (2011) finds no relationship. We note that the asymmetries in elasticity estimates arise from the inverse relationship between cross-elasticities and input shares. Investments in assets with relatively smaller shares are more responsive to changes in the user costs of assets with larger shares.

With regard to transportation and structures, we find that a 1 percent change in the user cost of structures is associated with a 1.3 percent increase in the investment in transport equipment with the asymmetric elasticity being about twice as large. These results contrast the results in Fatica (2013) who finds complementarity between the two inputs. We also find a tax-elasticity of 3.6 between transportation equipment and computer equipment with an asymmetric elasticity between the two inputs of about 3 times larger. Our results further show that differential taxation between plant equipment and computer equipment does induce investment distortions. In particular, we find that plant equipment and computer equipment are substitute inputs. A 1 percent increase in the user cost of computer equipment is associated with an increase in plant investment of about 2.3 percent. These findings agree with the results in Liu (2011) who finds a similar elasticity coefficient (of about 2.5).

Our estimates, though much larger than those found in the US (Liu, 2011) and the OECD (Fatica, 2013) provide some support of potentially non-trivial inter-asset distortions present in developing country contexts where differential taxation of capital remains an important feature of corporate tax policy. The larger coefficients reported here could be due to the much higher variation in the user cost of capital captured in this study. While Liu (2011) and Fatica (2013) only consider assets employed at the SIC 2-digit level and only for the manufacturing industry, our analysis is based on more disaggregated data at the SIC 4-digit level and covers all major industries such as manufacturing, construction, electricity, and others. The tax treatment for investment assets used in these industries vary as different tax depreciation rates are applied across different industries. This kind of variability in asset treatments across different industries is not available in other studies which only focus on one sector and are based on data aggregated at higher levels. Our study therefore potentially unravels the kind of elasticities that more disaggregated datasets could reveal. Empirical estimates of elasticities from both the productivity and investment literature suggest that more disaggregated datasets provide much larger elasticity estimates.

To gain a sense of the size of the inter-asset distortion due to differential taxation in terms of gaps in the investment shares, we follow the approach in Liu (2011) and impute hypothetical distributions of investment under neutral taxation and compare with the observed investment shares. Therefore, for each year, all assets are assigned the UCC computed with the equalised average tax rate across the sectors. Then using the coefficients of the SUR model, we predict investment shares corresponding to the equalized user cost of capital. This counter-factual experiment is revenue neutral given that total investment is held constant. Figure 4.1 shows the comparison of the hypothetical investment shares against the actual shares.

Figure 4.1: Comparison of investment shares under uniform and differential taxation of assets



Notes: The dotted lines represent fitted investment shares (neutral taxation) while the solid line represents the actual investment shares (prevailing non-uniform taxation). The y-axis represents investment shares.

Source: AFS (2007-2014), Statistics South Africa

Figure 4.1 shows that on average, differential taxation of investments has over the period induced under-investment in structures and computer equipment. We further note that there is systematic over-investment in plant and machinery equipment mostly driven by the generous tax treatment of plant and machinery relative to computer equipment. Results further show that before 2009, there was under-investment in transportation equipment. The trend however changes after 2010 where we observed over-investment in transportation equipment. The existence of significant inter-asset distortions due to differential taxation raises important policy questions, in particular, whether non-uniform taxation of assets and industries should be abandoned? At the minimum, such considerations would require a comparison of the financial and employment benefits versus the financial and job loss costs arising from differential taxation. Where differential tax results in a net increase in industrial profitability and increased jobs, and increased tax revenues, the government could pursue the policy provided measures are taken to ensure the job losses and inefficiencies caused in other sectors are mitigated. A further recommendation is that differential taxation of assets and industries could be prescribed for very specific sectors and industries, particularly those at risk of collapsing such as the steel manufacturing and aviation sectors that have seen a catastrophic decline in productivity and revenues in the recent past.

4.6 Conclusion

This chapter investigated the inter-asset distortion effects of differential corporate taxation on the allocation of investment assets in South Africa. While there is substantial variation in the tax treatment of investments in assets and across industries, little empirical evidence exists on the nature of any investment distortions due to differential taxation. Using a unique dataset of disaggregated industry-level financial statement data from 2007 to 2014, our estimates of inter-asset user cost elasticities reveal statistically significant and economically non-negligible inter-asset distortions due to non-uniform taxation of investments. In general, we show that investments in given assets not only respond to their tax incentives but the incentives of other assets.

The findings in this Chapter should however only be taken as exploratory, given the problems associated with the industrial panel used in this study where the composition of the firms in the sample may vary from year to year. Besides, using industrial units as investment decisions is conceptually problematic because investment discussions are usually undertaken at the firm level. Our findings are therefore only suggestive, but provide a strong foundation for future debate and studies on the economic and efficiency implications of differential taxation of assets and industries in South Africa and other developing countries more broadly.

An immediate implication of our findings is that ongoing corporate tax reforms in both South Africa and the developing world at large should design policies that minimise the potential investment distortions due to differential taxation. Ignoring the distortive implications of heterogeneous tax treatment could understate the efficiency and redistributive effects of tax policy.

Chapter 5

5. General Conclusion and Policy Implications

5.1 Summary of findings

This thesis has made contributions to the economic literature on corporate tax and investment by investigating the relationships between corporate tax and investment, by understanding the role of financial constraints in investment, and by exploring the likely distortive effects of corporate tax on investment allocation. These inter-related themes can have important implications for investment and economic growth and were therefore investigated in three empirical chapters of this thesis.

Chapter 2, the first empirical chapter, investigated whether firm-level investment responded to corporate tax incentives over a period of notable reforms. The paper estimated a reduced form neoclassical investment model using an autoregressive distributed lag specification. The chapter employed firm-level data from companies listed on the JSE over the period 1999 to 2012 and estimated both the investment rates and tax-adjusted user costs of capital variables. Using both OLS and GMM estimation, the study found consistent evidence that corporate tax changes did not translate into improvements in firm-level investment. Our findings deviate from the majority of studies undertaken in advanced countries but agree with an emerging strand of literature focused on developing countries that have found no effect of corporate tax policy changes on investment. The findings remain robust to changes in estimation specifications that control for various endogeneity problems such as measurement error, reverse causality, and dynamic panel bias.

