Taxation, user cost of capital and investment behaviour of New Zealand firms

Gulnara Nolan and Matt Nolan

WORKING PAPER 01/2021
March 2021

Working Papers in Public Finance

VICTORIA UNIVERSITY OF WELLINGTON
TE HERENGA WAKA

Chair in Public Finance

The Working Papers in Public Finance series is published by the Victoria Business School to disseminate initial research on public finance topics, from economists, accountants, finance, law and tax specialists, to a wider audience. Any opinions and views expressed in these papers are those of the author(s). They should not be attributed to Victoria University of Wellington or the sponsors of the Chair in Public Finance.

Further enquiries to:
The Administrator
Chair in Public Finance
Victoria University of Wellington
PO Box 600
Wellington 6041
New Zealand

Phone: +64-4-463-9656
Email: cpf-info@vuw.ac.nz

Papers in the series can be downloaded from the following website:
https://www.wgtn.ac.nz/sacl/centres-and-chairs/cpf/publications/working-papers

Taxation, user cost of capital and investment behaviour of New Zealand firms

Gulnara Nolan[1] and Matt Nolan[2]

Abstract

This paper investigates the relationship between the user cost of capital (UCC) and the investment behaviour of New Zealand firms both in the short and long run. The key goal is to understand how policy changes that influence this cost of capital translate into changes in productive investment in New Zealand.

Previous analysis on the UCC investment relationship in New Zealand focused on short-term impacts on overall investment, and implied there was a limited investment response among capital heavy manufacturing firms. This was at odds with results from other countries (e.g. Belgium, France, Germany, UK). Our paper extends the New Zealand analysis in two ways: it re-estimates the prior results based on additional data and improved specification tests, and it also estimates an error-correction model that more consistently estimates the long-term impact of UCC changes on the capital stock.

Our short-run findings are relatively consistent with prior New Zealand research. However, the long-run response of investment with respect to UCC changes (an elasticity of -1.4) is much larger than that implied in the prior research and previous estimates from macrodata. Furthermore, manufacturing firms also appeared to change their capital stock sizably from these estimates. The large response from our error correction estimates imply that the non-linearity of the dynamics of any investment response (e.g. due to lumpiness) needs to be accounted for when considering the long-run consequences of any policy changes that affect the user cost of capital.

Keywords

user cost of capital, taxation, investment

JEL classification

D22 D24 D25 E22

---

[1] Reserve Bank of New Zealand. Corresponding email: gulnara.nolan@rbnz.govt.nz.

[2] Inland Revenue.

1 Introduction

The aim of this paper is to estimate the relationship between the changes in the user-cost of capital (UCC) associated with changes in taxation, and the investment choices of firms.

The user cost of capital refers to the implied rental cost of utilising capital for productive purposes. As a result, the UCC may increase for a number of reasons: an increase in interest rates, higher prices for capital equipment, or a lift in the rate of taxation. This rental cost gives the hurdle rate of return for a business considering whether they want to utilise one more unit of capital equipment – as a result, we would expect the UCC and investment decisions to be linked. These measures and their interpretation are described in detail in Creedy and Gemmell (2017).

Utilising the neoclassical investment model, we describe firm investment behaviour contingent on sales of the firm and their user cost of capital. Investment dynamics are the result of adjustment costs for the firms changing their capital stock towards a desired level, implying that the nature and form of such costs are essential for understanding the investment behaviour of New Zealand businesses.

This study contributes to the literature in several ways. Firstly, it revisits prior New Zealand based estimates of the impact of the UCC on short-run investment (Fabling et al 2015), incorporating new data and adjusting the specification of the model based on additional tests. Secondly, we report estimates of the long-run elasticity of the capital stock to changes in the user cost of capital in New Zealand using firm-level data. The reported long-run elasticity has significant policy relevance in terms of capital depth in New Zealand, and allows a comparison with similar evidence from overseas and the macro evidence for such a response in New Zealand (Labuschagne and Vowles 2010).

Understanding how the user cost of capital influences investment is also part of a broader analysis of what drives New Zealand's productivity performance. As well as directly increasing the number of tools (the capital stock) that are available to produce output, investment and technology are intrinsically related to each other. Incentives to change investment patterns do not just come through increases in capital depth, but also influence multifactor productivity by embedding new forms of production that are closer to the productive margin. This is not something this paper considers explicitly, but good examples of this broader relationship can be found in the results of Djankov et al (1996) and Gemmell et al (2018)

This research uses changes in tax setting (e.g. tax rates, depreciation allowances) as the variation in the forward looking UCC of firms, and then estimates how this changes the firm's investment behaviour. There are multiple ways of figuring out the response of a policy change on taxation using microdata such as natural experiment (e.g. difference-in-difference and regression discontinuity estimates based on a policy change as in Zwick and Mahon (2017)) or regression based approaches. We will utilise the latter type of model.

Regression based approaches calculate explicit UCC values, and use these values as an explanatory variable in an investment regression. Typically the estimated relationship between the UCC and investment outcomes is based on the neoclassical investment model. In this research we estimate this relationship with a reduced form/implicit dynamics model (error-correction model) and a structural form/explicit dynamics model (Euler equation).

The key distinctions between the explicit and implicit approaches relate to the form of adjustment costs and the assumed expectations of the decision making firm.

Adjustment costs for changing the capital stock are necessary to explain the dynamic path of investment that occurs when the firm faces a shock. The explicit approach involves estimating an investment choice given an assumed functional form for adjustment costs (normally quadratic adjustment costs), while the implicit approach uses a reduced form model with less strict assumptions about the form of adjustment costs for firms. However, the trade-off from using less strict assumptions about adjustment costs is the related treatment of expectations variables - a structural model includes rational expectations about the forward looking investment choice, while a reduced form model does not capture this.

The structure of this paper is organised as follows. Section 2 provides a literature review on international and New Zealand evidence. Section 3 describes the models and their specifications. Section 4 presents data used in the empirical analysis. Section 5 discusses the empirical results and Section 6 concludes.

2 Literature review

Conceptually, the UCC measures used in this paper and their interpretation are described in detail in Creedy and Gemmell (2017). The forward-looking UCC measures in this paper apply the same method to the same underlying data sources as in Fabling et al (2013) and more information about their construction can be found in that paper.

Given these UCC measures there is a question about how to use that data to model the investment response. Chirinko (1993) outlines the broad modelling strategies for business fixed investment that would drive the literature forward with microdata. He specifically indicates the distinction between models with implicit and explicit dynamics on the basis of how adjustment costs are modelled. We make use of this distinction in this paper.

Caballero et al (1995) outlined the neoclassical benchmark UCC elasticity used in understanding aggregate investment responses was -1, and how information on firm level investment decisions map to aggregate investment dynamics. They found that long-run elasticities of investment with respect to cost of capital varied significantly from this benchmark for individual sectors (from -0.01 for transportation to -2.0 for textiles), but averaged out to -1.0 over the entire economy, consistent with the neoclassical benchmark. As a result, much of the literature since has been asking how aggregate investment responses compare to this benchmark.

