Corporate taxation and investment in South Africa: Evidence from the neoclassical framework*

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(Draft paper)

Abstract

This paper evaluates the responsiveness of capital investments to corporate tax changes during a period of notable reforms in South Africa. Using a neoclassical investment framework and an 11-year panel of publicly listed company data, we find that the corporate tax reforms of the 1990's and 2000's did not translate into significant increases in firm-level investment via the user cost of capital channel as predicted by neoclassical theory. Our results are similar to findings in other developing countries but stands in contrast to studies based on advanced economies. These findings therefore suggest the likely prominence of non-tax factors such as financial constraints or structural impediments as the likely important drivers of firm-level investment among South Africa firms. Therefore, policies that seek to stimulate firm investment should look beyond the provision of corporate tax incentives.

Keywords: corporate taxation, capital investment, user cost of capital

JEL codes: E22; H32; C23

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1. Introduction

The link between corporate taxation and capital investment is a key issue in corporate tax policy around the world. While neoclassical investment theory (Jorgenson, 1963; Hall and Jorgenson, 1967) predicts that the long run responsiveness of capital investment to tax changes is -1, there has been no convergence in the literature on the size of the investment elasticity. The existing research generally finds a negative relationship between corporate taxation and investment. However much of the research has focused on advanced economies, notably the United States and Europe (see for example Caballero et al, 1995; Chirinko et al, 1999; Bond et al, 2003; Dwenger, 2014; Buettner and Hoenig 2016). While some of these studies (such as Dwenger 2014; Buettner and Hoenig, 2016) find evidence in support of the neoclassical prediction, a significant number (for example Chirinko et al, 1999; Chirinko et al, 2011; Bond and Xing, 2015) still find that the user cost elasticities are way below unity- the theoretical benchmark.

Although investment largely responds to corporate tax policy in most developed countries, albeit with varying degrees of success, it is not clear whether the tax-adjusted user cost of capital is the appropriate mechanism through which corporate tax policy impacts investments in developing countries. There is generally very little empirical research on the impacts of corporate tax reforms in developing regions, and particularly sub-Saharan Africa. This is despite the existence of several documented episodes of notable corporate tax reforms meant to stimulate investment growth.

The unavailability of suitable and sufficient firm-level investment data overlapping periods of corporate tax reforms is one important reason for the lack of evidence in developing countries. Although company-level tax return datasets exists, the data are often unconsolidated and do not cover long enough periods especially around the 1990s and 2000‘s when key corporate tax reforms occurred in most sub-Saharan African countries. A possible work around to the unavailability of firm micro-data is to use company statement data for publicly traded companies. Unfortunately, most stock exchange markets are quite small in Africa and would therefore not provide large enough sample sizes. These peculiar factors have contributed to a lack of research on corporate taxation and investment in sub-Sahara Africa despite the corporate tax changes that have been noted.

Unsurprisingly, very few studies (such as Crnigoj, 2016 and World Bank, 2016) have investigated the link between corporate tax and investment in developing countries. These studies tend to find that unlike in advanced economies, investments do not respond to corporate tax reforms in the neoclassical context (Crnigoj, 2016; World Bank, 2016).

Using a unique and specially compiled dataset of publicly listed firms over a period of notable corporate tax reform in South Africa, this paper contributes to the corporate tax literature by evaluating whether firm-level investment in a developing country context can be explained by the neoclassical investment framework. Understanding the precise channels through which corporate tax changes affect investment is not only important for academic purposes, but also important in informing policy on the most effective mechanisms through which investment growth is impacted in South Africa. To the best of our knowledge, this is the very first micro-economic study in South Africa and the sub-Continent to investigate the neo-classical investment model in a period of significant corporate tax reform.

Our study uses appropriate model specifications and utilises estimation techniques that are robust to the traditional challenges noted in the literature. In particular, the likely endogeneity of our measure of the user cost of capital variable due to measurement error and simultaneity bias is taken into account by appropriate instrumentation. Furthermore, unobserved heterogeneity as well as the dynamic bias that arise in the context of firm panels and lagged dependant models (respectively) are also appropriately controlled for using the Blundell and Bond (1998) Generalised Method of Moments (GMM) approach.

Similar to results from a tiny set of papers that focus on developing or emerging countries, we find that firm level investment does not respond to corporate tax reform in South Africa in the neoclassical framework. Investment do not materialise via the user cost of capital channel as hypothesized by the neoclassical investment theory. Fazzari et al (1998) argues that in the absence of perfect capital markets, the separability of investment and sources of finance no longer holds in which case investment then respond to cash flow or liquidity (Fazzari et al, 1999). Given the presence of financial constraints among South African listed firm as reported by Vengesai and Kwenda (2018), the cash flow channel of investment is a plausible mechanism through which investments materialise. Designing corporate tax policies that are broad-based and acknowledging the role of broader financial factors in encouraging investments may yield better dividends for investment policy in South Africa.

This paper is organised as follows: the next section discusses the corporate tax reforms in South Africa since the late 1990's. 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. Section 3 presents a review of both the theoretical and empirical literature and then highlights the contributions that this paper makes. The data and methods are then discussed in section 4. The paper then presents and discusses the results in section 5 followed by the conclusion in section 6.

2. Corporate tax reforms and the user cost of capital

2.1 Corporate tax reforms 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 (Davies tax committee, 2018). The main objectives of these reforms were to stimulate investment and economic growth to address the persistent challenges of unemployment, poverty and inequality in South Africa (Katz commission, 1997; Davies tax committee, 2018). Some of the significant changes have included several episodes of reductions in the top marginal corporate tax rate and the introduction of the accelerated depreciation allowances in the early 2000's especially in the manufacturing sectors. These changes are reflected in the Income Tax Act 58 of 1962 as amended over the years (Republic of South Africa, 1962). A specific goals of these reforms is to encourage capital investment in the various assets and sectors of the South African economy.