Given the empirical findings in Chapter 2, Chapter 3 considered the possibility that the insignificant impact of corporate tax on investment found in Chapter 2 was due to the difficulty firms face in accessing financing for investment. Chapter 3 therefore investigated the financial constraints hypothesis using the same dataset and similar investment model as Chapter 2. The study established the presence of financial constraints among firms listed on the JSE. The findings were consistent and robust to various econometric problems.

Chapter 4 investigated the potential inter-asset distortion effects of differential corporate taxation in South Africa. The study constructed an asset-industry panel dataset and estimated inter-asset user-cost elasticities using a SUR model. The findings in Chapter 4 suggest the presence of inter-asset distortions arising from the use of non-uniform tax incentives for different assets and industries in South Africa. In particular, the results show that differential taxation led to over-investment in machinery and equipment and under-investment in non-residential structures, and transport and computer equipment. The evidence arising from Chapter 4 could however be regarded as exploratory because of some limitations associated with the use of the AFS industrial series data from StatsSA.

5.2 Policy implications

The findings in this thesis have important policy implications for the formulation of corporate tax policy and investment strategies in South Africa. Firstly, finding in Chapter 2 that investments do not respond to corporate tax incentives suggests that the continued provision of these incentives may be unproductive. The South African corporate sector could therefore be taxed normally, but with the corporate tax revenues raised invested in projects such as expanding the power generation, road, rail, and port infrastructure to improve the overall business and investment climate. At the minimum, corporate tax policy must re-consider the widespread use of corporate tax incentives in light of this evidence.

Second, our finding in Chapter 3 that investment is constrained by the availability of finance suggests that addressing the informational and agency cost problems among firms should be central to South Africa’s investment strategies. Government must play a key role in ensuring firms can continue to invest without constraints in accessing external finance. The existence of financial constraints even among South Africa’s largest firms reinforces the point that no single firm is immune to financial difficulty.

Finally, the findings in Chapter 4 suggest that corporate tax policy must be carefully designed to avoid the unintended consequences of investment misallocation. Minimizing the widespread and excessive use of non-uniform tax incentives could help improve the efficiency of investment allocation and promote sustainable investment growth.

5.3 Suggestions for Future Research

This thesis has provided some important insights as well as a foundation for future research. In the investigation of the link between corporate tax and investment, chapter 2 does not incorporate all the available tax incentives in the tax-adjusted user-cost of capital measure due to data limitations. For example, firm-specific tax incentives offered under the famous 12i tax incentive scheme could not be incorporated in the analysis. Future work should consider evaluating the impact of the DTI's 12i tax incentive scheme on investment using quasi-experimental research designs such as the difference-in-differences to exploit the fact that DTI's 12i incentives are a specially targeted incentive. Furthermore, given the recent evidence of substantial profit-shifting by South Africa's largest firms to overseas low tax jurisdictions, future studies should also investigate the likely dampening effects of profit-shifting on investment in South Africa.

Future studies could also explore the exact nature of financial constraints that the firms face. From the current evidence on South Africa, it is not clear whether the binding financial constraints come from informational problems, agency costs, or other frictions. Undertaking direct surveys of chief financial officers of listed firms would be a useful avenue of getting a better sense of the exact nature of the financial constraints that the firms face. Future studies could also explore the role of other structural factors in the context of South Africa[13].

Finally, future studies should further investigate the inter-asset misallocation of differential corporate tax. While the current findings in Chapter 4 do provide evidence of inter-asset investment misallocation due to differential taxation of assets and industries, the findings are based on the AFS industry panel dataset whose sample composition is inconsistent. Future studies could use different more fine-grained firm-level datasets as they become available or

[13] An unpublished mimeo undertaken during the exploratory phases of this PhD suggests that broader structural constraints such as infrastructural problems and informal markets are significant factors in fixed assets investment in sub-Saharan Africa. Future studies could explore the role of broader investment climate factors in investment determination in the South Africa specific context.

estimate the inter-assets distortions using computable general equilibrium models to get the economy-wide effects of non-uniform taxation of capital assets and industries.

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Appendices for Chapter 2

Table A1. Datastream variables used in Chapters 2 and 3.

Variable	Description	Code
Investment	CAPITAL EXPENDITURES represent the funds used to acquire fixed assets other than those associated with acquisitions. It includes but is not restricted to: Additions to property, plant and equipment and Investments in machinery and equipment.	WC04601
Capital stock	PROPERTY, PLANT AND EQUIPMENT (NET) represents Gross Property, Plant and Equipment less accumulated reserves for depreciation, depletion and amortization.	WC02501
Sales	NET SALES OR REVENUES represent gross sales and other operating revenue less discounts, returns and allowances. It includes but is not restricted to: Franchise sales when corresponding costs are available and included in expenses. Consulting fees	WC01001
Income before extra-ordinary items	NET INCOME BEFORE EXTRAORDINARY ITEMS/PREFERRED DIVIDENDS represents income before extraordinary items and preferred and common dividends, but after operating and non-operating income and expense, reserves, income taxes, minority interest and equity in earnings.	WC01551
Depreciation expense	DEPRECIATION represents the process of allocating the cost of a depreciable asset to the accounting periods covered during its expected useful life to a business. It is a non-cash charge for use and obsolescence of an asset.	WC01148
Cash flow	Inc before extra-ordinary items (WC01551) + depreciation expense (WC01148) divided by beginning of period capital stock (WC0250)	(WC01551+ WC01148)/ WC0250
Total assets	TOTAL ASSETS represent the sum of total current assets, long term receivables, investment in unconsolidated subsidiaries, other investments, net property plant and equipment and other assets.	WC02999
Long term debt	LONG TERM DEBT represents all interest-bearing financial obligations, excluding amounts due within one year. It is shown net of premium or discount	WC03251
Long term leverage	Long term debt (WC03251) / Total assets (WC02999)	WC03251 WC02999
Employees	EMPLOYEES represent the number of both full and part time employees of the company. *It excludes: Seasonal employees, Emergency employees*	WC07011

