Corporate Taxation and Inter-Asset Investment Distortions in South Africa*

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Abstract

South Africa has since the 1990's actively reformed its corporate tax policy to stimulate investment in various assets and industries. While the investment impact of corporate taxation has been evaluated in various studies, no effort has been made to assess the potential inter-asset distortions due to differential taxation. Using a unique asset-industry level dataset, we find evidence of inter-asset distortions arising from differrential taxation of assets and industries in South Africa. In particular, compared to a counterfactual benchmark where tax rates are equalized, we find that differential taxation induces under-investment in non-residential structure and computer equipment and over-investment in machinery and transportation equipment. The immediate policy implications are that ignoring distortions due to heterogeneous tax treatment could understate the efficiency and redistributive effects of tax policy in South Africa and other developing countries.

Keywords: user cost of capital, investment, corporate taxation

JEL classification: H21, H25, H32, E22

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1 CHAPTER 2: CORPORATE TAXATION AND INTER-ASSET INVESTMENT DISTORTIONS

1.1 Introduction

While the importance of corporate tax incentives in capital accumulation and economic growth has been widely researched in the corporate tax literature[1] , 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, reduced 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 effective taxation of different investment assets may alter the structure of business investment, and to that extent, distort capital investments (Liu, 2011). Whereas empirical research such as King and Fullerton (1984) and Auerbach (1996) has highlighted substantial differences in the effective tax burden faced by different asset categories due to different tax treatment, little research has been conducted to estimate the inter-asset distortion effect of the corporate income tax.

This chapter contributes new empirical evidence on the inter-asset distortion effects of the corporate tax using South Africa as a case study. First, we construct a dataset of industry level investments in different assets categories over a 9 year period from 2005 to 2013. Second, we compute asset-industry level user costs of capital and estimate both the own and cross asset substitution elasticities to assess the responsiveness of investments to tax incentives.

1.2 Brief literature review

Prior to the work of Liu (2011) and Fatica (2013), no empirical research directly estimated the inter-asset distortions of the corporate income tax. Since the 1980's, most studies have traditionally assessed the economic distortions of corporate taxation indirectly by observing tax induced differentials in the

[1] see for example, Chirinko et al. (1999), Vartia, 2008; Dwenger, 2009; Bond and Xing, 2010

marginal cost of investment at the asset or industry level. Studies such as Auerbach et al. (1983), King and Fullerton (1984), Auerbach and Hassett (1991) and Mackie (2002) find that differential capital taxation induces variations and hence distortions in the asset level user cost of capital and marginal effective tax rates. Auerbach (1983) for instance finds that the social cost of misallocation of capital arising from differential effective taxation stood at 3.19 percent of total capital stock in the US in 1981. Mackie (2002) on the other hand finds that differential taxation in the US tends to favour investment in equipment assets while disadvantaging non-residential structures.

Studies based on general equilibrium models have also provided further evidence of the welfare costs of differential corporate taxation[2]. Fullerton and Henderson (1989a) for instance find that inter-asset distortions are larger than inter-industry or inter-sectoral distortions and find that the estimated welfare cost of distortions is around 0.18 of GNI. To the best of our knowledge, the only studies that directly estimate the inter-asset distortion effects of differential corporate taxation are Liu (2011) and Fatica (2013). Both studies use asset-industry level panel data for the US and OECD respectively to estimate inter-asset distortions of the corporate tax using own and cross tax elasticities of asset investment. In this paper, we follow the estimation strategy of Liu (2011) and other related studies such as Fatica (2013) and Uzawa (1962) to estimate robust inter-asset elasticities and distortion effects.