Given the importance of expectations in investment decisions, it is natural to start with a structural/explicit dynamics approach to this question. The clearest example of an explicit dynamics model is the Euler equation model of Bond et al (2003). In this paper, the author's aim was to test whether cash-flow constraints influence firm investment by evaluating whether cash flow remained significant in a structural model of investment choice.

There is one New Zealand study in this space that has used this approach Fabling et al (2015). The study investigates how tax induced UCC changes affect investment behaviour of New Zealand firms using the Euler equation model. They find a negative relationship between the UCC and investment among firms in low capital intensity industries. This paper is a touchstone for our own explicit dynamic analysis in this paper.

However, these models have various problems in terms of statistical and economic assumptions. The dual assumptions of rational profit maximising choice and quadratic adjustment costs place significant restrictions on the model, and often lead to implausible behaviour. Very often, what we get in practice is inconsistent with the theoretical model on which the Euler equation is derived.

Moreover, the model requires valid instruments to identify the equation which makes the task not easy due to the difficulty of finding appropriate instruments. It is also argued that technology shocks will invalidate most candidate instrumental variables, which adds extra challenges for the estimation (Garber and King 1983). In order to address these issues, it is necessary to generate a better understanding of the adjustment costs associated with the investment choice.

Empirical evidence has long shown that a significant proportion of business investment may be lumpy (e.g. Doms and Dunne 1998) but the reason for this lumpiness matters for understanding the short-run dynamics of investment flows – whether it is business cycle variations, strategic corporate decisions, information problems, or credit frictions.

Given the difficulty of constructing appropriate controls to account for all of this, there is a question about how we can use the observed structure of investment in the data to construct estimates of adjustment costs. In this way, there is a growing literature focused on mixing simulation with estimation and incorporating uncertainty shocks to estimate investment responses (e.g. Bloom 2009). Extending this form of the model to include tax changes would be valuable for our understanding of the relationship between the UCC and investment choices. However, the largest innovation would be to use the less restrictive form of fixed costs suggested in this paper to re-estimate the structural form model. This can be done by splitting fixed costs into a component based on irreversibility, fixed costs of changing the capital stock, and the quadratic component – estimated using method of simulated moments.

Outside of the structural microdata approach discussed above there are two other ways to calculate investment responses to changes in the UCC - macro-modelling with aggregated data and reduced form modelling with microdata.

In the New Zealand context, estimates obtained from the New Zealand Treasury Model (NZTM) found an elasticity of -0.8 between the change in the cost of capital and the capital stock (Labuschagne and Vowles (2010), Szeto and Ryan (2009)). These estimates are based on the aggregate New Zealand data, which we use as a benchmark to compare our long-run elasticity derived from the micro-level data.

Reduced form estimates are the main way that the international literature has considered the question of investment and capital stock responses to the UCC. Although such models suffer from the Lucas Critique when analysing policy change (e.g. tax policy) as they are not estimating the primitives of the model, they have the advantage of not imposing a strict form of adjustment costs on the decision to change the capital stock.

As a result, an Euler equation model allows for rational expectations but assumes a very specific form for the adjustment cost of changing the capital stock (quadratic, symmetric). A reduced form model does not utilise forward looking behaviour but by using *implicit dynamics* it imposes fewer structural assumptions on adjustment costs.

Chirinko et al (1999) is a touchstone for considering the investment response to exogenous changes in the UCC. They applied a distributed lag model (DL) to estimate the response of investment to a change in the UCC. The overall result suggests that a higher UCC reduces investment, but by less than is commonly assumed. Their estimates suggest a capital stock elasticity of -0.25 with respect to changes in the UCC, compared to a value of -1 assumed in the benchmark neoclassical growth model.

In Bond et al (2003) (the same paper that derived the Euler equation approach above), an error correction model (ECM) specification is applied for the question of how financial constraints/cash flow influence investment. As with the Euler approach this is estimated by GMM methods with instrumental variable (IV) controls. The industry classification is limited to manufacturing to allow for clearer cross-country comparisons. An ECM assumes that firms demand some optimal amount of capital in the long-run based on their sales and UCC, and empirically estimates the short-run dynamics/transition rather than imposing a structural form. This compares to the earlier Euler equation model, which assumes investment is made in a forward looking manner and that there are quadratic and symmetric adjustment costs associated with changing the stock of capital.

For the long-run capital stock, Dwenger (2014) compares DL estimates to ECM estimates, showing that estimates of the elasticity of capital to changes in user costs are larger using an ECM. In her paper, the estimated ECM elasticity number (-1.3) is twice as large as the DL model elasticity (-0.65). This indicates that dealing with cointegration between sales, capital, and UCC appears to be important for getting sensible estimates of the long-run response of the capital stock from changes in the UCC.

Bond and Xing (2015) estimated the long-run effect of changes in the capital-output ratio from changes in the UCC, using cross-country evidence and a theoretical framework that allows for optimising behaviour. Furthermore, they show how this framework can be used to separate out the tax and non-tax components of UCC, and to separately estimate the response of investment in differing asset types (specifically building and equipment assets). Given a full description of the business tax system, including fiscal depreciation allowances, tax credits, and corporate tax rates, this allows the simulation of broad asset classes. This paper estimates static, DL, and ECM models of investment.

A different method for identifying the response of investment to UCC changes is used in Zwick and Mahon (2017). This paper focuses on estimating the short run investment response to a specific policy change. Although this doesn't allow simulation of alternative policies like the regression based methods above, the quasi-experimental evidence in this paper provides a stronger evidence base for the evaluation of the investment consequences of a given policy change. This paper reports significantly larger tax elasticities for investment in the short run than the regression based models, and captures significant variation in the firm responses based on a lot of other considerations such as the form of the tax instrument used, size, loss carry forwards and etc. Furthermore, unlike previous papers the estimated responses give significant evidence for financial frictions.

The Zwick and Mahon (2017) paper illustrates the importance of quasi-experimental evidence to complement – or question – the results from the standard regression based approaches. As a result, we would encourage future research to look for quasi-experimental opportunities to look at this question in New Zealand as a complement to the work undertaken in this paper.

3 Investment model and specification

In order to accurately estimate how changes in the user cost of capital influence investment, and ultimately the capital stock, we need to describe the transition path of the capital stock following a shock to the user cost. The reason why the capital stock does not instantaneously shift to a new equilibrium is related to adjustment costs related to changing the capital stock. As a result, different methods of estimating an investment/capital stock response are based on varying assumptions about the form such adjustment costs take.

3.1 Neoclassical investment model

As defined in Chirinko (1993), the desired capital stock at a point in time (K_t^*) can be defined assuming a constant elasticity of substitution between capital and variable inputs as:

(1) $K_t^* = \alpha Y_t C_t^{-\sigma}$

where σ is the elasticity of substitution between capital and labour, α is a technology parameter, and C_t is the UCC.