In addition to reductions in the headline corporate tax rate since the democratic transition, several other reforms have taken place such as reduction and eventual elimination of the secondary tax on companies (STC). The STC was introduced in the income tax code in 1993 to encourage companies to re-invest part of the earnings and to mitigate the decline in tax revenues. As of 1994, the STC rate stood at 25% but was reduce to 12.5% in 1996. The STC was further reduced to 10% in 2006 and being 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 in South Africa. 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 was quite substantial. Table 1 below shows the trends in corporate tax reductions over the period 1998 to 2009. The effective corporate tax rate was calculated under the assumption of a one third dividend pay-out for profitable firms.

Table 1: Corporate Tax Rates (1998-2009)

	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%

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

As can be seen in Table 1, both the headline and effective corporate tax rates declines steady over the period under review, providing significant investment incentives for the firms. 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. The mining sector also saw the introduction of 100% depreciation expensing of new plant and machinery; while depreciation schemes that offered a 50%, 30%, 20% accelerated depreciation were also introduced in the agriculture and renewable energy sectors in the same year. 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 in this case provides a general investment tax incentive.

In calculating the tax adjusted user cost of capital in this paper, we take into account the variations in the main headline tax rate and the general depreciation allowances. 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. For instance, under the 12i Tax Allowance Investment incentive (12i TAI), companies could receive various cash incentive grants, investment allowances and learnership allowances for reaching specified criteria. These cash grants and investment allowances are not specifically reported in the financial statements of the companies listed on the Johannesburg stock exchange 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 upper bound estimates for the likely actual firm-level user costs of capital.

2.2 User cost of capital

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 the marginal investment to cover depreciation, taxes, and the opportunity cost of investing (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.

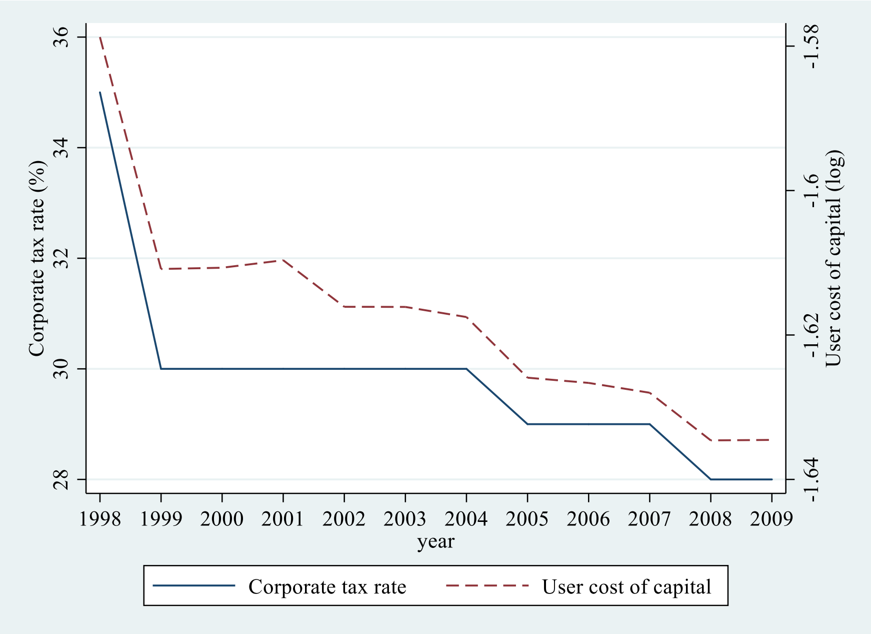
According to Egger et al. (2009), the "forward looking" user cost of capital unlike the "backward looking" average tax measures based on proportions of tax expenses to profits that have been used previously in the literature (for example Mutti and Grubert, 2004; Desai et al., 2007) is robust to endogeneity 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 Auerbach's (1983) 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. However the Chartelain et al (2003) formulation, which has been used extensively in studies that use financial statement data (for example Mojon et al, 2002; Karim and Azman-Saini, 2013; Shokr et al., 2017) can be applied to South African company level datasets. Following Chartelain et al (2003), the user cost of capital based on company financial statement data can be represented as;

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

where s is the sector-specific index, p_{st} is the price of final goods, p_{st}^I is the price of capital goods in sector s , τ is the corporate income tax rate while z is the present values of depreciated allowances. itc is the investment tax credit, AI is the apparent interest rate measured as interest payment over gross debt, LD is the long-term debt rate used as the proxy for the opportunity of equity. E, D and δ_s and are the book values of equity and debt, and the industry specific rate of economic depreciation respectively. Appendix I presents detail about each of the parameters used in calculating the user cost of capital. Figure 1 shows the evolution of the average user cost of capital alongside headline corporate tax rates.

Figure 1: Changes in corporate tax and user cost of capital



Source: South African income tax laws and own calculations based on firm level data and tax and macro-economic parameters.

As can be seen in Figure 1, the user cost of capital has moved in line with reductions in the corporate tax over the period under review. From a neoclassical perspective, reductions are corporate tax rates and the tax adjusted user cost of capital are expected to result in increases in firm level investment. In the next sections, we discuss and explore this expectation in detail and in the context of dynamic investment models.

3. Literature Review

3.1 Investment models

Theoretical models of corporate investment can be grouped into two broad classifications - the structural and reduced form models (Chirinko et al, 1993; Bond and van Reenen, 2007). Structural models such as the Q-model or the Euler equation have their estimating equations derived explicitly from dynamic optimisation problems (Bond and van Reenen, 2007) and are therefore attractive from a theoretical perspective. Q models - popularised by Hayashi (1982) - incorporate the role of market information in investment determination with the expected life-cycle returns of capital captured by the ratio of market values of capital to its replacement costs. While the Q model have been applied empirically (for example Hubbard et al, 1998; Audretsch and Elston, 2005; Peters 2017) important criticisms have been raised. First, Q models have very limited applications in contexts outside the stock markets where market capitalisation values exist (Simmler, 2012). Second, the models do not easily extend to contexts with financial frictions given that the assumed equivalence of marginal and average q only holds if finance and investment are independent of each other (Simmler, 2012; Hayashi, 1982).