1.3 Corporate taxation and Investment

1.3.1 User cost of capital

The impact of corporate taxation on investment has traditionally been analysed using the Jorgenson (1963) and Hall and Jorgenson (1967) neoclassical investment framework. The precise channel through which taxation affects investment is the user cost of capital. Under the behavioral 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 or 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 rate of interest *(r)* - the opportunity cost of capital. The level of

[2]Examples include Fullerton and Henderson (1989a,b); Jorgenson (1996); Auerbach (1989)

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) would be presented as;

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

Introducing corporate taxation necessitates modifying the equilibrium outcome in equation (1) above 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 # 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 nomimal interest rate, inflation rate and present value of accumulated depreciation allowances.

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)[3]. Thus, the UCC 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 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,

[3]A detailed introduction and discussion on the user cost of capital is provided in Creedy and Gemmell (2015).

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 off 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 though 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 deductability 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 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:

$$METR = \frac{\tilde{\rho} - \bar{r}}{\tilde{\rho}}$$

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 measure the tax wedge on a marginal investment, or the proportion of the returns of a marginal investment given up to compesate for taxation. It is the extent to which corporate taxation increases the cost of capital above $\bar{r}$ (World Bank (2015); Fatica (2013)) .

1.3.2 Corporate tax incentives in South Africa

The Income Tax Act 58 of 1962 as amended offers a variety of tax incentives meant to encourage capital investment in the different assets and sectors of the South African economy. As part of a broader tax reform effort over the last 20 years, the South African government has provided both general as well as selective tax incentives through various amendment Acts. For instance, general investment tax incentives by way of reductions in the statutory corporate tax rates have frequently been made. The corporate tax rate in 1994 was reduced from 48% to 40% before a further reduction to 35% in 1995 and to 30% in 2000. More recently, the corporate tax rates have further been reduced to 29% in 2007 and to 28% in 2009. The main objectives of these reforms has been to attract the much needed capital investment in the new post-apartheid South Africa. The South African government has effected similar reductions and reforms to the secondary tax on companies (STC) over the last 20 years. 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 South African Revenue Service (2010). The STC was initially taxed at 15% but increased to 25% in 1994 before being reduced to 12.5% in 1996 and to 10% in 2006. However, due to the need to re-align South Africa's dividend tax structure with global norms and to remove the perception of uncompetitive tax environment, the STC was eventually discontinued and replaced with a dividend tax levied on shareholders in 2012.

South Africa also provides specific tax incentives in selected investments and industries. For instance, since 2002, the tax codes allows accelerated depreciation of new plant and machinery in the manufacturing sector at the rate of 40%, 20%, 20% and 20%. The mining sector has 100% depreciation expensing of new plant and machinery while the agriculture and renewable energy sectors have a 50%, 30%, 20% accelerated depreciation scheme. In addition to accelerated depreciation, across all sectors, the tax code accomodates some preferential treatment of selected specific assets, by having higher tax depreciation rates compared to economics depreciation rates.

The South African income tax code also provides for the deductability 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 user cost of capital in this paper, we take into account all the variations in the above tax parameters.

The list above is certainly not exhaustive of all tax and non-tax incentives that could be modelled. Indeed, many other significant tax and non- tax incentives that exists under the law are available. For instance, under the 12i Tax Allowance Investment incentive (12i TAI), firms could receive various cash incentive grants, investment allowances and learnership allowance for reaching specificied criteria. These cash grants and investment alowances are not fully reported in any firm level survey or industry level dataset yet and therefore not incorporated into out analysis. To this extent therefore, our estimate of the user cost of capital and marginal effeective tax rates could be considered as lower bounds.[4]

1.4 Data and variables

1.4.1 Data

This paper exploits detailed industry-level financial statement data published in the disaggregated annual financial statistics series compiled by Statistics South Africa (StatsSA). The detailed data comprises consolidated industry-level income statement, balance sheet and fixed asset information of various industries in South Africa. The data is presented at all the standard industrial classification (SIC) levels. We use data at the SIC4 digit level as this has most sub-group industries and the most observations over the time period. At the SIC-4 digit level, data is available for an 8 year period from 2007 to 2014 and covers at least 200 industrial groupings. The dependent variable - the share of asset investment - is calculated as a share of investment in asset i relative to the annual gross fixed assets additions in new fixed assets in a given industry i at a given time t. The StatsSA industry-level dataset classifies assets by nature of use according to accounting practice and standards. 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. We drop land and capital work-in-progress assets because the former is typically fixed for the industries in our analysis and the latter is difficult to allocate to a specific asset category. The balance sheets also includes intagible fixed assets such as the value of intellectual property rights and copyrights. We also exclude these intangible assets as our main concern is the impact of taxation on physical and depreciable fixed assets.