The UCC can be thought of as the rental price of utilising a capital asset for one period. The derivation of the UCC is given in Appendix A.

Total gross investment is then split into net and replacement investment. Replacement investment is the investment necessary to prevent the capital stock from declining due to depreciation (δK_t), while net investment is the addition to the capital stock going through time. As a result, the transition towards the new capital stock depends on a path for net investment.

In that way, the UCC determines the desired capital stock for the firm, while the process of undertaking net investment determines the path they take to reach that desired capital stock.

If this adjustment was costless then net investment would solely refer to instantaneous adjustment to the desired capital stock. However, if there were *adjustment costs* associated with shifting towards a new desired capital level it may be preferable to shift the necessary net investment through time. This timing issue associated with adjustment costs indicates that there is a process of *investment dynamics* that will occur given a change to the UCC.

Regression based models tackle this issue in two ways: explicit dynamics models, and implicit dynamics models. Implicit dynamics models take the time series properties of the data and use this to nest a long-run specification of the investment dynamics. Explicit dynamics models provide a structural form for adjustment costs and assume some form of forward looking decision rule. The estimation procedure then involves estimating the parameters of this model.

Both approaches have limitations. The implicit approach is subject to the Lucas Critique (Lucas 1976), which implies that the parameter estimates may not be policy invariant. The explicit approach tends to rely on strong assumptions about the form of decision rule used and adjustment costs faced by the firm.

As in Bond et al (2003), we view it as appropriate to estimate both forms of models in order to check sensitivity of our empirical results.

The implicit dynamics model selected in this paper is an Error Correction model of the form estimated by Dwenger (2014). The explicit dynamics model used is an Euler equation model with quadratic adjustment costs, mirroring previous research in New Zealand by Fabling et al (2015).

Both approaches rely on the *forward looking UCC* as defined in Fabling et al (2013). This helps to deal with the endogeneity between the UCC and investment based on the composition of investment, and as a result it is only variation in the expected future UCC (based on changes in policy settings) that is viewed as relevant for the investment response. Furthermore, this implies a specific assumption about the expectations of businesses – namely that they expect current tax settings to remain unchanged over the life of an asset when they make the investment choice.[3]

A table of the tax policy changes that influenced this forward looking UCC can be found in Table 6.

3.2 Explicit dynamic approach. Euler equation model

We use the Euler equation model originally derived by Bond and Meghir (1994) and augmented by Fabling et al (2015), which is estimated from dynamic optimization under assumptions of symmetric, quadratic adjustment costs and price taking in input and output markets.

An explicit model assumes that the firm follows a decision rule that aims to maximise the expected value of the firm at time $t(V_t)$. Given the assumptions above this can be written as the following Bellman equation:

(2) $$V_t = \max_{L_t,K_t} \left\{ F(L_t, K_t; \tau_t) - G(I_t, K_t; \tau_t) - p_t^I - w_t L_t + \frac{1}{1+r} E_t V_{t+1} \right\}$$

Where L_t and K_t are the labour and capital inputs respectively, *r* is the discount rate, $\boldsymbol{\delta}$is the depreciation rate, F is the production function, G is the adjustment cost function, and w_t and p_t^I are the use cost of the labour and capital inputs respectively.

Using subscripts to define the partial derivative, the optimal investment choice satisfies:

(3) $$G_I(I_t, K_t; \tau_t) + p_t^I = F_K(L_t, K_t; \tau_t) - G_K\left(L_{t,} K_t; \tau_t\right) + \frac{1-\delta}{1-r} E_t \frac{\partial V_{t+1}}{\partial K_t + 1} = \frac{\partial V_t}{\partial K_t}$$

where $\frac{\partial V_t}{\partial K_t}$ is the shadow value of capital. Assuming symmetric, quadratic adjustment costs with a scale variable α the investment rate can be defined as:

(4) $$\frac{I_t}{K_t} = \frac{1}{\alpha} \left(\frac{\partial V_t}{\partial K_t} - p_t^I \right) + \tau_t$$

[3] We use Devereux and Griffith's (2003) definition of the forward looking UCC, which is based on investment that is a single period perturbation in the capital stock – or essentially that the asset is sold at the end of a period. Klemm (2012) shows how effective average tax rates may be different if the asset is not sold, however Klemm's method gives the same EMTR and therefore UCC figures for changes in the statutory corporate tax rate and permanent changes in depreciation rates – which match the policy changes in New Zealand during this period.

Given this, the goal is to find a method to estimate $\frac{\partial V_t}{\partial K_t}$. In the Euler equation approach we make use of rational expectations, implying that for a random variable X_t we can say that its future value $X_{t+1} = E_{t+1}X_{t+1} + \epsilon_{t+1}$ where ϵ_{t+1} is the forecast error for the future value of that variable. Given this, the investment function can be rewritten in the following way:

$$(5) \quad \frac{I_t}{K_t} = A + \frac{1-\delta}{1-r}\left(\frac{I_{t+1}}{K_{t+1}}\right) + \frac{1}{\alpha}F_K(L_t, K_t;\ \tau_t) + \frac{1}{2}\left(\frac{I_t}{K_t}\right)^2 + \frac{1-\delta}{\alpha(1-r)}p_{t+1}^I - \frac{1}{\alpha}p_t^I + \widetilde{\epsilon_{t+1}}$$

Where A is a constant term and $\widetilde{\epsilon_{t+1}}$ is the combined forecast errors for the forward looking variables (the investment rate and the purchase price of capital at t+1). This model can then be lagged by one time period and rewritten to be in terms of t and t-1 for estimation.

As a result, the empirical specification for the *i*th firm is as given in Bond et al 2003 and Fabling et al (2015) as:

$$(6) \quad \frac{I_{i,t}}{K_{i,t}} = \beta_1\left(\frac{I_{i,t-1}}{K_{i,t-1}}\right) - \beta_2\left(\frac{I_{i,t-1}}{K_{i,t-1}}\right)^2 - \beta_3\left(\frac{\Pi_{i,t-1}}{K_{i,t-1}}\right) + \beta_4\left(\frac{Y_{i,t-1}}{K_{i,t-1}}\right) - \beta_5 C_{i,t} + d_t + \eta_i + \upsilon_{i,t}$$

where $\Pi_{i,t-1}$ is firm profit, $Y_{i,t-1}$ is firms sales, $C_{i,t}$ is the firm specific user cost of capital, and d_t and η_i are time and firm specific fixed effects.

To estimate the parameters of the Euler equation, we use a GMM estimator with instruments as motivated by Arellano and Bond (1991). The reason for doing this is two-fold i) the forecast errors are correlated with the dependent variable ii) the fixed effects are correlated with the estimated coefficient on the lagged dependent variable.