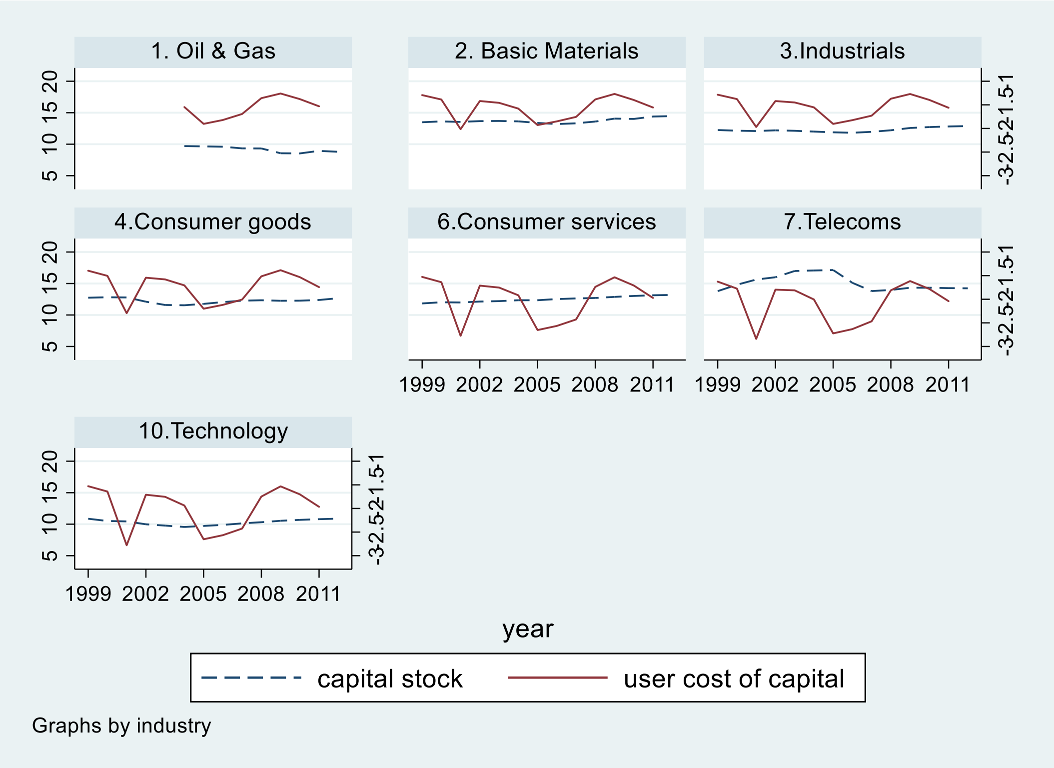
Source: Thomson Financial (2007)

Table A1. Datastream variables used in Chapters 2 and 3 (continued)

Variable	Datastream description	Code
Dividends	CASH DIVIDENDS PAID - TOTAL represent the total common and preferred dividends paid to shareholders of the company. *It excludes: Dividends paid to minority shareholders.*	WC04551
Earnings before interest and tax (EBIT)	EARNINGS BEFORE INTEREST AND TAXES (EBIT) represent the earnings of a company before interest expense and income taxes. It is calculated by taking the pre-tax income and adding back interest expense on debt and subtracting interest capitalized.	WC18191
Market capitalisation	Market Price-Year End * Common Shares Outstanding *If Common Shares Outstanding is not available for the current year or prior year, then Common Shares Outstanding-Current is used*	WC08001

Source: Thomson Financial (2007)

Figure A1: Changes in capital and user cost over time, by industry (1999-2012)



Notes: Changes in mean logs of capital and user cost of capital. The UCC includes the aggregate debt and equity interest components.
Source: Datastream (2016) company database and own calculations, 1999-2021.

Table A2: Sensitivity of GMM estimates to varying instrument lag specifications

VARIABLES	(1) 2-4 lags	(2) 2-6 lags	(3) All lags	(4) 3-5 lags
$I_{i,t-1}/K_{i,t-2}$	0.306***	0.245***	0.242***	0.179
	(0.078)	(0.068)	(0.052)	(0.118)
$\Delta ucc_{i,t}$				
σ_0	0.014	0.019	0.023	0.025
	(0.036)	(0.042)	(0.044)	(0.037)
σ_1	-0.034	-0.037	-0.049*	-0.033
	(0.028)	(0.025)	(0.025)	(0.026)
σ_2	-0.029	-0.036*	-0.051**	-0.026
	(0.019)	(0.021)	(0.022)	(0.020)
σ_3	-0.021	-0.022	-0.026	-0.007
	(0.019)	(0.021)	(0.021)	(0.020)
SUM(σ)	**-0.070**	**-0.076**	**-0.102**	**-0.041**
	(0.077)	**(0.082)**	**(0.081)**	**(0.80)**
$\Delta\beta_{i,t}$				
β_0	0.459***	0.479**	0.426**	0.445**
	(0.158)	(0.214)	(0.164)	(0.197)
β_1	0.102**	0.140***	0.153***	0.349***
	(0.046)	(0.050)	(0.048)	(0.106)
β_2	-0.010	0.012	0.000	0.029
	(0.057)	(0.063)	(0.061)	(0.053)
β_3	-0.048	-0.037	-0.046	-0.021
	(0.052)	(0.059)	(0.055)	(0.046)
SUM(*β*)	**0.503*** **	**0.593** **	**0.533*** **	**0.802*** **
	(0.178)	**(0.229)**	**(0.184)**	**(0.248)**
Observations	1,083	1,083	1,083	1,083
No. of firms	174	174	174	174
No. of instruments	101	144	201	100
AR(1) p-value	0.012	0.011	0.012	0.029
AR(2) p-value	0.606	0.723	0.740	0.973
Sargan-Hansen (p-value)	0.438	0.372	0.911	0.560

Notes:
Dependant variable: Investment, scaled by the replacement cost of the beginning of period capital stock ($I_{i,t}/K_{i,t-1}$). SUM(σ) and SUM(β) denote the long run coefficient of the user cost of capital and output respectively, calculated as described in the text. Standard errors in parentheses. Significance levels are denoted as: *** p<0.01, ** p<0.05, * p<0.1. The instruments for the estimated equations are the lags of the regressors lagged as indicated in the column headings above. All regressions are estimated using the system GMM estimator (Blundell and Bond, 1998) and include industry-year effects.
Source: Datastream (2016) company database and own calculations, 1999-2012.