The Euler is the other theoretically derived, dynamic optimisation based model also applied in the corporate investment literature (see for example Bond et al (2003), Federici and Parisi (2015), Cevik et al (2018)). While the Euler can be extended to include firms in financially constrained and uncompetitive markets, the model has been criticised for being too restrictive (Chirinko et al (1999); Dwenger (2014)). In particular, the imposition of quadratic adjustment costs has been criticised as being empirically implausible (Doms and Dunne, 1998) and too strict in the context of investments under irreversibility (Dixit and Pindyck, 1994).

In contrast to the structural models, the neoclassical models such as Jorgenson (1963) and Eisner and Nadiri (1968) are reduced form models derived from a static (rather than dynamic) model of firm investment optimisation. These model has been criticised for their ad-hoc dynamification in econometric specifications as lags are often empirically determined; and for being fully derived from theory. The neoclassical models however usually perform well empirically, and for this reason the reduced form models have been applied widely in the corporate tax literature. Based on our review of the theoretical models and the methodological preferences of the notable contributions in the literature (Chirinko et al, 1999; Dwenger, 2014; Buettner and Hoenig, 2016), this study will use the neoclassical model to study the firm-level investment dynamics in South Africa.

3.2 Empirical evidence

Following Jorgenson's (1963) neoclassical theory of investment, several empirical studies have emerged testing the validity of a cost elasticity of unity (-1) in a Cobb-Douglass framework. Although subsequent research has largely found negative user cost elasticities, the literature is far from convergence on the size estimate. Eisner and Nadiri (1968) are among the first studies to test the neoclassical investment model. Using US manufacturing industry data, the study found the user cost of capital to be less than 1 and between the range 0 and -0.33 (Eisner and Nadiri, 1968). Subsequent studies such as Auerbach and Hasset (1992) and more recently

Smith (2007), and Bond and Xing (2015), also based on aggregate data have reported elasticities of total fixed investment to user cost of capital of around -0.4 and less.

The empirical literature highlights various problems associated with estimating investment models based on aggregated or industry level data. Chirinko et al (1999) and Goolsbee (2014) for example argue that the tax effects found in such studies may be biased downwards due problems such as measurement error, firm heterogeneity and simultaneity. Dwenger (2014) and Bond and Xing (2015) further point out that aggregated data may suffer limited variation thereby making identification of the user cost parameter difficult.

For the above reasons, it is generally agreed that more granular data such as firm-level data would be best suited in studying the investment dynamics of corporate tax changes. As micro-level datasets have become more accessible over time, empirical research has now shifted to micro-based investment models to explore the user cost elasticity puzzle. One such prominent study is Chirinko et al (1999) who used a US manufacturing sector firm-level panel to estimate the long-run user cost elasticity. Chirinko et al (1999) however only found a relatively small user cost of -0.25, despite controlling for aggregation bias, endogeneity and dynamic bias in that study. Other studies using micro data such as Cummins et al (1994), who examined investment patterns during episodes of tax reform in the USA and found the estimates of the long run user cost to be between -0.5 to -1 (Cummins et al, 1994). Another prominent US based micro-study is Caballero et al (1995), who report a wide range of long run user cost elasticities of between -0.01 and -2 based on plant-level investment data from the US manufacturing sector.

These early studies (and in particular Chirinko et al, 1999) inspired an explosion in firm level corporate investment studies. Notable studies that have advanced the methodological approach include Bond et al (2003), Chartelain et al (2003), Harhoff and Ramb (2001), Dwenger (2014), Buettner and Hoenig (2016), Federici and Parisi (2015), Chirinko et al (2011) and Bond and Xing (2015) who have significantly advanced the empirical approaches in modelling neoclassical investment dynamics using data from advanced economies. Studies such as Harhoff and Ramb (2001), Dwenger and Walsh (2011), Chirinko et al (2011), Dwenger (2014);

Bond and Xing (2015), Buettner & Hoenig (2016) have focused on empirical specifications of the dynamic models. Other studies however like Bond et al (2003); Chartelain et al (2003) and Buettner and Hoenig (2016) have extended the neoclassical model to include other determinants of investments such as liquidity constraints and business expectations which are typically outside the neoclassical framework. Although the above studies generally find negative elasticities as expected, the size estimates are generally below the theoretical prediction of -1.

As can be seen, the empirical evidence on the impact of corporate tax on investment is concentrated in advanced economies, notably the US and Europe – an observation also noted by Bond and Xing (2015). The literature has very few studies outside the advanced economies. Recent research outside the advanced economies include Crnigoj (2016), who uses a neoclassical framework to evaluate the impact of the corporate tax reforms in Slovenia following the 2009 financial crisis. That paper found no impact of corporate tax reforms on investment and concludes that the neoclassical investment model was not appropriate in explaining investment in the context of firm constraints (Crnigoj, 2016). Similarly, a recent study that investigated firm level dynamics across the developing south-east Asian region finds that fixed capital investment does not react to moderate corporate tax changes (Cevik and Miryugin, 2018). Empirical evidence from the sub-Saharan Africa is very scanty, with only a single study found that directly evaluates the corporate tax effects on investment in South Africa (World Bank, 2016). That study found no significant and robust impact of corporate changes on investment across all firms in the sample (World Bank, 2016).

Based on the above literature review, this study contributes new evidence on the impact of corporate tax policy on firm level investment in developing countries using the South African case study. Given that most of the empirical literature is concentrated in developed economies and has found divergent results, it is important to consider new insights and results from a developing country context such as South Africa. Although a few studies have explored this topic in developing countries such a Slovenia, and selected south-eastern Asian countries, the current evidence map largely excludes Africa, which could have very different conditions that affect firm level investments. While there is already an existing study on South Africa conducted by the World Bank (2016), that study does not cover the period over which South

Africa implemented the most significant corporate tax policy changes with the express aim of increasing firm level investment. This study therefore contributes important evidence on whether the neoclassical investment model of firm capital accumulation holds in a developing country context. The paper uses a unique and specially compiled firm-level dataset of publicly listed companies on the South African Johannesburg Stock Exchange. We estimate the standard neoclassical investment model using the system GMM estimators by Blundell and Bond (1998).