In Fabling et al (2015) the instruments used are right hand-side variables dated from t-2 to t-6. We use the same instruments in this paper, but recognise that it is possible that very long lags are less correlated with current changes in the dependent variable than the most recent levels, and that adding longer lags as instruments the estimator becomes imprecise in the sense that valid but weak instruments are added. To test that, we apply Bayesian Information Criterion (BIC) and Akaike Information Criterion (AIC) tests to identify the optimal lag length for our instruments. The tests suggest that the appropriate lag length for instruments is 3 lags in our data, rather than 6.

There may have also been a change in investment behaviour over this period due to the Global Financial Crisis (GFC), due to changes in expectations, uncertainty, or an adjustment in patterns of financial intermediation.

To allow for that the model was estimated using post-GFC control.[4] However, there were no significant changes in the results and so these results are not reported here. This may be in part due to the fact the model was estimated in first differences.

3.3 Implicit dynamic approach. Error-correction models in dynamic heterogeneous panels

As an alternative to the Euler equation structural model, we also estimate the investment dynamics using an error-correction specification. This methodology will

[4] A dummy variable from Q4 2008 to the end of the sample.

allow us to make use of the cointegration between capital and its user cost, and therefore define a long-run relationship between the UCC and the capital stock.

The traditional model for implicitly estimating investment dynamics is the DL (distributed lag) model of Chirinko (1993). Here we use the idea that, if there was no adjustment cost associated with changing the capital stock, investment would refer to the optimal response of the capital stock for meeting new sales/the demand for capital. However, there are adjustment costs both in terms of the time it takes to deliver products and the capacity for the firm to undertake changes in their capital stock. As a result, current observed investment is both related to demand for capital now and the demand for capital in prior periods. In this way, sales in prior periods in part explain current investment in the face of adjustment costs.

As a result, the reduced form equation for net investment is given as a distributed lag on new orders:

(7) $I_t^n = \sum_{j=0}^{J} \beta_j \Delta K_{t-j}^*$

with *J* the number of lags that are relevant for explaining current net investment. Given a firm specific, time invariant, rate of depreciation in the capital stock (δ_i) we can write the overall investment rate for a given firm as:

(8) $I_{i,t} = \delta_i K_{i,t-1} + \sum_{j=0}^{J} \beta_j \Delta K_{i,t-j}^*$

This model is generally estimated in terms of rates rather than levels due to the right-skewness of investment data, with firm specific fixed effects. It can then be estimated either in auto-regressive distributed lag (ARDL) form[5] or more commonly in DL form. Furthermore, for both DL and ARDL models there are several reasons why there may be endogeneity between the UCC and the investment rate which require instruments:

- Attenuation bias: Measurement error in the UCC tends to bias estimates towards zero (Dwenger 2014).
- Endogeneity of UCC: Firm-specific structures and after tax interest rates will be correlated with investment, making the UCC endogenous.
- Simultaneity: If an increase in demand for capital increases its price (or increases the interest rate) this can limit the short-run increase in investment.
- Cash and credit constraints and shocks: Investment shocks and other shocks (to sales, cash flow, or credit availability) might be correlated.

In such models the long-run effect of a change in the UCC on investment is measured by i) for an ARDL model the geometric series implied by the coefficient on the lagged dependent variable ii) for the DL model the sum of the coefficients on the lagged UCC terms.

Although a DL is model is commonly used to estimate long-run effects, it may understate the responsiveness of investment due to non-convexities in the adjustment cost or time path for investment. If the adjustment cost is non-convex (eg lumpy) the

[5] using GMM with IV instruments to correct for Nickell Bias (Nickell (1981)) generated by the combination of lagged dependent variables and fixed effect terms.

relationship between the investment path and the UCC could be impossible to represent with a DL model.

As a result, it may be preferable to estimate the long-term relationship between the UCC and the capital stock directly. In order to do this we estimate the long-run response of the capital stock to variation in the UCC using an error-correction specification.

For this we can rewrite equation (1) in log terms, where lower case letters refer to log values. This gives:

$$(9)\quad k_t^* = \log(\alpha) + y_t - \sigma c_t$$

Following Dwenger (2014) we can reparametrize and rearrange to get the following:

$$(10)\quad k_{i,t} = \alpha + \phi k_{i,t-1} - \beta_0 c_{i,t} + \beta_1 y_{i,t} - \sum_{j=0}^{J} \beta_2 \Delta c_{i,t-j} + \sum_{j=0}^{J} \beta_3 \Delta y_{i,t-j} + \sum_{T=1}^{T-1} \beta_4 \mu d_t + f_i + \epsilon_{i,t}$$

The above equation can be adjusted to include additional explanatory variables (e.g. cash flow constraints). The long-run elasticity of interest cannot be read directly from equation (10), but is equal to $\frac{\beta_0}{1-\phi}$.

This is estimated using the Blundell and Bond (1998) estimator. This estimator (commonly termed as a System GMM) is preferred as a replacement for the Arellano and Bond estimator, where the lagged levels are often rather poor instruments for first differenced variables, especially if the variables are close to a random walk.

Blundell and Bond's modified estimator combines the difference equation of the Arellano and Bond estimator with level variables. For this estimator, the difference variables are used as instruments for estimating the level parameters while the level variables are used as instruments as before.[6]

In practice, the microdata literature uses a variety of methodologies to estimate error-correction models with dynamic panel data. In Pesaran and Smith (1995) and Pesaran et al (1999) the Mean-Group and the Pooled Mean-Group methods were given as methods to estimate the model from dynamic heterogeneous panels. This is applied when looking at investment choices in Bond and Xing (2015).

These two techniques allow for heterogeneity across groups in dynamic panels; however they also require a relatively long time series. Our time series data runs from 2000 to 2017, which, with the lagged instruments required, is not long enough to exploit the Mean Group estimation. As a result, we only report values for the Blundell Bond estimator below.

Before starting the estimation process, it is necessary to perform a cointegration test to establish that an error correction model is valid. If the variables are cointegrated, an error-correction model (ECM) is applied for the estimation. Without a cointegrating

---

[6] To estimate the ECM in dynamic heterogeneous panel we use the one-step Blundell and Bond model with the “xtabond2” package in Stata. We specify our model with the equation level sub-option implying that year dummies are to be considered as instruments in the level equation, which is our main focus as the level equation captures the long-run elasticities between the UCC and investment.

relationship between capital and the UCC an ECM would not be valid, and a DL model should be used instead.

We apply the Westerlund panel cointegration test (Westerlund 2007) as used in Dwenger (2014). Running this test we could reject the null that there was no cointegration between capital, the user cost of capital and the cash flow variables.[7]

[7] We also performed a Fischer test using xtunitroot in Stata. For the entire sample the null hypothesis of cointegration was rejected with this test, but when we replaced series with gaps it was accepted.