Table A3: Sensitivity of GMM estimates to different instrument sets

VARIABLES	(1) 2-5 lags	(2) 2-7 lags	(3) 2-5 lags	(4) 2-7 lags
$I_{i,t-1}/K_{i,t-2}$	0.205***	0.207***	0.278***	0.272***
	(0.072)	(0.069)	(0.049)	(0.055)
$\Delta ucc_{i,t}$				
σ_0	0.050	0.049	0.029	0.036
	(0.040)	(0.043)	(0.033)	(0.035)
σ_1	-0.037	-0.049*	-0.044**	-0.048**
	(0.026)	(0.027)	(0.022)	(0.024)
σ_2	-0.030	-0.044**	-0.016	-0.029*
	(0.021)	(0.021)	(0.020)	(0.017)
σ_3	-0.008	-0.017	-0.013	-0.016
	(0.021)	(0.020)	(0.020)	(0.017)
SUM(σ)	**-0.025**	**-0.061**	**-0.043**	**-0.057**
	(0.085)	**(0.081)**	**(0.074)**	**(0.071)**
$\Delta s_{i,t}$				
β_0	0.453**	0.456**	0.396***	0.404**
	(0.181)	(0.189)	(0.142)	(0.194)
β_1	0.120**	0.132***	0.096*	0.098*
	(0.052)	(0.050)	(0.054)	(0.056)
β_2	0.028	0.026	0.034	0.034
	(0.050)	(0.053)	(0.046)	(0.043)
β_3	-0.033	-0.033	-0.025	-0.028
	(0.062)	(0.061)	(0.049)	(0.050)
SUM(β)	**0.567*** **	**0.581*** **	**0.501*** **	**0.507*** **
	(0.194)	**(0.210)**	**(0.160)**	**(0.186)**
Observations	1,083	1,083	1,083	1,083
No. of firms	174	174	174	174
No. of instruments	122	155	83	105
AR(1) p-value	0.013	0.013	0.009	0.010
AR(2) p-value	0.786	0.796	0.636	0.646
Sargan-Hansen (p-value)	0.505	0.371	0.749	0.610

Notes:
Dependant variable: Investment, scaled by the replacement cost of the beginning of period capital stock ($I_{i,t}/K_{i,t-1}$). SUM(σ) and SUM(β) denote the long run coefficient of the user cost of capital and output respectively, calculated as described in the text. Standard errors in parentheses. Significance levels are denoted as: *** p<0.01, ** p<0.05, * p<0.1. The instruments for the first-differenced regressions are the values of estimated equations are the values in levels of the first-differenced lags of $\Delta ucc_{i,t}$ .and $\Delta ucc_{i,t}$ (as specified in Dwenger, 2014). The regressions in columns (1) and (2) allow the lag of investment ($I_{i,t-1}/K_{i,t-2}$) to enter as the instrument set in levels starting at the second lag. Columns(3) and (4) exclude the investment lag from the instrument set. All regressions are estimated using the system GMM estimator (Blundell and Bond, 1998) and include sets of time dummies.
Source: Datastream (2016) company database and own calculations, 1999-2012.

Table A4: Comparison of estimation by one-or two-step GMM estimation procedures

VARIABLES	(1) 1-step Sys (lags 2-5)	(2) 1-step Sys (lags 2-7)	(3) 1 step Diff (lags 2-5)	(4) 2-step Diff (lags 2-5)
$I_{i,t-1}/K_{i,t-2}$	0.275***	0.235***	0.157**	0.160**
	(0.064)	(0.059)	(0.063)	(0.062)
$\Delta ucc_{i,t}$				
σ_0	0.021	0.025	0.090	0.092**
	(0.044)	(0.043)	(0.076)	(0.044)
σ_1	-0.048*	-0.045	-0.025	-0.022
	(0.028)	(0.028)	(0.038)	(0.021)
σ_2	-0.049**	-0.048**	-0.008	0.017
	(0.021)	(0.022)	(0.035)	(0.025)
σ_3	-0.030	-0.025	0.009	0.035
	(0.022)	(0.021)	(0.049)	(0.028)
SUM(σ)	**-0.105**	**-0.093**	**0.066**	**0.122**
	(0.081)	**(0.081)**	**(0.145)**	**(0.091)**
$\Delta s_{i,t}$				
β_0	0.462**	0.469**	0.585***	0.525***
	(0.198)	(0.190)	(0.215)	(0.185)
β_1	0.132***	0.149***	0.147**	0.161***
	(0.050)	(0.048)	(0.062)	(0.050)
β_2	-0.013	0.002	-0.004	0.029
	(0.061)	(0.061)	(0.066)	(0.055)
β_3	-0.045	-0.045	-0.048	-0.018
	(0.062)	(0.059)	(0.082)	(0.063)
SUM(β)	**0.537****	**0.574*****	**0.680****	**0.700*****
	(0.221)	**(0.214)**	**(0.280)**	**(0.235)**
Observations	1,083	1,083	907	907
No. of firms	174	174	157	157
No. of instruments	124	161	95	95
AR(1) p-value	0.011	0.011	0.005	0.014
AR(2) p-value	0.681	0.751	0.981	0.926
Sargan-Hansen (p-value)	0.318	0.270	0.782	0.782

Notes:
Dependant variable: Investment, scaled by the replacement cost of the beginning of period capital stock ($I_{i,t}/K_{i,t-1}$). SUM(σ) and SUM(β) denote the long run coefficient of the user cost of capital and output respectively, calculated as described in the text. Standard errors in parentheses. Significance levels are denoted as: *** p<0.01, ** p<0.05, * p<0.1. The instruments for the first-differenced regressions are the values of the lagged regressors. The regressions in columns (1) and (2) are estimated using the one-step system GMM while Columns (3) and (4) are estimated using the one-and two-step difference GMM procedure (respectively). All regressions include industry-time effects.
Source: Datastream (2016) company database and own calculations, 1999-2012.

Table A5: Consideration for attrition bias in the Investment-Corporate tax literature

Relevant study	Country/Regional focus	Is attrition mentioned/discussed?	Is attrition bias corrected for?
Cevik and Miryugin (2018)	Indonesia, Malaysia, Philippines, Thailand Vietnam	Not mentioned	No
World Bank (2016)	South Africa	Not mentioned	No
Crnigoj (2016)	Slovenia	Not mentioned	No
Buettner and Hoenig (2016)	Germany	Not mentioned	No
Federici and Parisi (2015)	Italy	Not mentioned	No
Dwenger (2014)	Germany	Discussed	Yes
Karim (2012)	Malaysia	Not mentioned	No
Simmler (2012)	Germany	Not mentioned	No
Dwenger (2009)	Germany	Discussed	Yes
Gilchirst and Egon (2007)	USA	Not mentioned	No
Chatelain et al (2003)	Germany, France, Italy, Spain, Austria, Belgium, Luxenbourg	Not mentioned	No
Harhoff and Ramb (2001)	Germany	Not mentioned	No
Chirinko et. al (1999)	USA	Not mentioned	No