4. Data and estimation strategy

4.1 Data

Firm level investment and the tax-adjusted user cost of capital are the main variables required to estimate the effects corporate tax on investment. The main source of this data are financial statements of the companies listed on the South African Johannesburg Stock Exchange. Tax parameters such as the tax rates and asset depreciation rate required to estimate the user costs of capital are publicly available from the income tax schedule published by the South African Revenue Services (SARS) and from the South African income tax act (amended).

The company data was collected from Datastream - an online financial data subscription service by Thomson Reuters. While the use of large firm data may under represent small firm, listed companies represent the character of the corporate sector in South Africa (Jansen, 2004). Moreover, large companies are likely to be more sensitive to marginal changes in corporate tax policy than smaller firms. The dataset comprises companies from various sectors of the economy. While the industry sector can be identified by at least two variables that capture industrial classification, we used the Industry classification benchmark (ICB) variables as opposed to the general industrial classification (GIC) variables as the former was more complete with fewer missing observations.

After obtaining the data, we restricted our sample to non-financial firms and to firms with investment and user cost values over the period 1999 to 2009. As previously discussed, this period was chose as it coincided with the most significant corporate tax changes in South Africa. Our sample was further restricted to only companies that had at least four records to accommodate the use of at least two lags and first differencing in most of our econometric specifications. After the above data cleaning, our final sample comprised about 186 unique companies and 1851 firm year-observations. Tables A1 and A2 in the appendix show the distribution of the firms by Industry and the distribution of the (firm-year) observations by year.

Finally, all the key variables used in this paper were defined according to the literature. Firm-specific investment ($I_{i,t}$) is calculated as net capital expenditure normalized by the replacement cost value of capital stock ($K_{i,t-1}$). Because the replacement values are not available in Datastream, we updated the capital historical book values using the perpetual inventory formula following Bond and Xing (2015) among others. Net sales ($S_{i,t}$) which we used as a proxy for output is calculated by deflating the nominal sales series using the consumer price index (CPI) series from Statistics South Africa. Finally the user cost of capital ($UCC_{i,t}$) was calculated for all firms and over all the years using the approach by Chartelain et al (2003) as already indicated. Appendix B presents more information on the calculation of each of the key variables.

Table 2 presents descriptive statistics for the key variables used in estimating the investment models. The average rate of investment for a typical firm is about 24% of the net fixed assets. This is somewhat in line with the range reported by other studies such as Crnigoj (2016) and Vengesai and Kwenda (2018) who reported net investment rates of about 27% and 37% for Slovenia and all of Africa respectively. The average growth rate in sales was about 20% which is somewhat higher compared to other studies (Dwenger 2009). The user cost of capital on the other hand declined by an average 0.4% - the decline is as expected given the corporate tax reductions and reforms over the period. The average user cost of capital stands at 19%, which implies that on average the South African corporate tax system incentivised marginal investments given that the top marginal statutory tax rate stood at 28%.

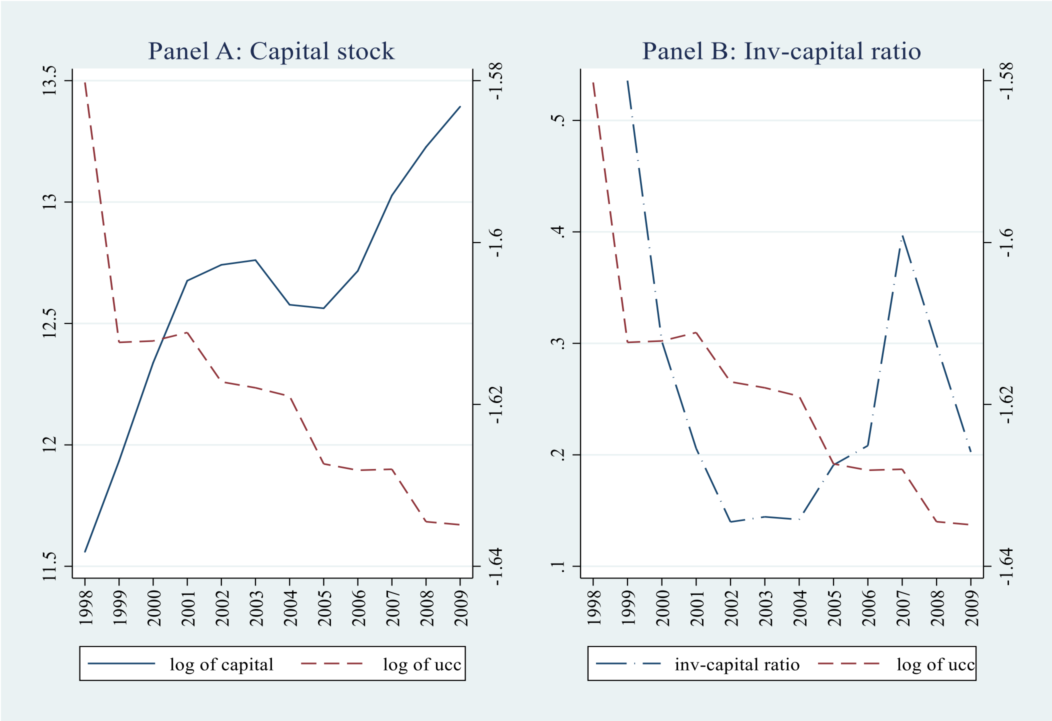
Table 2: Descriptive statistics of the key variables