The data used in constructing the cost of capital come from various sources. The inter-bank prime lending rate and the 10-year yield rates government bonds

[4]Furthermore, numerous other non-tax incentive programmes providing grants and business support meant to boost investment, productivity and broad-based economic participation are available. For example the Black Business Supplier Development Programme provides grants to improve competitiveness and marketing of black-owned businesses; while the Critical Infrastructure Development Programme provides infrastructure cost sharing grants to promote key infrastructure developments. For a comprehensive list of all tax incentives and cash grants and investment support programmes availabe under South African corporate legislature, see of Trade and Industry (2011)

used as measures of the cost of debt and equity respectively were obtained from the South African Reserve Bank website. The CPI series from StatsSA were used to capture inflation. The headline corporate tax rate and the secondary tax on companies rates were used to calculate effective statutory tax rates used in as inputs in calculating the asset-industry user cost of capital. Asset level economic depreciation rates and tax depreciation rates were obtained from a recent World Bank study on South Africa.

Figure 1: Corporate Taxation, Inflation and Interest rates

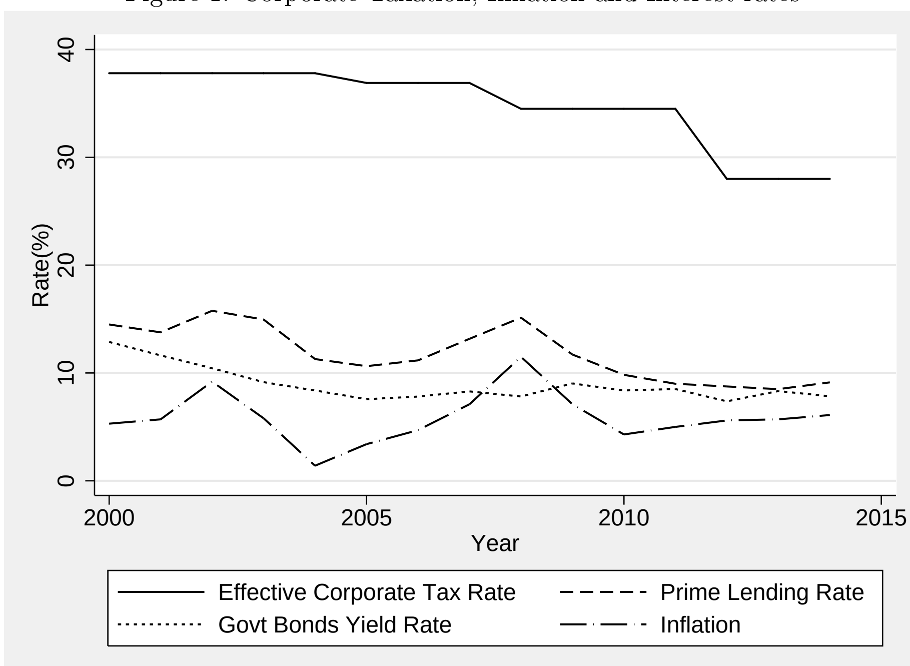


Figure 1 shows movements in the effective corporate tax rate, inflation rate and the prime interest rate and 10 year government yield rate over the period 2000 to 2014. Over this period, the tax code has consistently reduced both the corporate tax and the secondary tax on companies tax rates with the main objective of encouraging capital investment and harmonising the South Africa tax legislation with global practiceSouth African Revenue Service (2010). Since 2005, inflation has been declined somewhat, together with the inter-bank prime rate and government bond rates.