Table A6: Attrition; and Exclusion of new entrants

	Attrition Bias		Survivor	
	(1)	(2)	(3)	(4)
	2-5 lags	2-7 lags	2-2 lags	2-4 lags
$I_{i,t-1}/K_{i,t-2}$	0.283***	0.241***	0.235	0.295**
	(0.081)	(0.086)	(0.170)	(0.121)
$\Delta ucc_{i,t}$				
σ_0	-0.003	0.014	0.040	0.041
	(0.058)	(0.053)	(0.039)	(0.030)
σ_1	-0.035	-0.043	-0.036**	-0.030*
	(0.029)	(0.028)	(0.017)	(0.016)
σ_2	-0.043	-0.046*	-0.005	-0.006
	(0.029)	(0.027)	(0.015)	(0.013)
σ_3	-0.035	-0.030	0.013	0.011
	(0.032)	(0.029)	(0.018)	(0.014)
SUM(σ)	**-0.115**	**-0.106**	**0.011**	**0.016**
	(0.120)	**(0.111)**	**(0.072)**	**(0.059)**
$\Delta s_{i,t}$				
β_0	0.471**	0.476**	0.249***	0.231***
	(0.212)	(0.204)	(0.077)	(0.066)
β_1	0.122**	0.148***	0.081**	0.092***
	(0.054)	(0.053)	(0.032)	(0.029)
β_2	-0.008	0.004	0.162*	0.050
	(0.062)	(0.067)	(0.088)	(0.044)
β_3	-0.034	-0.039	0.062	0.032
	(0.065)	(0.060)	(0.107)	(0.033)
SUM(β)	**1.056****	**1.106*****	**0.554*****	**0.405*****
	(0.431)	**(0.417)**	**(0.207)**	**(0.102)**
IMR	0.014	-0.005	-	-
	(0.039)	(0.031)	-	-
Observations	1,077	1,077	679	679
No. of firms	174	174	77	77
No. of instruments	124	161	53	101
AR(1) p-value	0.011	0.011	0.007	0.007
AR(2) p-value	0.646	0.732	0.858	0.852
Sargan-Hansen (p-value)	0.225	0.371	0.513	0.949

Notes:
Dependant variable: Investment, scaled by the replacement cost of the beginning of period capital stock ($I_{i,t}/K_{i,t-1}$). SUM(σ) and SUM(β) denote the long run coefficient of the user cost of capital and output respectively, calculated as described in the text. Standard errors in parentheses. Significance levels are denoted as: *** p<0.01, ** p<0.05, * p<0.1. The instruments for the first-differenced regressions are the values of the lagged regressors. All estimates done by two-step system GMM. All regresions include industry-time effects.
Source: Datastream (2016) company database and own calculations, 1999-2012.

Table A7: Pre-financial crisis impact (1999-2008)

VARIABLES	(1)	(2)
$I_{i,t-1}/K_{i,t-2}$	0.407***	0.316**
	(0.115)	(0.143)
$\Delta ucc_{i,t}$		
σ_0	0.040	0.048
	(0.035)	(0.046)
σ_1	-0.020	-0.010
	(0.029)	(0.037)
σ_2	-0.003	-0.002
	(0.026)	(0.037)
σ_3	0.009	0.014
	(0.026)	(0.037)
SUM(σ)	**0.026**	**0.049**
	(0.099)	**(0.134)**
$\Delta s_{i,t}$		
β_0	0.514	0.655
	(0.329)	(0.428)
β_1	0.055	0.068
	(0.101)	(0.108)
β_2	-0.010	-0.015
	(0.051)	(0.064)
β_3	-0.056	-0.073
	(0.067)	(0.098)
SUM(β)	**0.502***	**0.636***
	(0.272)	**(0.365)**
Observations	652	652
No. of firms	136	136
No. of instruments	79	98
AR(1) p-value	0.007	0.007
AR(2) p-value	0.958	0.799
Sargan-Hansen (p-value)	0671	0.530

Notes:
Dependant variable: Investment, scaled by the replacement cost of the beginning of period capital stock ($I_{i,t}/K_{i,t-1}$). SUM(σ) and SUM(β) denote the long run coefficient of the user cost of capital and output respectively, calculated as described in the text. Standard errors in parentheses. Significance levels are denoted as: *** p<0.01, ** p<0.05, * p<0.1. The instruments for the first-differenced regressions are the values of the lagged regressors. All regressions estimated using the two-step system GMM. All regresions include industry-time effects.
Source: Datastream (2016) company database and own calculations, 1999-2012.

Table A8: alternative specifications of UCC

VARIABLES	(1)	(2)
$I_{i,t-1}/K_{i,t-2}$	0.415***	0.321***
	(0.087)	(0.068)
$\Delta ucc_{i,t}$		
σ_0	-0.089	-0.199
	(1.371)	(1.437)
σ_1	-0.502	-0.857
	(1.576)	(1.659)
σ_2	-0.926	-1.674
	(1.540)	(1.628)
σ_3	-1.036	-2.004
	(1.412)	(1.465)
SUM(σ)	**-2.554**	**-4.735**
	(4.467)	**(4.372)**
$\Delta s_{i,t}$		
β_0	0.409***	0.448***
	(0.144)	(0.148)
β_1	0.063*	0.105***
	(0.038)	(0.038)
β_2	-0.021	-0.011
	(0.040)	(0.043)
β_3	-0.025	-0.015
	(0.045)	(0.048)
SUM(β)	**0.427*** **	**0.527*** **
	(0.137)	**(0.146)**
Observations	1,295	1,295
No. of firms	189	189
No. of instruments	114	157
AR(1) p-value	0.006	0.006
AR(2) p-value	0.478	0.605
Sargan-Hansen (p-value)	0.478	0.405

Notes:
Dependant variable: Investment, scaled by the replacement cost of the beginning of period capital stock ($I_{i,t}/K_{i,t-1}$). *S*UM(σ) and *S*UM(*β*) denote the long run coefficient of the user cost of capital and output respectively, calculated as described in the text. Standard errors in parentheses. Significance levels are denoted as: *** p<0.01, ** p<0.05, * p<0.1. The instruments for the first-differenced regressions are the values of the lagged regressors. All regressions estimated using the two-step system GMM. All regresions include industry-time effects
Source: Datastream (2016) company database and own calculations, 1999-2012.