4 Data

We use firm-level panel data for the tax years 1999/00 to 2017/2018 inclusive. As in Fabling et al (2015) we access data from Stats NZ's Longitudinal Business Database (LBD). Data and measurement follows Fabling et al (2015), where information on investment, output, profit, and fixed assets are sourced from the Annual Enterprise Survey (AES), data on Industry classifications, drawn from the Longitudinal Business Frame (LBF) and employment information from the Linked Employer-Employee Data (LEED). We supplemented our data by IR4 data to include foreign owned firms.
There have been no changes in business tax settings since the Fabling et al (2015) was released, as a result fiscal rates for the UCC calculation remain unchanged.

We distinguish between six fixed asset classes when calculating UCCs: land, buildings, furniture and fittings, plant, machinery and equipment (PME), computer hardware and software, and motor vehicles. The UCC is then calculated on the basis of the relative share of these assets held by the firm. This assumes marginal investment is made up of same composition as the prior average investment.

Foreign owned firms were excluded from the sample in Fabling et al (2015) due to data limitations. Previously, the UCC for foreign firms could not be calculated because information on debt and equity from IR10 data was not available till 2005. For this paper, we have access to additional data on firms' financial statements, and so we were able to incorporate this into our analysis of foreign owned firms.

A foreign owned firm is defined as a firm that reports any FDI in a given year. As FDI is reported only when a foreign owner holds over a given percentage of the business (typically 10%) this appears to be a reasonable proxy for foreign ownership (e.g. a small foreign purchase of shares is termed portfolio investment). To try to limit our investment analysis to cases where the foreign owner is the primary decision maker in the firm, we have further restricted the foreign ownership to cases where foreign business ownership is greater than, or equal to, 50%.

This also implies that there are excluded firms from our sample that are neither classed as domestic or foreign. The different measures of UCC, depending on whether it is a domestic or foreign owned firm, are discussed further in Appendix A below.

Only private for profit firms are included in the sample. The behaviour of non-profits and public entities is likely to be fundamentally different from private for profit firms, and generally tax changes are not motivated to change investment by these groups.

4.1 Summary statistics

Summary statistics are reported in Appendix B; however the key points of interest are mentioned here.

Table 1 shows the mean values of the variables used in our econometric analysis for domestic firms between 1999 and 2017. Our sample for domestic firms consists of 5,058 observations. The mean value of the investment rate (I/K) has gone up by over 45 percent from 1999, with similar increases for the full sample and manufacturing. Likewise, the average change in the UCC was similar for both the full sample and manufacturing.

Table 2 reports mean values for both foreign and domestic firms between 2005 and 2017. The sample of foreign firms consists of 3,027 observations. While I/K is similar between domestic and foreign firms, the average increase in the UCC is slightly higher for foreign firms. Empirical results

4.2 Euler equation specification

We begin our analysis with the Euler equation model, derived from dynamic optimisation in the presence of symmetric, quadratic adjustment costs.

Table 3 reports results for the Euler equation-GMM analysis. These results are estimated using a first-differenced GMM estimator which removes the firm-specific effects by differencing the equations. Lagged values of our endogenous variables are used as instruments. The instruments dated as t-2, t-3 which allow for contemporaneous correlation between these variables and shocks to the investment equation, as shown in the table, the UCC coefficient is negative and statistically significant.

Point estimates for the full sample suggest that a one standard deviation increase in the UCC [8] is associated with a reduction of the investment rate by 0.049[9], a material change relative to the average investment rate of 0.25 mean value of the I/K.

Fabling et al (2015) found that the capital intensive manufacturing industry was less responsive to the UCC than firms overall. This was a surprising result, given the higher estimated effects in the international literature. In our results, we find that the underlying responsiveness of the manufacturing sector is higher than business overall. However, this result is particularly imprecise and so is not statistically significant - either in an absolute sense or in terms of its difference from the aggregate result.

As in Fabling et al (2015) the cash flow variable remains insignificant as an explanation of the investment rate. This implies no excess sensitivity of investment spending to fluctuations in cash flow, which may indicate that firms are not credit constrained. However, we would encourage future research to look at this question in more detail before drawing any strong conclusions.

Table 4 reports results for domestic and foreign owned firms respectively. Since the firms' financial data are required to calculate the corporate level UCC for foreign owned firms, the data is restricted to the years 2005 to 2017. The UCC coefficient for domestic shareholders is still negative and statistically significant; however foreign investors tend to be less responsive to changes in the UCC than their domestic counterparts.

The relative unresponsiveness of foreign investors is surprising. In theory foreign investors should have a larger investment response from changes in the user cost of capital, as they will not be subject to home bias in this jurisdiction and will be willing to invest only in so far as they make a fixed pre-tax rate of return. As a result, a limited response either implies that foreign investors are able to pass-on the tax, that foreign investment tends to be lumpier and so appears less responsive in the short-run, or that they already make super-normal returns (e.g. location specific rents) when investing in New Zealand.

---

[8] A change of 0.0038 based on the years in which tax reforms occurred.

[9] Equal to the standard deviation multiplied by the estimated parameter, or 0.0038x(-12.963).

However, we would interpret the foreign owed firm results with caution - we would suggest avoiding taking this as evidence that foreign investors are unresponsive to New Zealand tax changes. Given our selection criteria it is possible that the types of firms included were particularly unresponsive compared to the true marginal foreign investor. Foreign direct investment inflows as a percentage of GDP have been relatively constant over this period, while they have increased significantly across the rest of the world - and this analysis does not investigate why this is the case.

As the Euler equation approach represents a dynamic path for investment, we can use this equation to calculate the approximate long-run change in the capital stock by finding its implied steady state value[10]. These results indicate a long-run elasticity of approximately -0.7, in line with the macro estimates used in Szeto and Ryan (2009).

For the overall investment results, the Euler equation approach indicates that investment rates are responsive to changes in the user cost of capital due to taxation but more weakly than the standard neoclassical benchmark suggests - over both the short and long run. Although this may be the case, it could also be the result of a mis-specified structural form - specifically the assumption of quadratic adjustment costs. If the long-run effect is robust we should be able to replicate it with an appropriate time series approach, such as an error correction model. This is what we attempt next.

4.3 Error-correction model results

The regression results for the Error-correction model (ECM) are presented in Table 5.

For the ECM, we took the same approach as Dwenger (2014) and estimated the one-step ECM with System-GMM. We found that the long-term UCC coefficient is negative and statistically significant at 1% level. Our estimated long-run elasticities were well above the neoclassical benchmark at -1.42 which is close to the elasticity found in Dwenger (2014).[11]

However, relative to other studies utilising an ECM to consider the investment response to changes in the tax component of the UCC our estimated investment response is larger. Bond and Xing (2015) found the range -0.3 to -0.5 for total capital, and -0.3 to -0.7 for total equipment. Similarly, Fatica (2018) found an aggregate elasticity of around -0.5, with both Bond and Xing (2015) and Fatica (2018) using a mean-group estimator for their estimated coefficients. Yilmaz and Wen (2019) suggested a larger investment response which was closer to our results for New Zealand (between -1.1 and -1.3) among Canadian firms, however they were only looking at equipment and machinery investment - with investment in structures and buildings likely to be less responsive to tax changes.