1.4.2 Calculation of Interest rates and depreciation allowances

The calculation of asset level cost of capital required that we first estimate the nominal interest rate and present value of depreciation allowance on a unit value 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:

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

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 disaggregaed industry level balance sheets for each industry. i_t and e_t is the inter-bank prime lending rate and the yield rate on 10-year South African government bonds taken to respectively represent the cost of debt and equity. 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 1 dollar investment, the present value of the depreciation allowance over the life of the investment can be presented as;

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

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;

$$z_{ikt} = \frac{1 - e^{-rY}}{rY}$$

All the above variables are then used to calculated the user cost of capital for each asset i, in industry k and at time t as follows;

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

The user cost of capital will vary by the type of asset and the type of industry as a result of the interaction between the industry-level interest rates and asset-level tax incentives. The multiple dimensions of the components of the user cost of capital therefore provide a rich source of variation within and between assets and facilitates identification of the inter-asset distortion effects of corporate taxation.

Table 1: Mean and Standard Deviation of COC and z

Tax Parameters	2007-2008	2009-2010	2011-2012	2013-2014
COC: Structures	8.77	12.71	11.25	9.93
	(2.28)	(2.94)	(2.64)	(2.26)
COC: Computer	31.62	43.38	40.48	41.74
	(9.94)	(10.93)	(11.11)	(10.81)
COC: Transport	24.41	28.71	26.94	25.82
	(3.20)	(3.31)	(3.49)	(3.46)
COC: 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)

Note: 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. COC and z are the user cost of capital and present value of depreciation allowance for each given asset, respectively.

Table 1 above shows the mean and standard deviation of the user cost of capital (UCC) and the present value of depreciation allowances (z) associated with the different capital investments under consideration. 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 presumably as 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 lifes for structures. The higher cost of capital for computing and transportation equipment is a result of the relatively low asset lives and a lack of tax depreciation incentives for these categories.

1.4.3 Descriptive Statistics

Table 2 below 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. Not surprisingly, machinery equipment has the largest share of investment, with computer equipment having the least share. The cost of capital is most favourable for machinery and plant equipment and structures, perhaps as a result of the more generous depreciation allowances and slow economic depreciation, respectively.

Table 2: 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

Note: 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 the PPI for the respective asset.

1.5 Estimation Framework

The investment distortion effects of corporate taxation can be modelled using a transcendental logarithmic (translog) cost function[5] which allows for a rich

[5]The translog function was developed by Christensen et al. (1973) and has been widely used in the productivity literature. See Berndt and Christensen (1973) and Berndt and Wood (1975) for early applications.

pattern of substitution between input pairs. Following Liu (2011), the general functional form of the long-run translog cost function can be specified as;

$$\begin{aligned} lnC = \alpha_0 + \alpha_Q lnQ + \sum_i \alpha_i lnP_i + \frac{1}{2}\gamma_{QQ}\left(lnQ\right)^2 + \sum \gamma_{Qi} lnQlnP_i \\ + \frac{1}{2}\sum_i \sum_j B_{ij} lnP_i lnP_j + B_i Time + \frac{1}{2} B_T Time^2 + \\ B_{TQ} TimelnQ + \sum_{i=1}^{n} B_{Ti} TimelnP_i + B_i Industry + \\ \frac{1}{2} B_I Industry^2 + B_{IQ} IndustrylnQ + B_{Ii} IndustrylnP_i + \varepsilon \end{aligned}$$

