Working Paper No. 448

February 2013

User Cost of Debt-Financed Capital in Irish Manufacturing Industry: 1985 – 2011

Nuša Žnuderl and Ide Kearney

Abstract: This paper provides estimates of the cost of debt-financed capital to Irish manufacturing industry over the period 1985 to 2011. The estimates are provided for two types of capital assets, machinery and equipment and industrial buildings. They also incorporate policy interventions aimed at influencing investment behaviour of manufacturing firms in Ireland. The results show that large capital gains recorded during the Celtic Tiger period created a downward distortion in the user cost of investing in industrial buildings. On average, policy interventions reduced the cost of capital compared to the cost of capital in the absence of these interventions, and the tax-related interventions were more favourable in the case of industrial building than for machinery and equipment.

Keywords: cost of capital, manufacturing, Ireland, Celtic Tiger, capital gains, grants, taxation, allowances

Corresponding Author: nusa.znuderl@esri.ie

* We thank John Frain, John FitzGerald, Conor O'Toole and participants at the 2012 ISNE conference and the ESRI seminars, for comments, discussions and suggestions. We also thank Kieran Culhane (CSO), Críona Brassill (Forfás), Donal Smith (Central Bank of Ireland) and Christian Carugo (Central Bank of Ireland) who provided data and answered data queries at various stages during the preparation of the paper.

User Cost of Debt-Financed Capital in Irish Manufacturing Industry: 1985 – 2011

1. Introduction

Macroeconomic theory relates long run economic growth to the expansion in the productive capacity of inputs in the production process. Therefore it is important to understand the underlying drivers of the quantity and quality of factors of production in an economy. An obvious starting point is to examine the impact of factor prices on the decision by firms to employ different combinations of inputs in the production process. A measure of factor prices is an essential input in such analysis, and while it is relatively easy to measure the cost of labour, it is far more difficult to put a number on the cost of capital to the firm over a given period of time.

This paper provides estimates of the cost of debt-financed capital to Irish manufacturing industry over the period 1985 to 2011. Enterprise surveys conducted in 2005 (The World Bank, 2012) and 2012 (Department of Finance, 2012) suggest that debt financing is the single most important external source of investment financing for Irish private sector enterprises[1], accounting for approximately 50% of total external financing sources. In 2012 this is followed by trade credit (19%), equity (15%), debt from non-bank financial institutions (4%), new debt issues (4%), and informal lending sources (8%) (Department of Finance, 2012).

Estimates presented in this paper are based on the concept of the user cost of capital, broadly defined as a measure of the economic cost to a firm of its usage of capital goods and services over a given time period. They are provided for two types of capital assets: machinery and equipment and industrial buildings. The results show that between 1985 and 2008, the user cost of investing in machinery and equipment was higher than the user cost of investing in industrial buildings, indicating a relatively higher marginal productivity of machinery and equipment over this period. The main reason for this difference over the period 1985 to 2000 is a relatively higher depreciation cost of machinery and equipment, while during the Celtic Tiger period the main factor behind the difference is higher real capital gains on industrial buildings. While throughout the period real capital gains had a relatively small impact on the user cost of investing in machinery and equipment, large real capital gains on industrial buildings during the Celtic Tiger period caused a downward distortion in the cost of investing in this asset. The estimates incorporate the impact of various policy interventions - corporate taxation, capital grants and depreciation allowances - aimed at influencing investment behaviour of manufacturing firms in Ireland. The results show that, on average, these policy interventions reduced the cost of capital compared to

[1] Internal funds/retained earnings accounted for 50% of overall investment financing in 2005 (The World Bank, 2012) and 74% of investment financing in 2012 (Department of Finance, 2012).

the cost of capital in the absence of these interventions. In particular, the lowest cost of capital was incurred by firms which could avail of all policy interventions, while firms not affected by any policy intervention faced the highest cost of capital, the market cost. With the exception of the period 2009 to 2011, the tax-related policy interventions were more favourable in the case of industrial buildings. Therefore, in addition to an already distorted cost of investing in industrial buildings due to real capital gains, policy interventions further exacerbated the difference in the relative attractiveness of the two types of assets as investment opportunities at the margin. In 2009 a real capital loss on industrial buildings occurred for the first time over the period, and in 2009, 2010 and 2011 the user cost of investing in industrial buildings exceeded the cost of investing in machinery and equipment.