In order to check the validity of the instruments both the Sargan and Hansen tests of the over-identifying restriction were applied. Both indicated that the instruments were valid.

As there are expectation variables in the underlying structural equation, the short-run response to a change in the UCC associated with an ECM will likely be mis-estimated

[10] When the change in net investment due to the UCC shock is equal to zero.

[11] The long-run elasticity is calculated as the response of the long-run capital stock to percentage changes in the user cost of capital. Hence, for the parameter on lagged lnk=0.835 and on UCC=-0.235, we obtain the long-run elasticity of the UCC 0.235/(1-0.835)= -1.42.

(Dwenger 2014). This implies that these results should only be used to understand the long-run changes in the capital stock, which is our main focus.

Table 5 also reports results for the manufacturing industry. The long-run elasticity is -0.95, a statistically significant negative value. Although the size of the manufacturing response is relatively similar to that estimated from the structural approach, the fact that it was statistically significant suggests that capital heavy manufacturing firms do respond to tax changes.

However, the manufacturing industry elasticity is lower than the elasticity for all firms. Our analysis does not point to why there would be a weaker investment response in the manufacturing industry; however such an outcome might be associated with manufacturing firms supplying heterogeneous goods or earning economic rents.

5 Conclusion

This paper estimates the response of business investment and the capital stock to the tax-induced changes in the user cost of capital. We study both short-run and long-run responses to changes in the UCC by New Zealand firms and compare this to international evidence.

We use two methodologies to check the sensitivity of our results to varying assumptions. Firstly, using the Euler equation method for short-run impacts, we find that in aggregate, investment by New Zealand firms does respond to changes in the UCC - our estimates for firm investment for all firms were statistically significant and within the range consistent with the previous results. However, the investment response for manufacturing firms was negative but not statistically different from zero. Our findings also didn't find any response in the investment of foreign firms from changes in the UCC.

We have also estimated the long-run effects of the UCC changes on investment using an error-correction model. We found a strong long-run capital stock response to changes in the UCC, with a 1% decline in the UCC increasing the capital stock by 1.4%. This result is consistent with international evidence using a similar method, and is much higher than the aggregate estimates used in New Zealand previously.

Given the stark long-run differences in the structural and reduced form approaches, we believe it would be valuable to undertake further structural estimates with less restrictive assumptions about adjustment costs as in Bloom (2009). Such an exercise would provide an important cross-check of the long-run response found in this paper, and also shed additional light on questions regarding the short-run response of investment to changes in the cost of capital - a question that is relevant when both monetary and fiscal authorities are concerned about insufficient demand in the economy.

References

Arellano, Manuel and Stephen Bond. 1991. “Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations." *Review of Economic Studies*, 58(2):277-297.

Bloom, Nicholas. 2009. “The Impact of Uncertainty Shocks." *Econometrica*, 77(3): 623-685.

Blundell, Richard, and Stephen Bond. 1998. “Initial Conditions and Moment Restrictions in Dynamic Panel Data Models." *Journal of Econometrics*, ,(1):115-143.

Bond, Stephen, and Costas Meghir. 1994. “Dynamic Investment Models and the Firm's Financial Policy." *The Review of Economic Studies*, 61(2):197-222.

Bond, Stephen, and Jing Xing. 2015. “Corporate Taxation and Capital Accumulation: Evidence from Sectoral Panel Data for 14 OECD Countries." *Journal of Public Economics*, 130:15-31.

Bond, Stephen, Julie Elston, Jacques Mairesse, and Benoit Mulkay. 2003. “Financial Factors and Investment in Belgium, France, Germany, and the United Kingdom: A Comparison using company panel data." *The Review of Economics Statistics*, 85(1):153-165.

Caballero, Ricardo, Eduardo Engel, John Haltiwanger, Michael Wood ford, and Robert Hall. 1995. “Distribution of Pre-Tax Top Personal Incomes." *Brookings Papers on Economic Activity*, 1995(2):1-54.

Chirinko, Robert S. 1993. “Business Fixed Investment Spending: Modelling Strategies, Empirical Results, and Policy Implications." *Journal of Economic Literature*, 31(4):1875-1911.

Chirinko, Robert S., Steven Fazzari, and Andrew Meyer. 1999. “How Responsive is Business Capital Formation to its User Cost? An Exploration with Micro Data." *Journal of Economic Literature*, 74(1):53-80.

Creedy, John, and Norman Gemmell. 2017. “Taxation and the User Cost of Capital." *Journal of Economic Surveys*, 31(1):201-225.

Devereux, Michael, and Rachel Griffith. 2003. “Evaluating Tax Policy for Location Decisions.” *International Tax and Public Finance*, 10(2): 107-126.

Doms, Mark and Timothy Dunne. 1998. “Capital Adjustment Patterns in Manufacturing Plants.” *Review of Economic Dynamics,* 1(2):409-429.

Djankov, Simeon, Tim Ganser, Caralee McLiesh, Rita Ramalho, and Andrei Shleifer. 1996. “The Effect of Corporate Taxes on Investment and Entrepreneurship." *American Economic Journal: Macroeconomics*, 2(3):31-64.

Dwenger, Nadja. 2014. “User Cost Elasticity of Capital Revisited." *Economica*, 81(321): 161-186.

Fabling, Richard, Norman Gemmell, Richard Kneller, and Lynda Sanderson. 2013. "Estimating Firm-Level Effective Marginal Tax Rates and the User Cost of Capital in New Zealand." *Treasury Working Paper Series*, No. 13/19.

Fabling, Richard, Richard Kneller, and Lynda Sanderson. 2015. "The Impact of Tax Changes on the Short-Run Investment Behaviour of New Zealand Firms." *Motu Working Paper*, 2015/4.

Fatica, Serena. 2018. "Business Capital Accumulation and the User Cost: Is There a Heterogeneity Bias?" *Journal of Macroeconomics*, 56:15-34.

Garber, Peter, and Robert King. 1983. "Deep Structural Excavation?: A Critique of Euler Equation Methods." *NBER Technical Working Paper* No. 31.

Gemmell, Norman, Richard Kneller, Danny McGowan, Ismael Sanz, and Jose F. Sanz-Sanz. 2018. "Corporate Taxation and Productivity Catch-Up: Evidence from European Firms." *The Scandinavian Journal of Economics*, 120(2): 372-399.

Klemm, Alexander. 2008. "Effective Average Tax Rates for Permanent Investment." *IMF Working Papers,* No. 2008/56.