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 level dummies. The $\beta'_{ij}s$ 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 (3) with respect to the log of the price of input i:

$$S_i = \frac{\partial lnC}{\partial lnP_i} = \frac{(X_i P_i)}{C} = \alpha i + \gamma_{Qi} lnQ + \sum_j \beta_{ij} lnP_i + B_{Ti} Time + B_{Ii} Industry$$

where S_i is the cost share of input i. By definition, all cost shares sum to 1 and the cost function is homogenous of degree one in price. These conditions suggest that the following restrictions must hold for well behaved investment shares;

$$\sum_i \alpha_i = 1 \tag{4}$$

$$\sum_i \gamma_{Qi} = 0, \;\; and$$

$$\sum_j \beta_{ij} = \sum_i \beta_{ij} = 0 \tag{5}$$

1.6 Empirical Specification and Results

1.6.1 SUR Model

The set of the linear restrictions in section 1.5 imply a singular variance matrix in the equation system, requiring one investment category to be dropped. In this paper, we model investment in industrial structures, computer equipment, transportation equipment and plant and machinery equipment. Given that the variance matrix is singular, we drop one share equation and divide the price of every other asset by the price of transportation equipment. Note that the choice of which equation to drop is arbitrary and the results are invariant to the equation dropped. We can therefore empirically estimate the investment share of asset i in industry k at time t (S_{ikt}) as:

$$S_{ikt} = \alpha_i + \sum_j B_{ij} ln\left(\frac{COC_{ikt}}{COC_{trans,kt}}\right) + \sum y_{ij} ln\left(\frac{P_{ikt}}{P_{trans,kt}}\right) + \eta_k + \varepsilon_{ikt} \quad (6)$$

Equation (3) above can be estimated in a Seemingly Unrelated Regression framework given the likelihood that the disturbances in the different equations are correlated (Zellner, 1962; Liu, 2011).

Table 3 above reports coefficient estimates of the system of equations obtained under various model assumptions. Columns 1 and 2 show results from a pooled OLS regression under the assumption of no contemporaneous correlation between the erorr terms. Column 3 presents results obtained from a seemingly unrelated regression model where we assume cross-equation crorrelation of the error terms in the various equations. Columns 4 and 5 present results from a three stage least squares specification using various instrumental variables.

While the coefficient estimates in Table 3 have little economic intuition and are not informative of the size of the effect of cost of capital on investments, a few conclusions can be drawn with regard to the choice of the model to use in estimating the cost of capital elasticities. First, we note that controlling for real prices, together with time and industry fixed effects significantly improves the estimation precision of the COC coefficients. Second, taking account of the cross equation error correlations improves the efficiency with which coefficients are estimated. The Breuch-Pagan Langrage multiplier test for the independence of the disturbances across equations with a $\chi^2(3)$ value of 198.55 and p-value of 0.00 suggests strong evidence of contemporaneous correlation between the erorr

Table 3: Seemingly Unrelated Regression Estimates

		(1)	(2)	(3)	(4)	(5)
Equation for Structures	COC_{struc}	0.01	-0.13*	-0.12**	-10.98	23.30
		(0.03)	(0.07)	(0.06)	(17.76)	(33.80)
	COC_{comp}	0.07***	-0.49***	-0.45***	-6.40	23.29
		(0.02)	(0.16)	(0.14)	(9.54)	(45.14)
	COC_{Trans}	-0.23***	0.32***	0.29***	-40.99	-38.55***
		(0.03)	(0.12)	(0.10)	(67.60)	(14.87)
Equation for Computers	COC_{struc}	0.07***	-0.49***	-0.45***	-6.40	23.29
		(0.02)	(0.16)	(0.14)	(9.54)	(45.14)
	COC_{comp}	0.15***	-1.78***	-1.62***	-2.93	-8.66
		(0.02)	(0.53)	(0.48)	(5.50)	(62.06)
	COC_{Trans}	-0.05***	0.90***	0.88***	-20.02	1.94
		(0.02)	(0.32)	(0.31)	(36.09)	(21.73)
Equation for Transport	COC_{struc}	-0.23***	0.32***	0.29***	-40.99	-38.55***
		(0.03)	(0.12)	(0.10)	(67.60)	(14.87)
	COC_{comp}	-0.05***	0.90***	0.88***	-20.02	1.94
		(0.02)	(0.32)	(0.31)	(36.09)	(21.73)
	COC_{Trans}	0.12**	-0.61	-0.77	-159.52	-103.91***
		(0.05)	(0.52)	(0.50)	(257.70)	(31.84)
N		1,065	1,065	1,065	825	1,065