	Mean	Median	Standard deviation	N

$Log(K_{i,t})$	12.70	12.81	2.717	1834
$I_{i,t}/K_{i,t-1}$	0.248	0.127	0.428	1649
$Log(S_{i,t})$	14.12	14.34	2.317	1801
$\Delta.S_{i,t}/S_{i,t-1}$	0.216	0.078	1.610	1610
$UCC_{i,t}$	0.198	0.196	0.008	1844
$\Delta.UCC_{i,t}/ UCC_{i,t-1}$	-0.004	0.000	0.009	1641

Figure 2 further explores the relationships between the capital stock and investment-capital ratios against movements in the user costs of capital over time. As can be seen in panel A, there is a clear negative relationship between capital stock and user cost of capital over time. These trends are as expected, and in line with both neoclassical theoretical as well as policy maker expectations that reductions in effective corporate taxation and hence reductions in the tax-adjusted user costs of capital would encourage firms to increase capital accumulation via investments. Panel B, which show how investment ratio perform over time as the user cost of capital declines does not have a clear upward linear trend, perhaps due to noise that is often associated with investment-capital ratios in levels. However, two discernible patterns are clear: investment ratios decline before 2004 and thereafter somewhat increase on average.

Figure 2: Capital stock, Investment ratios and Cost of Capital



To better understand the patterns between investment and user costs of capital, we replicate the analysis in Figure 2 at the industry-level. Figures 3 and 4 show the co-movements between the logs of capital and user cost of capital; and the investment-ratios and user costs of capital respectively. We note that largely, the industry level patterns in most cases follow the overall trends noted in Figure 2. In Figure 3, all the relationship between log of capital and log of user cost of capital appears linear in all the sectors, except the telecommunications sector where we note a quadratic patterns in the log of capital. Figure 4 on the other hand does not indicate clear linear inverse relations between investment ratios and the user costs of capital. The patterns largely show non-linear patterns across the industries.

Figure 3: Capital stock and Cost of Capital, by Industry

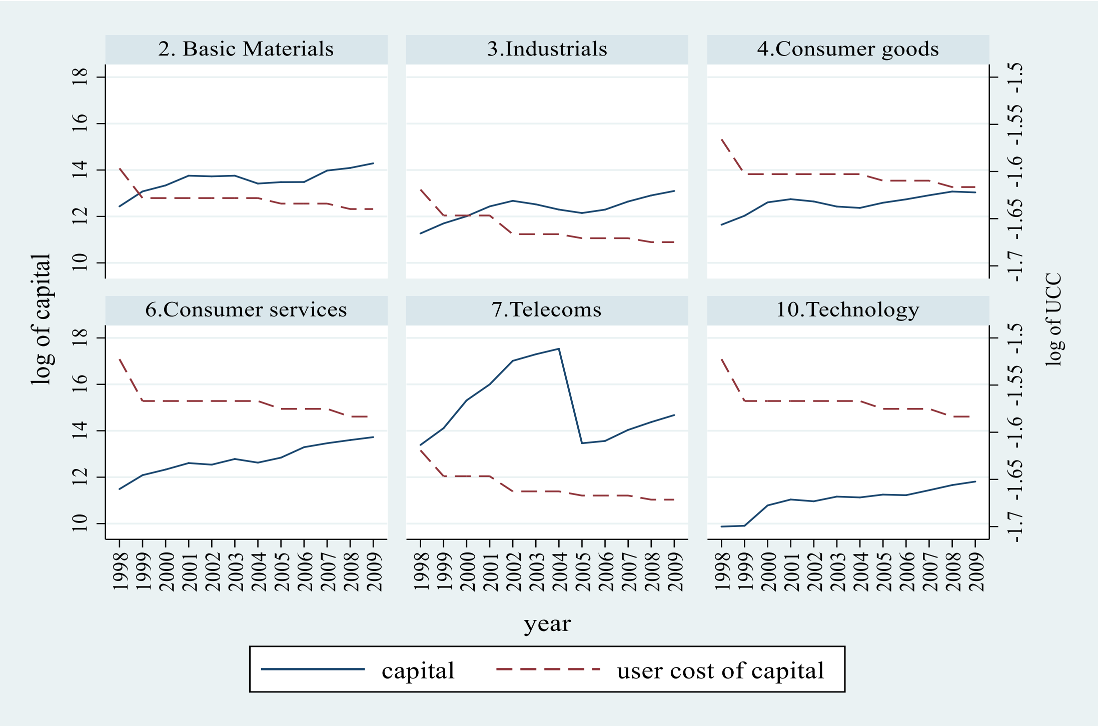
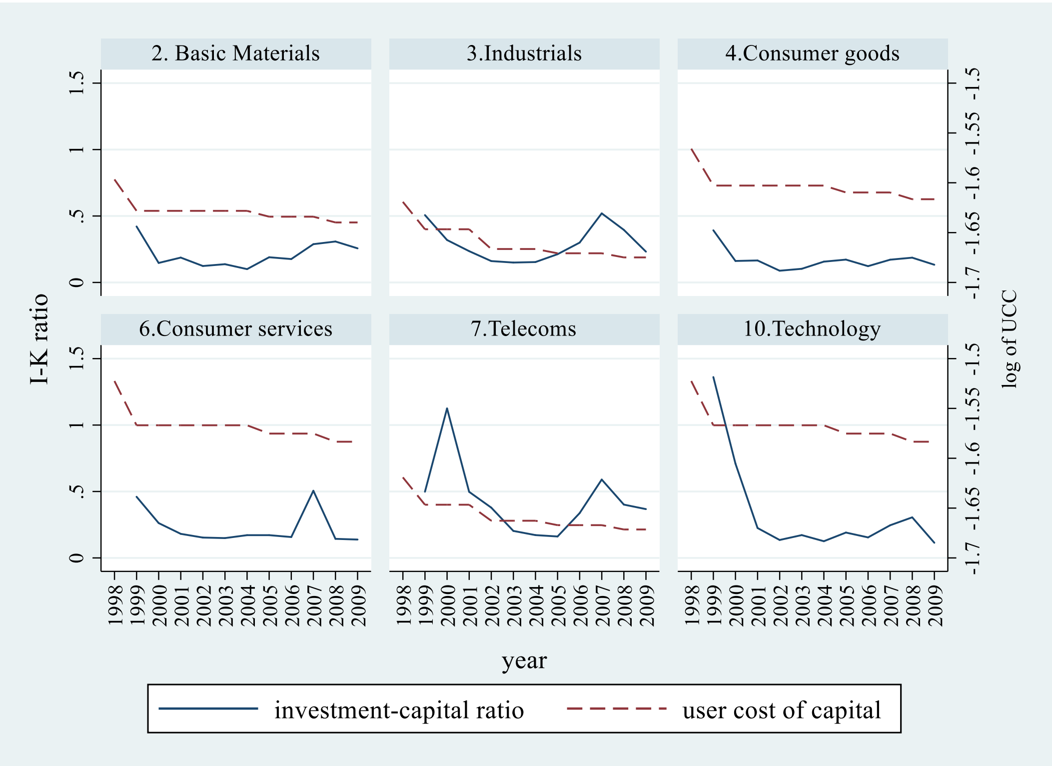