Labuschagne, Natalie, and Polly Vowles. 2010. "Why are Real Interest Rates in New Zealand so High? Evidence and Drivers?" *Treasury Working Paper Series*, 10(9):39-54.

Lucas, Robert. 1976. "Econometric Policy Evaluation: A Critique." *Carnegie-Rochester Conference Series on Public Policy*, 1(1):19-46.

Nickell, Stephen. 1981. "Biases in Dynamic Models with Fixed Effects." *Econometrica*, 49(6):1417-1426.

Pesaran, M. Hashem, and Ron P. Smith. 1995. "Estimating Long-run Relationships from Dynamic Heterogeneous Panels." *Journal of Econometrics*, 68: 79-113.

Szeto, Kam Leong, and Michael Ryan. 2009. "An Introduction to the New Zealand Treasury Model." *Treasury Working Paper Series*, No. 09/02.

Westerlund, Joakim. 2007. "Testing for Error-Correction in Panel Data." *Oxford Bulletin of Economics and Statistics*, 69:709-748.

Yilmaz, Fatih, and Jean-Francois Wen. 2019. "Tax Elasticity Estimates for Capital Stocks." *Central Bank of the Republic of Turkey Working Paper* No. 19/01.

Zwick, Eric, and James Mahon. 2017. "Tax Policy and Heterogeneous Investment Behavior." *American Economic Review*, 107(1):217-248.

Appendix A: Derivation of the UCC

Measures of the net user cost under corporate-level taxation re-calculated following Fabling et al (2013). For New Zealand, we distinguish between debt and equity sources of funds, and whether the marginal investor is a foreign or domestic resident. Foreign owners are not subject to New Zealand personal taxation on equity returns but instead face the corporate tax as their final New Zealand level of taxation. Because of New Zealand's imputation system, corporate taxes are simply a withholding tax for domestic residents, so at the personal level it is the personal tax scale that is relevant.

As a result, allowing corporate taxation Hall-Jorgensen's (1967) formula can be rewritten to calculate the real user cost of capital, C, as:

$$C = \frac{\{1-\tau(Z+k)\}(r^*+\delta)}{1-\delta}$$

where τ is statutory corporate tax rate; Z is present value of depreciation allowances (discounted at the nominal interest rate); k is tax allowance value of any investment tax credits available (captured by 'depreciation loadings' in NZ); δ is rate of economic depreciation (asset-value-weighted average based on the depreciation rates applicable to each of the firm's asset classes); r^* is real cost of funds, equal to the required after-tax rate of return. For foreign-sourced equity funds, the investor is not generally subject to New Zealand taxation on the equity return, hence we may set $r^* = r_E$, where r_E is real return on equity demanded by the investor.

The UCC calculation differs based on whether we are looking at a domestic firm/investor (with *m* as the top personal tax rate) or a foreign firm/investor as shown in the table below.

	Net UCC	Gross UCC
Foreign-sourced or corporate taxation:	$C_{net} = \frac{\{1-\tau(Z+k)\}(r^*+\delta)}{1-\tau} - \delta$ With debt financing: $r^* = \left\lfloor r(1-\tau) - \frac{\tau\pi}{1+\pi} \right\rfloor$	$C = \frac{\{1-\tau(Z+k)\}(r^*+\delta)}{1-\delta}$ With equity financing: $r^* = r_E$
Domestic shareholder-level taxation:	$C_{net} = \frac{\{1-m(Z+k)\}(r^*+\delta)}{1-m} - \delta$ With debt or equity financing: where $r^* = \left\lfloor r(1-m) - \frac{m\pi}{1+\pi} \right\rfloor$	$C = \frac{\{1-m(Z+k)\}(r^*+\delta)}{1-m}$

Appendix B: Tables

Table 1. Summary statistics : 1999-2017 domestic only

	Full sample			Manufacturing		
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
I/K	5,058	0.26	0.25	1,182	0.20	0.18
I/K^2	5,058	0.13	0.36	1,182	0.07	0.15
Π/K	5,058	1.62	7.84	1,182	0.72	1.16
Y/K	5,058	21.68	42.09	1,182	8.64	10.47
ΔUCC	4,062	0.04	0.0038	927	0.04	0.0033

Table 2. Summary statistics : 2005-2017 domestic vs foreign

	Domestic						Foreign					
	Full sample			Manufacturing			Full sample			Manufacturing		
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
I/K	3,423	0.25	0.24	768	0.20	0.18	3,027	0.28	0.26	969	0.17	0.17
I/K^2	3,423	0.12	0.30	768	0.07	0.16	3,027	0.15	0.38	969	0.06	0.17
Π/K	3,423	1.60	8.98	768	0.61	0.78	3,027	12.5	169.5	969	1.89	6.09
Y/K	3,423	23.1	46.1	768	8.01	8.28	3,027	39.0	158.	969	12.55	35.77
ΔUCC	3,096	0.04	0.00	690	0.04	0.00	2,376	0.06	0.01	768	0.06	0.01

Table 3. 1999-2017 Euler equation model: GMM first differences with lags t-3

	Full sample		Manufacturing	
I/K	0.174	0.176	-0.76	-0.77
	[0.124]	[0.123]	[0.551]	[0.561]
I/K^2	0.002	-0.001	2.143	2.17
	[0.264]	[0.262]	[1.380]	[1.407]
Π/K	0.002	0.002	0.008	0.007
	[0.006]	[0.006]	[0.046]	[0.046]
Y/K	-0.001	-0.001	0.035	0.036
	[0.001]	[0.001]	[0.025]	[0.026]
ΔUCC		-12.963**		-19.313
		[5.964]		[21.487]
Observations	3309	3309	762	762
		Wald chi2(16) = 39.77		Wald chi2(16) = 10.54
		Prob > chi2 = 0.0008		Prob > chi2 = 0.8370

Robust standard errors in brackets. Significant at: *** 1%, ** 5%, * 10%. UCCs calculated using $t-2$ asset weights.

Table 4. Domestic versus Foreign owned firms for years > 2005

	Full sample				Manufacturing			
	Domestic		Foreign		Domestic		Foreign	
I/K	0.263*	0.262*	0.531**	0.532**	0.015	0.015	-0.44	-0.437
	[0.141]	[0.141]	[0.208]	[0.209]	[0.401]	[0.402]	[1.272]	[1.269]
I/K^2	-0.093	-0.092	-0.672*	-0.675*	0.415	0.414	2.853	2.843
	[0.276]	[0.275]	[0.404]	[0.407]	[0.967]	[0.969]	[5.491]	[5.479]
Π/K	0.004	0.004	0	0	0.047	0.047	0.026	0.026
	[0.005]	[0.005]	[0.000]	[0.000]	[0.048]	[0.048]	[0.042]	[0.042]
Y/K	-0.001	-0.001	0	0	-0.01	-0.011	-0.01	-0.01
	[0.001]	[0.001]	[0.002]	[0.002]	[0.008]	[0.008]	[0.016]	[0.016]
ΔUCC		-11.507*		-2.537		12.335		-5.987
		[6.539]		[2.170]		[16.886]		[6.500]
Observations	2,613	2,613	1,854	1,854	534	534	630	630
	Wald chi2(12) = 40.61 Prob > chi2 = 0.0001		Wald chi2(13) = 27.62 Prob > chi2 = 0.0102		Wald chi2(12) = 15.51 Prob > chi2 = .2149		Wald chi2(13) = 3.58 Prob > chi2 = 0.9949	

Robust standard errors in brackets. Significant at: *** 1%, ** 5%, * 10%. UCCs calculated using t–2 asset weights.