Note: Standard errors in parenthesis. * indicates significance at 0.10 level, ** indicates significance at 0.05 level, *** indicates significance at 0.01 level.

terms. The SUR model is therefore the most efficient estimation strategy. The results in column 3 are therefore our preferred estimation results. Table 4 summarises the estimated cost of capital coefficients from the system of equations. The table shows the coefficients together with the associated standard errors and 95% confidence intervals.

1.6.2 Elasticities

The elasticities of investment demand can be used to establish the responsiveness of investment to corporate tax policy. The parameter estimates from the SUR model in Table 4 can be used to calculate both the own- and cross-COC elasticities of investment demand for the different asset categories. The own-COC demand elasticities show the responsiveness of investment demand to corporate tax incentives for a given asset. Cross-COC demand elasticities on the other hand measure the responsiveness of investments to other asset types. In comparision with the 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 is however largely driven by the relatively

Table 4: Parameter Estimates: SUR Model

	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

Note: The parameter estimates related to the plant equation are imputed using regression estimates from the SUR model.

tiny share of computer equipment in aggregate capital investment. Following Uzawa (1962) and Liu (2011), the cross and own tax elasticities of demand, calculated under the assumption of fixed capital investment, can be derived as follows;

$$\xi_{ij} = \frac{\hat{\beta_{ij}} + S_i S_j}{S_i} \;\; \forall\, i \neq j; \;\; \xi_{ij} = \frac{\hat{\beta_{ii}} + S_i^2}{S_i} \forall\, i \tag{7}$$

where S_i, $S_j$are the investment shares for asset i or j respectively. The $\hat{\beta}$'s are the estimated coefficients on the log of cost of capital from equation 6. The associated variance of the demand elasticities are then calculated using the delta methodPindyck (1979):

$$V(\xi_{ij}) = \left(\frac{1}{S_i}\right)^2 * V(\hat{\beta_{ij}}) \;\forall\, i, j \tag{8}$$

Table 5 presents the estimated own-COC and cross-COC elasticities of investment demand

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-COC 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

Table 5: Own & Cross-COC elasticities

	Structures	Computer Equipment	Transportation Equipment	Pant & Machinery Equipment
input shares	12.81%	8.74%	25.16%	53.30%
Factor i	$\xi_i, struc$	$\xi_i, comp$	$\xi_i, trans$	$\xi_i, plant$
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**
Equipment	1.647	5.546	3.556	7.176
Transportation	1.286***	3.594***	-3.821*	-1.058
Equipment	0.398	1.235	1.968	2.088
Plant & Machinery	0.647	2.32**	-.500	-2.468
Equipment	0.3940	1.1760	0.9856	1.9196

Note: Standard errors in parenthesis. * indicates significance at 0.10 level, ** indicates significance at 0.05 level, *** indicates significance at 0.01 level.

that the own investment elasticities 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. The demand elasticities of structures are generally comparable with findings in the very small literature that uses diaggregated 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 esitmates of about -1.29. Our elasticity estimate of -3.82 for transportation equipment is subtantially different from Liu (2011) and Fatica (2013) who find insignificant elasticity estimates in the US and the OECD respecively. Similar to 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 is however largely driven by the relatively tiny share of computer equipment in aggregate capital investment. The inverse relationship between demand elasticities and investment share in apparent in equation (8). 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. Economic theory does not predict any signs for the cross-tax elasticities. Overall, the findings in the very limited literature on COC elasticities tends to find more substitution relations and much fewer complementary relations between input pairs.