Appendices for Chapter 3

B1: Endogenous Switching Regression with Unknown Sample Separation

This paper uses an endogenous switching regression model with unknown sample separation (Maddala, 1986) to simultaneously determine the firm investment behaviour and the likelihood of financial constraints among firms. The presentation below closely follows that in Quader and Taylor (2018) and Lokshin and Sajaia (2004). As indicated, the ex-ante classification of firms in the financially constrained or unconstrained groups using single factor criteria such as firm size, for example, could lead to the problem of endogenous sample selection. This problem could persist even when sample splitting criteria are based on validated indices or multiple-factor criteria for sample splitting. The Switching regression allows for controlling for multiple variables that determine the status of financial constraints status without the need to split the sample into various groups.

The model assumes that there are two investment regimes, regime 1 and regime 2; and whilst the number of regimes is taken as given, the points for structural changes between the regimes are not known and must be estimated simultaneously with the investment equations. Conditional on the degree of asymmetric costs, a firm may operate in one of the given unobservable regimes; and investment with its relationship with financial constraints can differ between regimes. The endogenous switching equation has the following structure of equations that must be simultaneously estimated:

$$I_{1it} = X_{it}\beta_1 + v_{1it} \tag{2.1}$$

$$I_{2it} = X_{it}\beta_2 + v_{2it} \tag{2.2}$$

$$y_{it}^* = Z_{it}\alpha + \varepsilon_{it} \tag{2.3}$$

where equations 2.1 and 2.2 are the structural equations that describe firms' investment behaviour in the different regimes. The selection equation that determines the probability of being in the financially constrained or unconstrained regime is presented in equation 3.3. X_{it} represents the determinants of corporate investment while Z_{it} are the determinants of the propensity of being in a given regime at time t. β_1, β_2 and α are the parameter vectors to be estimated while v_1, β_2 , and ε are the error terms. Observed investments, I_i, undertaken by firm i at time t are defined as:

$$I_{it} = I_{1it}, \qquad y_{it} = 0 \;\; if \; y_{it}^{*} < 0, \tag{2.4}$$

$$I_{it} = I_{2it}, \qquad y_{it} = 1 \;\; if \; y_{it}^{*} \geq 0, \tag{2.5}$$

The likelihood of being in the first or second regime is captured by the latent variable y_{it}^{*} while y_{it} is the observed sample splitting criterion function which identifies the regime. Firms switch between regimes once y_{it}^{*} reaches a given threshold value.

The vector of the error terms in the investment and switching functions, $(v_{1it}, v_{2it}, \varepsilon_{it})'$ is assumed to be jointly normally independently distributed with zero mean and covariance matrix Ω, which allows a non-zero correlation between the investment shocks and shocks to firms characteristics and endogenous switching between the two investment regimes where:

$$\Omega = \begin{pmatrix} \sigma_1^2 & \sigma_{12} & \sigma_{1\varepsilon} \\ \sigma_{21} & \sigma_2^2 & \sigma_{2\varepsilon} \\ \sigma_{\varepsilon 1} & \sigma_{\varepsilon 2} & 1 \end{pmatrix}. \tag{2.6}$$

The extent to which investment spending differs across the two regimes and the likelihood that firms are assigned to either regime are simultaneously determined. The model is estimated using maximum likelihood. Omitting the i, t subscripts, the log likelihood function for the switching regression model outlined in Equations (2.1) to (2.6) can be given by;

$$\ln l = \sum \left\{ y \left[\ln\big(\Phi(\gamma_1)\big) + \ln\left(\frac{\phi\left(\frac{\gamma_1}{\sigma_1}\right)}{\sigma_1} \right) \right] + (1-y) \left[\ln\big(1-\Phi(\gamma_2)\big) + \ln\left(\frac{\phi\left(\frac{v_2}{\sigma_2}\right)}{\sigma_2} \right) \right] \right\}. \tag{2.7}$$

Where the cumulative normal distribution function and normal density function are denoted by Φ and ϕ, respectively. Given that there are two regimes, $j = 1{,}2$, the parameter γ_j is defines as;

$$\gamma_j = \frac{\left(Z_\alpha + \frac{\rho_j \gamma_j}{\sigma_j} \right)}{\sqrt{\left(1-\rho_j^2\right)}} \tag{2.8}$$

Where $\rho_j = \sigma_{j\varepsilon}^2 / \sigma_\varepsilon \sigma_j$. The dependent variables in the regime equations (2.1 and 2.2) are investment while the dependent variable in the selection equation (2.3) is a binary classification variable which is coded as 1 for the financially constrained firms and 0 otherwise.

Table B1: OLS estimation of the sensitivity of Investment-Cashflow coefficient using multiple sample splitting criteria

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Lagged Inv	0.147**	0.381***	0.244***	0.312***	0.187***	0.360***	0.279***	0.300***	0.340***	0.244***
	(0.065)	(0.072)	(0.037)	(0.034)	(0.057)	(0.068)	(0.062)	(0.030)	(0.041)	(0.031)
Change in sales	0.270**	0.281***	0.126	0.346***	0.274**	0.267***	0.271**	0.210***	0.288*	0.258***
	(0.130)	(0.075)	(0.085)	(0.116)	(0.128)	(0.072)	(0.126)	(0.050)	(0.150)	(0.084)
Cash flow	0.197***	0.106***	0.194**	0.110***	0.190***	0.109***	0.217***	0.077***	0.123***	0.162**
	(0.056)	(0.040)	(0.080)	(0.031)	(0.061)	(0.039)	(0.067)	(0.021)	(0.034)	(0.063)
Constant	0.168***	0.066***	0.151***	0.057	0.128**	0.077***	0.126**	0.094***	0.050	0.116***
	(0.049)	(0.021)	(0.037)	(0.040)	(0.052)	(0.020)	(0.059)	(0.015)	(0.049)	(0.021)
Observations	330	899	384	845	331	898	451	778	571	658
R-squared	0.336	0.464	0.340	0.441	0.346	0.447	0.409	0.450	0.450	0.341

Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.
For the sensitivity analysis, the following alternative measures of sample splitting criteria are used:
Columns (1) and (2): Total assets in place of Total sales as a proxy for firm size.
Columns (3) and (4): Number of employees as an alternative proxy for firm size
Columns (5) and (6): Market valuation with the expectation that lower value firms are likely constrained.
Columns (7) and (8): Alternative definition of dividend pay-out ratio as dividends/earnings before interest and taxes (rather than over total assets).
Columns (9) and (10): Leverage ratio is used as the alternative sample splitting criteria.