2. Theoretical Framework

2.1. Derivation of the Expression for the Market Cost of Capital[2]

The starting point for the analysis is the market cost of capital, defined as the cost of capital that firms would incur in the absence of policy interventions.[3] The expression for the market cost of capital is derived from a model of investment behaviour based on the neoclassical theory of optimal capital accumulation (Jorgenson, 1963, 1967). The theory assumes that firms operate in a certain, frictionless world, where the production process is described by a production function which, at every point in time, relates flows of labour and capital inputs to the flow of output. By investing in capital goods, the firm supplies capital services to itself.

Following the derivation in Jorgenson (1967), let Q, L and I denote levels of output, variable input, and investment in durable goods, and p, w, and q denote the prices of Q, L, and I, respectively. Then, the net revenue to the firm at time t, R(t), is given by:

$$R(t) = p(t)Q(t) - w(t)L(t) - q(t)I(t) \tag{1}$$

Let i(s) denote the nominal discount rate at times. Then the present value of the firm, W, is given by:

$$W = \int_0^\infty e^{-\int_0^t i(s)ds} R(t)dt \tag{2a}$$

Without loss of generality (Jorgenson, 1967), it can be assumed that $i(s) = i$, so that the present value can be expressed as:

$$W = \int_0^\infty e^{-it} R(t)dt. \tag{2b}$$

[2] The derivation in this paper is taken from Jorgenson (1967).

[3] Policy interventions include corporate taxation, capital grants and depreciation allowances. They are discussed in subsequent sections of the paper.

When maximising its present value, the firm is subject to two constraints. First, assuming that capital stock is fully utilised and capital replacement δ is proportional to capital stock, the expression for net investment is given by:

$$\dot{K} = I(t) - \delta K(t); \tag{3}$$

where $\dot{K} = \frac{dK}{dt}$ is the rate of change in the flow of capital services with respect to time.

Second, output, labour and capital services are constrained by the production function, which is assumed to be strictly convex and twice differentiable with positive marginal rates of substitution between inputs and positive marginal productivities of both inputs (Jorgenson, 1967):

$$F(Q,L,K) = 0 \Leftrightarrow F(L,K) - Q = 0; \Longrightarrow \frac{\partial F}{\partial L} > 0, \frac{\partial F}{\partial K} > 0, \frac{\partial F}{\partial Q} < 0 \tag{4}$$

Overall, the objective of the firm is to maximize the net present value (2b) subject to (3) and (4).

In order to solve the optimisation problem, the following Lagrangian, L, is considered (Jorgenson, 1967):

$$L = \int_0^\infty \left[e^{-it}R(t) + \lambda_0(t)F(Q,L,K) + \lambda_1(t)\left(\dot{K} - I + \delta K\right)\right]dt = \int_0^\infty f(t)dt.$$

The corresponding Euler necessary conditions, which determine the path of Q, L and K that gives the maximum present value in (2b) subject to constraints (3) and (4), are (Jorgenson, 1967):

$$\frac{\partial f}{\partial Q} = e^{-it}p + \lambda_0(t)\frac{\partial F}{\partial Q} = 0, \tag{5}$$

$$\frac{\partial f}{\partial L} = -e^{-it}w + \lambda_0(t)\frac{\partial F}{\partial L} = 0, \tag{6}$$