Figure 4: Investment ratios and Cost of Capital, by Industry



4.2 Models and estimation strategy

4.2.1 A model of optimal capital stock

According to Esner and Nadiri (1968), the demand for investment in a dynamic context can be derived from the first-order conditions of a profit maximising firm. Using a production function with constant elasticity of substitution (σ) between capital and labour, the optimal capital stock ($K^*_{i,t}$) for firm i at time t can be written as;

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

were $t = \sigma + \frac{1-\sigma}{v}$.

The optimal level of capital is a function of a firm's level of output or sales $S_{i,t}$, a firm-specific distribution parameter A_i that accounts for the firm-specific relative factor shares of labour and capital, technology T_t as well as the user cost of capital $UCC_{i,t}$ as previously defined.

The parameter of interest is the long-term elasticity of capital stock with respect to the UCC, given by $-\sigma$. In a frictionless world without adjustment costs, a firm's current capital stock always equals the optimal capital level. The optimal capital stock can therefore be stated as a log-linear function of the log of current sales $S_{i,t}$, log of 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:

$$k^*_{i,t} = c + a_i + \beta s_{i,t} - \sigma ucc_{i,t} + \sum_{t=1}^{T-1} \tau d_t$$

In the presence of adjustment costs however, firms do not adjust immediately to their optimal targets. To capture this, the current capital stock is modelled as dependent on its lagged values, as well as both the current and past values of sales and user cost of capital. Adding the stochastic error term $\varepsilon_{i,t}$, current capital stock can be expressed as

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

4.2.2 First differenced distributed lag model

The prevailing model in the literature is the first differenced distributed lag model due to Eisner and Nadiri (1968) and Chirinko et al (1999). Given that firm-data are usually skewed to the right, Chirinko et al (1999) propose specifying the equation for capital with all variables as ratios or rates. Taking differences of equation 5 results in the following first-differenced autoregressive distributed lag model:

$$\Delta k_{i,t} = \sum_{h=1}^{H} \phi_h \Delta k_{i,t-h} + \sum_{h=0}^{H} \beta_h \Delta s_{i,t-h} - \sum_{h=0}^{H} \sigma_h \Delta ucc_{i,t-h} + \Delta\varepsilon_{i,t}$$

Substituting the change in capital with the difference between the investments scaled by the capital stock at the beginning of the period; and a firm-specific time invariant depreciation rate results in the following equivalent: $\Delta k_{i,t} = \frac{I_{i,t}}{K_{i,t-1}} - \delta_i$. Replacing this into equation 6 yields;

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

In the currently prevailing model by Chirinko et al (1999), the distributed lag model above is simplified by excluding the lagged dependent variable. Chirinko et al (1999) however includes cash flow normalised by the beginning of period as a proxy for financial constraints. According to Modigliani and Miller (1958), firm investment decisions are not related to financing decisions under the assumption of perfect markets. However, in the presence of imperfect capital markets, the separability between investment and financial decisions no longer holds as contended by Fazzari et al (1988). Without a doubt, firms in developing countries including South Africa face liquidity constraints and therefore including cash flow as a proxy for the financial constraints is appropriate even in this paper. Including the current and lagged values of cash flow leads to the following estimation prevailing distributed lag investment equation (Chirinko et. al, 1999):

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

From the equation above, the long run user cost elasticity of capital is estimated by adding up the $\sigma's$. Under this model, there is no explicit modelling of the equilibrium relationship between capital, output and taxes (user cost of capital). The directly estimate the long run equilibrium relationship between capital investment and corporate taxation, the study estimates an error correction model specified in the next section.

4.2.3 Error correction model

The distributed lag model in equation 5 can be re-parameterised into an error correction model which is useful in separating out the short run and long-run effects of tax changes on investment. The corresponding error correction model based on equation 5 and reduced to one lag yields the following one-step ECM model:

$$k_{i,t} = c + \phi k_{i,t-1} + \sum_{k=0}^{H-1} \mu_k \Delta s_{i,t-k} - \sum_{k=0}^{H-1} \alpha_k \Delta ucc_{i,t-k} - \sigma' ucc_{i,t-1} + \beta' s_{i,t-1} + \sum_{t=1}^{T-1} \tau d_t + a_i + \varepsilon_{i,t}$$

were $\sigma' = -(\phi - 1)\sigma$ and $\beta' = -(\phi - 1)\beta$. The short term responses of a change in the user cost of capital or output (sales) are captured by $\sigma's$ and $\sigma's$ respectively. The long run response of capital to changes in user cost of capital are however captured by $\sigma = \sigma'/(1-\phi)$ while $\beta = \beta'/(1-\phi)$ captures the long run effects of changes in sales.