Source: Datastream (2016) company database and own calculations, 1999-2012.

Table B2: Sensitivity of investment to cashflow using difference GMM

	Small Firms	Larger firms	Small Firms	Larger firms	Low dividend ratio firms	High dividend ratio firms	Low dividend ratio firms	High dividend ratio firms
	2-step estimator		1-step estimator		2-step estimator		1-step estimator	
Lagged investment	0.093	0.301*	0.093	0.272**	0.208	0.134	0.163	0.137
	(0.131)	(0.162)	(0.123)	(0.131)	(0.232)	(0.108)	(0.233)	(0.102)
Change in sales	0.242	0.351**	0.328*	0.361**	0.322*	0.184	0.287	0.232
	(0.199)	(0.149)	(0.181)	(0.158)	(0.168)	(0.224)	(0.217)	(0.228)
Cash flow	0.346**	0.135	0.428***	0.164*	0.188**	0.259**	0.245**	0.286***
	(0.135)	(0.086)	(0.125)	(0.083)	(0.090)	(0.104)	(0.097)	(0.094)
Observations	281	798	281	798	385	694	385	694
Number of firms	54	91	54	91	92	102	92	102
No. of instruments	34	34	34	34	34	34	34	34
AR(1) (p-value)	0.123	0.075	0.073	0.114	0.148	0.037	0.082	0.001
AR(2) (p-value)	0.374	0.301	0.324	0.283	0.569	0.834	0.669	0.742
Sargan-Hansen (p-value)	0.597	0.609	0.597	0.609	0.321	0.354	0.321	0.354

Notes: The dependent variable is investment to capital ratio ($I_{i,t}/K_{i,t-1}$). All regressions are estimated using the two-and one-step difference GMM estimator (Arellano and Bond, 1991) and all specifications include sets of time dummies. The instruments used are the second lags of investment, change in sales and cash flow. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 denote the significance levels. All regresions include industry-time effects.

Source: Datastream (2016) company database and own calculations, 1999-2012.

Appendices for Chapter 4

C1: Brief derivation of the King and Fullerton (1984) UCC concept used in this Chapter.

As already pointed out in the previous Chapters, the appropriate channel through which taxation affects investment is the user cost of capital (Jorgenson, 1963; Hall and Jorgenson, 1967). Below, we briefly development the UCC concept used in this Chapter.

Under the behavioural assumption of profit maximisation and in the simplest case of no taxation, no inflation, no depreciation, and no consideration for capital gains or losses, a firm will hire capital until the value of an additional unit of investment is equal to its cost. This cost of capital rental, when evaluated at the profit maximising point is what is referred to as the user cost of capital. In the simplified case above, the user cost of capital is equal to the opportunity cost of capital (or rate of interest). The level of capital investment will therefore vary with changes in the equilibrium user cost of capital. Allowing for economic depreciation, δ, which effectively increases the rental cost of capital, the user cost of capital (UCC) in a particular asset could be presented as:

$$UCC = r + \delta \tag{1}$$

Introducing corporate taxation necessitates modifying the equilibrium outcome in equation (i) to accommodate various features of the corporate tax system. For example, tax depreciation allowances or investment tax credits imply a reduction in the effective per unit cost of capital by some amount, ξ, such that the per unit cost becomes \$$(1-\xi)$. On the other hand, the statutory marginal corporate tax rate, τ, effectively increases the required return to capital. Putting these new terms together, equation (1) now becomes:

$$UCC = \frac{(r^{*} + \delta)(1-\xi)}{(1-\tau)} \tag{2}$$

where r^{*} is the after-tax real interest rate. In countries where inflation and depreciation allowances are significant parameters, equation (2) can be more specifically written as:

$$UCC = \frac{(r - \pi + \delta)(1-\tau\phi)}{(1-\tau)} \tag{3}$$

where r, π and ϕ represent the nominal interest rate, inflation rate, and present value of accumulated depreciation allowances, respectively. The equilibrium condition defining the user cost of capital states that the after-tax cost of capital associated with the effective investment of $\$(1-\xi)$ must equal the after-tax return. The UCC is therefore the before-tax capital rental, or rate of return that equalises the (after-tax) cost of capital to the post-tax returns. Conceptually, it is the minimum return a firm needs on the marginal investment to cover depreciation, taxes, and the opportunity cost of an investment (Liu, 2011)[14]. Thus, the UCC is comprehensive, considering the investment effects of not only tax policy (e.g. statutory tax rates, depreciation, and investment allowances, etc) but also macro-economic price effects and asset and financing structures.

As seen in equation (3) above, various factors can influence the user cost of capital and a firm's investment decision. Economic depreciation for instance, which allows a given portion of investment costs to be deducted from taxable income could lower the user cost of capital. To the extent that tax depreciation is higher than economic depreciation, a higher portion of after-tax income is retained early in the depreciation cycle of an asset. Effectively, tax depreciation that is higher than economic depreciation creates an investment subsidy and may encourage investment. Other more direct provisions such as investment expenditure allowances or investment credits directly reduce the unit cost of investment by writing o of a portion of investment expenditures against taxable incomes or reducing taxes paid by a given percentage. The effect of rising inflation can affect investment decisions through multiple mechanisms. An increase in inflation can result in a decline in the real value of depreciation allowances, thus eroding the tax benefits of depreciation allowances and increasing the user cost of capital. On the other hand, factors such as the deductibility of interest on debt capital and given high inflation reduces the tax burden and effective cost of capital. These results hold especially in jurisdictions where debt deductions or depreciation allowance are not indexed for inflation.