Of the 12 cross-elasticity estimates, 8 are statistically different from zero - indicating the presence of inter-asset distortions. Some asset-level investment 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 decreaese 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 inputs are tax-substitutes while Liu (2011) finds no relationship[6]. We note that the asymmetries in elasticity estimates arise from the inverse relationship between cross-elasticicities 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 leads to about 1.3 percent increase in the investment in transport equipment with the asymmetric elasticity being about twice as large. These results contrasts 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 being 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 tax-inputs. A 1 percent increase in the user cost of computer equipment lead to an increase in plant investment of about 2.3 percents. These findings conform with 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 support to the potentially non-trivial inter-asset distortions present in developing countries. The larger coefficients reported here could be due to the much higher variation in user cost of capi-

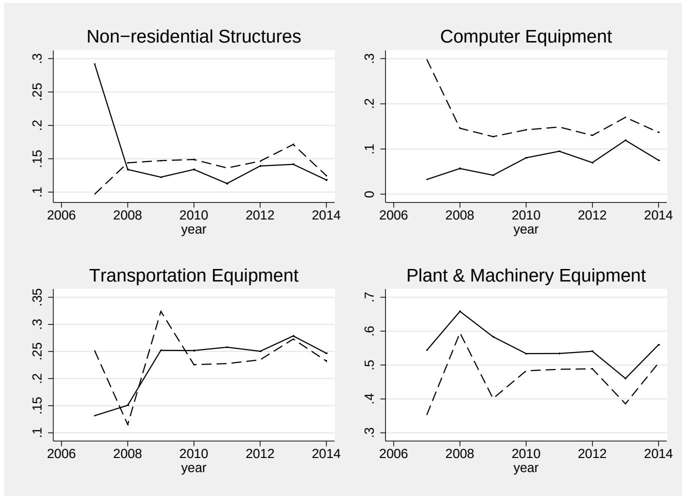
[6]Note that only a plant-level analysis of input use can reveal the true nature of the substition and complemetary relationships between assets.

tal captured in this study. While (Liu, 2011) and (Fatica, 2013) only consider assets employed in 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 a more disaggregated datasets could reveal. Empirical estimates of elasticities from both the productivity and investment literature suggests that more disagregated datasets provide much larger elasticity estimates. Early evidence of the effect of disaggregation shows that cross-asset elasticities are when estimated at the more detailed asset level than at the sectoral and industrial levels. As more detailed and nuanced data has become publicly available, studies based on micro-level data consisently reveal much larger elasticities compared to studies based on aggregate data. Critiques of aggregate data models argue that elasticity estimates from aggregate data may lack sufficient variation in important parameters and may suffer measurement and aggregation bias which may bias the estimates downwards (Chirinko et al., 1999; Harhoff and Ramb, 2001).

To estimate the size of the inter-asset distortion due to differential taxation, we follow Fullerton and Henderson (1989a) and (Liu, 2011) and impute a hypothetical distribution of investment under neutral taxation and compare with the observed investment shares. Operationally and for each year, all assets are assigned the COC computed with the equalised average tax rate across all 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 2 shows the comparison of the hypothetical investment share against the actual shares.

Figure 2, 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 prior to 2009, there was under-investment in transportation equipment. The trend however changes

Figure 2: Investment Shares: Differential taxation



Notes: The dotted line shows the fitted investment share under neutral taxation while the solid line shows the investment share under differential taxation.

after 2010 where we observed over-investment in transportation equipment.

1.7 Conclusion

This paper investigates 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 datat from 2007 to 2014, our estimates of inter-asset user cost elasticities reveal statististically signficant and economically non-negligible inter-asset distortions due to non-uniform taxation of investments. In general, we show that the investments assets not only respond to their own tax incentives, but to the incentives of other assets.

Our findings suggest that current corporate tax policies that offer differentiated and asset or industry-specific investment incentives may be causing significant distortions. Its is therefore important that ongoing corporate tax reforms taking place in both South Africa and the developing world at large takes into account 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.

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