4.2.4 Estimation strategy

For both the DLM and ECM, we used the generalised method of moments (GMM) which is robust to a number of econometric problems that could bias our estimates. Studies such as Lang et al (1996) have estimated investment models using pooled regression models under that assumption of no unobserved individual effects. Addressing this shortcoming using the fixed effects edtimator is still unlikely to address the problem of endogeneity in the context of a dynamic investment model. 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 is increases indefinitely. A solution to the nickel bias is using the Anderson-Hsiao (1982) estimator which uses first differencing and appropriate instrumentation to obtain consistent estimates. The Anderson-Hsiao estimator is however also inefficient, as it does not take into account all the moment conditions. The GMM estimators on the other hand exploit all available moment conditions thereby solving the problem of weak instruments and yielding more efficient results. We use the system GMM estimator (Blundell and Bond, 1998) in this paper across both the distributed lag and error correction models.

5. Results and discussion

Although our preferred specification is the error correction model, we first briefly consider results obtained using autoregressive distributed lag models to enable comparison with other studies (such as Chirinko et al (1999); Dwenger (2014); Crnigoj (2016)). In the autoregressive distributed lag specification, the short run effects are derived from an empirical specification search rather than determined ex ante; and the long run effects are simply the sum of the short run effects. After experimenting with a number of lags, we use the current and three past lags of user cost of capital and sales in our models. Table 2 shows the impact of the neoclassical determinants of investment using the ARDL framework.

Table 2: Estimates of user cost of capital and sales in an ARDL specification

	OLS	Fixed Effects	GMM	GMM
$I_{i,t}/K_{i,t-1}$			Lags (2)	Lags(2-4)
$I_{i,t-1}/K_{i,t-2}$	0.280***	0.007	0.630***	0.553***
	(0.091)	(0.057)	(0.132)	(0.102)
$\Delta ucc_{i,t}$				
σ_0	0.943	0.296	1.951	-0.560
	(1.557)	(1.900)	(6.710)	(4.670)

σ_1	-0.787	-0.837	-1.545	-0.091
	(1.444)	(1.523)	(1.477)	(1.349)
σ_2	-0.225	-0.053	4.539	-0.031
	(1.117)	(1.076)	(6.129)	(0.770)
σ_3	0.377	0.344	-5.895	-2.399
	(1.254)	(1.410)	(8.931)	(2.129)
SUM(σ)	**0.308**	**-0.251**	**-0.949**	**-3.082**
	(3.425)	(4.496)	(17.434)	(5.746)
$\Delta\beta_{i,t}$				
β_0	0.100***	0.074***	0.054	0.064**
	(0.029)	(0.021)	(0.054)	(0.032)
β_1	0.086**	0.070***	0.039*	0.052*
	(0.034)	(0.026)	(0.023)	(0.027)
β_2	0.011	0.006	-0.071**	-0.009
	(0.016)	(0.015)	(0.030)	(0.020)
β_3	0.040***	0.018	0.117*	0.034**
	(0.012)	(0.013)	(0.065)	(0.016)
SUM(β)	**0.237*****	**0.169*****	**0.134****	**0.141****
	(0.067)	(0.048)	(0.058)	(0.060)
Observations	1,035	1,035	1,035	1,035
Number of firms	172	172	172	172
Arellano-Bond test (p-value), order 1			0.001	0.005
Arellano-Bond test (p-value), order 2			0.301	0.302
Hansen test (p-value)			0.371	0.108

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 denotes the significance at the 1%, 5% and `0% level respectively. All regressions include sets of time dummies.

The results in the first and second columns are based on the ordinary least squares (OLS) and Fixed Effect models while the results in the last two columns are based on the GMM estimator with various instrument lags. Across all specifications, we generally find that South African firm-level investment does not respond to tax incentives via the user cost of capital channel. The response to output is however significant and robust across the various specifications, thereby lending support to the use of the accelerator or output based models used in this study. Focusing on the individual models, the results from the pooled OLS models are likely biased due to the omission of the firm specific unobserved heterogeneity- which is an important aspect in the context of firm-level investment. Focusing on only the long run effects, we see that controlling for the firm-specific heterogeneity using the fixed-effects model results in changes in the signs and size of the long run user cost and output coefficients. In particular the coefficient on the tax variable is now correctly signed (even though insignificant) while the coefficient on output becomes smaller. The changes in the coefficients are suggestive of the presence of fixed effects and therefore indicate bias in the OLS estimates.

While the fixed effects model may be preferable because it accounts for unobserved firm-heterogeneity, the underlying demeaning process gives rise to bias in the lagged coefficient of the dependent variable due to resulting correlation between the lagged dependent variable and the mean error (Nickell, 1977). The fixed effects model is therefore inconsistent in the context of dynamic panels such as the neoclassical investment model. To address the limitations in the above OLS and fixed effects estimators, we use the two step GMM estimator which is also robust to endogeneity in the neoclassical determinants of investment as well as to serial correlation and heteroskedasticity. Although insignificant, the tax coefficients in the GMM context are larger while the output coefficient are smaller than the corresponding results in the OLS or fixed effects models. The GMM models yield very similar results, but our preferred specification is column 3, which uses fewer instruments and thus performs better on the Hansen test for over-identifying instruments. This specification also indicates that the investment model does not suffer significant second-order serial correlation as indicated by the Arellano-Bond (AR2) tests.

As already indicated, we find that in the ARDL framework, firm-level investment does not respond to corporate tax incentives. This finding is surprising, given that frequent corporate tax policy changes were made in the period under review for the sole purpose of encouraging company-level investment. We do however find that firm-level investment responds significantly to increases in output. In particular, a 10% increase in sales is associated with a 1.3% increase in firm level investment. Before we turn to a discussion of these findings, we also present findings from the error correction model in Table 3.