Table 5: System-GMM estimates for one-step ECM

$k_{i,t}$	All firms	Manufacturing only
$k_{i,t-1}(\boldsymbol{\phi})$	0.835***	0.802***
	(0.0364)	(0.0770)
$\Delta ucc_{i,t}$	-1.032	-2.199
	(0.744)	(4.975)
$\Delta ucc_{i,t-1}$	0.282	1.075
	(0.520)	(1.988)
$\Delta ucc_{i,t-2}$	0.745	2.441
	(0.506)	(2.163)
$\Delta s_{i,t}$	0.152**	0.304**
	(0.0681)	(0.121)
$\Delta s_{i,t-1}$	0.0313	0.0600
	(0.0217)	(0.0377)
$\Delta s_{i,t-2}$	0.0228*	0.000198
	(0.0122)	(0.0273)
User Cost of Capital (σ')	-0.235***	-0.189**
	(0.0545)	(0.0742)
Sales (β')	0.0637*	0.227***
	(0.0327)	(0.0707)
$CF_{i,t}/K_{i,t-1}$	0.0875***	-0.00734
	(0.0230)	(0.0392)
Constant	-0.335**	0
	(0.155)	(0)
Observations	27,459	3,975
Number of firms	6228	912

Notes: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

A full set of year dummies is included. The instruments for the first differenced regression are the values (in levels) of $\Delta ucc_{i,t}$ *and* $\Delta s_{i,t}$; in the specification including cash flow, $CF_{i,t}/K_{i,t-1}$ is lagged two years and additionally used as an instrument
Sargan test of overid. restrictions: chi2(263) = 298.55; Prob > chi2 = 0.065
Hansen test of overid. restrictions: chi2(263) = 242.42; Prob > chi2 = 0.814
F(31, 6228) = 1386.41; Prob > F = 0.000.

Table 6: Representative fiscal depreciation rates including loading

Year	Corporate tax rate	Top personal tax rate	Land	Buildings	Furniture & fittings	Plant, machinery, equipment	Computers	Vehicles	Intangibles
1999	0.33	0.33	0	0.04	0.18	0.264	0.48	0.264	0.24
2000	0.33	0.33	0	0.04	0.18	0.264	0.48	0.264	0.24
2001	0.33	0.39	0	0.04	0.18	0.264	0.48	0.264	0.24
2002	0.33	0.39	0	0.04	0.18	0.264	0.48	0.264	0.24
2003	0.33	0.39	0	0.04	0.18	0.264	0.48	0.264	0.24
2004	0.33	0.39	0	0.04	0.18	0.264	0.48	0.264	0.24
2005	0.33	0.39	0	0.04	0.18	0.264	0.48	0.264	0.24
2006	0.33	0.39	0	0.03	0.192	0.3	0.6	0.3	0.24
2007	0.33	0.39	0	0.03	0.192	0.3	0.6	0.3	0.24
2008	0.33	0.39	0	0.03	0.192	0.3	0.6	0.3	0.24
2009	0.3	0.39	0	0.03	0.192	0.3	0.6	0.3	0.24
2010	0.3	0.38	0	0.03	0.192	0.3	0.6	0.3	0.24
2011	0.3	0.355	0	0.03	0.16	0.25	0.5	0.25	0.2
2012	0.28	0.33	0	0	0.16	0.25	0.5	0.25	0.2
2013	0.28	0.33	0	0	0.16	0.25	0.5	0.25	0.2
2014	0.28	0.33	0	0	0.16	0.25	0.5	0.25	0.2
2015	0.28	0.33	0	0	0.16	0.25	0.5	0.25	0.2
2016	0.28	0.33	0	0	0.16	0.25	0.5	0.25	0.2
2017	0.28	0.33	0	0	0.16	0.25	0.5	0.25	0.2

Integrated Data Infrastructure disclaimer

The results in this paper are not official statistics. They have been created for research purposes from the Integrated Data Infrastructure (IDI) managed by Statistics NZ. The opinions, findings, recommendations, and conclusions expressed in this paper are those of the author(s), not Statistics NZ. Access to the anonymised data used in this study was provided by Statistics NZ in accordance with security and confidentiality provisions of the Statistics Act 1975. Only people authorised by the Statistics Act 1975 are allowed to see data about a particular person, household, business, or organisation. The results in this paper have been confidentialised to protect these groups from identification. Careful consideration has been given to the privacy, security, and confidentiality issues associated with using administrative and survey data in the IDI. Further detail can be found in the Privacy impact assessment for the Integrated Data Infrastructure available from www.stats.govt.nz.

IRD disclaimer

The results are based in part on tax data supplied by Inland Revenue to Statistics NZ under the Tax Administration Act 1994. This tax data must be used only for statistical purposes, and no individual information may be published or disclosed in any other form, or provided to Inland Revenue for administrative or regulatory purposes. Any person who has had access to the unit record data has certified that they have been shown, have read, and have understood section 81 of the Tax Administration Act 1994, which relates to secrecy. Any discussion of data limitations or weaknesses is in the context of using the IDI for statistical purposes, and is not related to the data's ability to support Inland Revenue's core operational requirement

Acknowledgements

We would like to sincerely thank Lynda Sanderson for her engagement and help with this project, especially for her help with the code and data processing. John Creedy, Norman Gemmell, and Matt Benge were all important figures in initially motivating this research. Furthermore, we would also like to thank John McDermott and Richard Fabling for comments on the earlier version of this paper. Finally, we would like to thank the MBIE colleagues, specifically Corey Allan and Sharon Pells for their feedback on the code and paper respectively. The results presented in this paper were produced when Gulnara Nolan was employed by the Ministry of Business, Innovation and Employment.

About the authors

Gulnara Nolan is a Senior Economic Analyst at the Reserve Bank of New Zealand

Email: gulnara.nolan@rbnz.govt.nz

Matt Nolan is a Senior Policy Advisor at Inland Revenue

Email: matt.nolan@ird.govt.nz

About the Authors

Gulnara Nolan is a Senior Economic Analyst at the Reserve Bank of New Zealand.
Email: gulnara.nolan@rbnz.govt.nz

Matt Nolan is a Senior Policy Advisor at Inland Revenue.
Email: matt.nolan@ird.govt.nz