Associated with the concept of user cost of capital is the marginal effective tax rate (METR), which is the effective tax burden on a marginal investment. The METR is defined as the

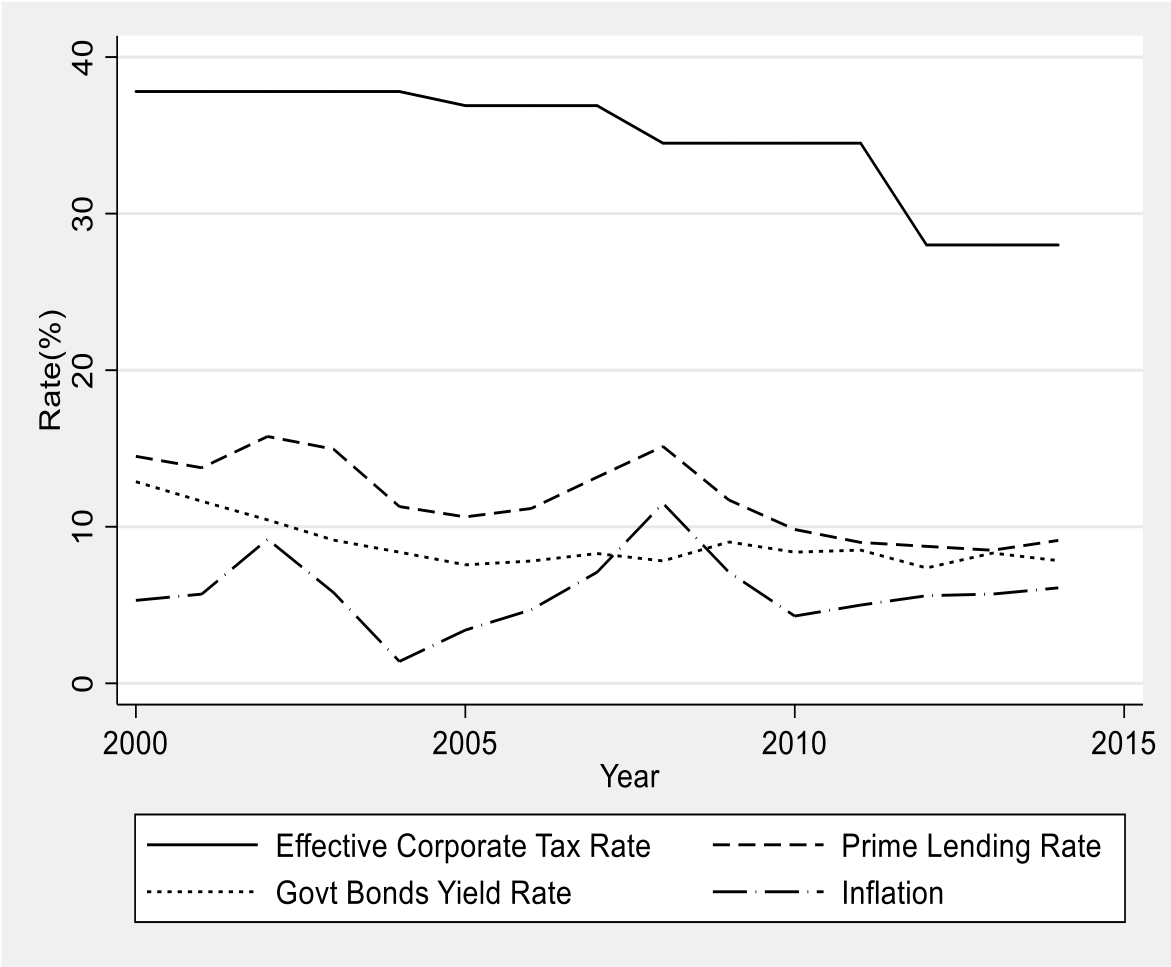
[14] A detailed introduction and discussion of the user-cost of capital approach used in this Chapter is provided in (Creedy and Gemmell, 2017)

difference between the UCC net of depreciation and the after-tax rate of return on an alternative asset over the cost of capital net of depreciation:

$$METR = \frac{\tilde{\rho} - \bar{r}}{\tilde{\rho}} \quad (4)$$

Where $\tilde{\rho}$ is the UCC net of depreciation or the real social rate of return and $\bar{r}$ is the after-tax rate of return on an alternative asset. The METR effectively measures the tax wedge on a marginal investment or the proportion of the returns of a marginal investment given up to compensate for taxation. It is the extent to which corporate taxation increases the cost of capital above $\bar{r}$ (Fatica, 2013; World Bank, 2015).

Figure C1: Evolution of Corporate tax rates, Inflation and Interest rates used in the calculation of the UCC.



Notes: Effective corporate tax rate is the average of the headline and secondary tax rates period.
Source: SARS and the South African Reserve Bank data series website.

Figure C1 shows movements in the effective corporate tax rate, inflation rate, the prime interest rate, and the 10-year government yield rate over the period 2000 to 2014. Although only the series over the period 2007 to 2018 are used, we show the series over a longer period for a more complete picture of the movement in the series. As can be seen, the tax code has consistently reduced both the headline and secondary tax rates on companies. Since 2005, inflation, together with the inter-bank prime rate and government bond rates have somewhat declined.

C2: Calculation of interest rates and depreciation allowances

Following the literature, the calculation of asset-level cost of capital requires first estimating the nominal interest rate and the present value of depreciation allowance on a unit of investment. The components are computed as follows:

Nominal Interest Rate, r_{kt}

We calculate the nominal discount rate for industry *k* at time *t* as the weighted average of the after-tax rates of return to debt and equity:

$$r_{kt} = i_t(1 - \tau_t) + (1 - \theta_{kt})e_t \quad (1)$$

Where θ_{kt} is the share of assets financed by debt calculated as the ratio of total liabilities to total assets. I calculate these ratios using the disaggregated industry-level balance sheets for each industry. i_t and e_t are the inter-bank prime lending rate and the yield rate on 10-year South African government bonds used as proxies for the cost of debt and equity (respectively). Note that the tax term $(1 - \tau_t)$ represents the tax deductibility investment incentive provided for in the South African tax code.

Depreciation allowances, Z_{ikt}

The calculation of present value depreciation allowances requires information on the depreciation methods as well as the appropriate industry-level discount rates and tax asset lives. Assuming a 1dollar investment, the present value of the depreciation allowance over the life of the investment can be presented as:

$$z_{ikt} = \int_0^{Y_{it}} e^{-r_k t s_{it}} D_{it}(s_{it}) ds \quad (2)$$

Where Y_{it} represents the tax life of asset *i* in year *t*, and r_{kt} is the nominal discount rate previously defined. D_{it} represents the depreciation method. In the case of straight-line depreciation as is provided for in the South African tax code, the present value of the depreciation allowances can be expressed as:

$$z_{ikt} = \frac{1 - e^{-rY}}{rY} \quad (3)$$

Using the above parameters and variables, the asset-specific user-cost of capital asset *i*, in industry *k* and at time *t* as follows:

$$UCC_{ikt} = \frac{(r_{kt} - \pi_t + \delta_i)(1 - \tau_t z_{ikt})}{(1 - \pi_t)} \tag{4}$$