Table 3: ECMs

VARIABLES	(1) $\Delta.K_t$	(2) $\Delta.K_t$	(3) $\Delta.K_t$	(4) $\Delta.K_t$
$K_{i,t-1}$	0.820***	0.790***	0.812***	0.905***
	(0.050)	(0.069)	(0.076)	(0.048)
Long Run Estimates				
User cost of capital	1.064	2.323	-1.054	-3.445
	(4.254)	(4.312)	(4.858)	(5.302)
Output (sales)	0.750**	0.809***	0.199	0.118

	(0.164)	(0.159)	(0.176)	(0.192)
Short Run Estimates				
Δ.UCC	10.922	-3.658	6.281	1.667
	(8.740)	(8.990)	(4.518)	(3.600)
Δ.Output (sales)	0.291*	0.353	0.008	0.057
	(0.175)	(0.224)	(0.071)	(0.038)
Constant	0.931	1.301	1.955	0.826
	(1.303)	(1.618)	(1.555)	(0.956)
Error correction term	-0.180***	-0.210***	-0.188**	-0.095*
	(0.050)	(0.069)	(0.076)	(0.048)
Observations	1,630	1,630	1,023	1,023
Number of firms	201	201	95	95
Arellano-Bond AR(1) (p-value)	0.048	0.077	0.048	0.051
Arellano-Bond AR(2) (p-value)	0.470	0.536	0.283	0.321
Hansen test (p-value)	0.263	0.272	0.185	0.176

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 denotes the significance at the 1%, 5% and `0% level respectively. All regressions include sets of time dummies.

Table 3 reports the results of the investment model in equation 3 using the ECM specification which enables us to separate the long run from the temporary effects of tax and output changes. The results in the first two columns are based on the full unbalanced panel while columns (3) and (4) are based on the balanced panel. The results in column (1) and (3) are based on the second lag instruments while columns (2) and (4) has instruments lagged from the second to the fourth period. Our models satisfy a number of expectations. Based on the Arellano-bond AR (2) tests of no second order serial correlation and the Hansen test of instrument validity, the model does not exhibit second order serial-correlation in the residuals and the GMM instruments from the second up to the fourth lag are valid. Our regression results also pass additional basic specification tests. In particular, the coefficients of less than 1 on the lagged capital variable is consistent with dynamic stability. In addition, the negative and statistically significant error correction term across the models suggest the existence of a long-run relationship between investment and its determinants in the neoclassical investment model. The adjustment terms indicates that approximates 18-21% of the disequilibrium between investment and output is settled in each year, resulting in an adjustment speed of about 5 to 6 years to return to equilibrium.

Using both the ARDL and ECM specifications, our study finds that firm-level investment in South Africa does not necessarily respond to tax incentives in the neoclassical framework. The results are consistent across various empirical specifications common in the literature and robust to various estimation techniques. Our findings are similar to a study in Slovenia (Crnigoj, 2016) and a recent World Bank supported study in South Africa (World Bank, 2016) which find insignificant overall effect of tax incentives on firm level investments. The null effects of corporate tax policy in stimulating investment may point to the existence of financial constraints among South African firms. As suggested by Fazzari et al (1988; 2000), investment may no longer respond to corporate tax policy in the presence of liquidity constraints. In other words, the separability between investment and financial decisions no longer holds in the context of imperfect capital markets and investment may only respond to the availability of internal finance and not through the user cost channel (Fazzari et al, 1988).

The absence of significant financial constraints may explain the relatively better performance of neoclassical investment models in more advanced economies compared to developing countries where financial markets are relatively under-developed and potentially constrained (Crnigoj, 2016). Although we do not further evaluate the role of liquidity constraints on investment in this paper, Vengesai and Kwenda (2018) point out that South Africa firms have relatively higher leverage rates in comparison with other African listed firms thereby suggesting the likely role of financial or other structural factors in determining firm-level investment. Elsewhere in Europe, Bond et al (2003) suggested that financial constraints appeared to have important effects on UK firm investment relatively to continental European firms whose financial systems perform better in the 1980s. The null effects of corporate tax on investment are therefore likely due to the existence of financial constraints or other structural impediments on firm-level investment.

6. Conclusion

This paper considered the impact of corporate tax changes on firm level investment in South African listed firms in a period of frequent corporate tax changes. To the best of our knowledge, this is the first study in the sub-Saharan African context, to consider the impact of corporate tax changes in a neoclassical investment framework and over a period of focused corporate tax changes meant to simulate firm-level investment. We find that while the consented corporate tax policy changes were successful in reducing the marginal cost of investment as reflected by reductions in the user costs of capital over the period 1999 to 2009, but the reductions did not translate into significant investments. Firm output was however consistently found to be a significant driver of firm level investment – a results that is in the neoclassical framework in line with theory and consistent with findings in the broader investment literature. The findings are overall consistent across all the econometric specifications explored in this study.

The insignificance of the impact of corporate tax reductions on firm investment is likely due to the existence of financial or other structural constraints in South Africa. Given the findings in the recently related studies which suggest that South African firms are faced with relatively high debt ratios as well as significant skilled labour and electricity shortages, its perhaps not entirely surprising that tax incentives play little importance in encouraging investment growth in South Africa. Therefore, exploring the role of the financial and structural constraints in future studies would be important to explaining what drives firm level investment in South Africa.

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Appendix A:

Table A1: Industry classification of the sample

ICB classification	No. of firms
2. Basic Materials	437
3.Industrials	609
4.Consumer goods	219
6.Consumer services	342
7.Telecoms	38

10.Technology	206
Total	1851

Table A2: Firm-year observations

year	No of observations	%
1998	106	5.73
1999	125	6.75
2000	129	6.97
2001	133	7.19
2002	137	7.4
2003	144	7.78
2004	162	8.75
2005	177	9.56
2006	184	9.94
2007	184	9.94
2008	186	10.05
2009	184	9.94
Total	1851	100

Appendix B: variable definition

Capital stock: perpetual inventory formula as applied in Dwenger (2014) and Bond and Xing (2015):

$$K_t = (1 - \delta)K_{t-1} + I_t$$

were K_t represents capital stock, I_t represents real investment and δ is the sector specific depreciation rate.