$$\frac{\partial f}{\partial I} = -e^{-it}q - \lambda_1(t) = 0, \tag{7}$$

$$\frac{\partial f}{\partial K} - \frac{d}{dt}\frac{\partial f}{\partial K} = \lambda_0(t)\frac{\partial F}{\partial \dot{K}} + \delta\lambda_1(t) - \frac{d}{dt}\lambda_1(t) = 0, \tag{8}$$

$$\frac{\partial f}{\partial \lambda_0} = F(Q,L,K) = 0, \tag{9}$$

$$\frac{\partial f}{\partial \lambda_1} = \dot{K} - I + \delta K \tag{10}$$

The following marginal productivity condition for labour services follows from (5) and (6) [4]:

$$\frac{\partial Q}{\partial L} = \frac{w}{p} \tag{11}$$

Because output, labour, wages and prices are functions of time, the marginal productivity condition holds at all points in time over an indefinite future.

It follows from (7) that $\lambda_1(t) = -e^{-it}q$. Consequently, the first order condition for capital services (8) can be rewritten as:

$$\lambda_0(t)\frac{\partial F}{\partial \dot{K}} - \delta e^{-it}q - re^{-it}q + e^{-it}\dot{q} = 0 \tag{12}$$

Solving a system of (12) and (5) yields the marginal productivity condition for capital services:

$$\frac{\partial Q}{\partial K} = \frac{q(i+\delta)-\dot{q}}{p} = \frac{c}{p}, \tag{13}$$

where the nominal user cost of capital is $c = q\left(i + \delta - \frac{\dot{q}}{q}\right)$. (14a)

As output, prices, and the discount rate are functions of time, this marginal productivity condition holds at all points in time over and indefinite future.

The nominal user cost of capital in equation 14a is defined as "… the implicit rental value of capital services supplied by the firm to itself" (Jorgenson, 1967, p.143). It relates four variables: investment price q, nominal interest rate i, depreciation rate δ, and the proportionate change in investment prices $\frac{\dot{q}}{q}$.

In the original Jorgenson (1963) paper it was assumed that nominal capital gains on the price of investment good, $\frac{\dot{q}}{q}$, are 'transitory' and do not affect the long-run demand for capital. However, this assumption that $\frac{\dot{q}}{q} = 0$ is dropped in more recent studies, as discussed in section 3 below, and the effect of capital gains on the cost of capital is also taken into account in this paper. In turn, this approach assumes that firms could realise capital gains on the price of their fixed assets, either through a sale of the asset, or through borrowing against the value of the asset[5].

Finally, let π denote the inflation rate in the price of output p. If the real interest rate r is defined as $r = i - \pi$, and the real capital gain Γ is defined as $\Gamma = \frac{\dot{q}}{q} - \pi$, the the expression

---

4 The restriction $\frac{dF}{dQ} < 0$ in the production function constraint (4) ensures a positive marginal productivity condition in (11).

5 The framework in this section would need to be modified if it was assumed that firms are unable to realise capital gains entirely (due to credit constraints, which prevent them to borrow against the value of the assets, or otherwise). A simple way of incorporating firms' limited ability to realise capital gains in this framework would be to limit the reduction in the cost of capital due to capital gains to a fraction of the total possible reduction, depending on the extent to which capital gains can be realised.

for the nominal user cost of capital in equation 14a can be rewritten in terms of investment price q, real interest rate r, depreciation rate δ, and real capital gain Γ as follows:

$$c = q\left(i + \delta - \frac{\dot{q}}{q}\right) = q\big((r+\pi) + \delta - (\Gamma + \pi)\big) = q(r + \delta - \Gamma) \qquad (14b)$$

In this paper this user cost of capital in the absence of policy interventions is referred to as the market cost of capital, C_{Mkt}. It is a starting point for the analysis in the form using the real interest rate and the real capital gain as shown in equation 14b.

2.2. Impact of Individual Policy Interventions on Market Cost of Capital

In addition to the factors incorporated in the market cost of capital, investment decisions of firms in Ireland are affected by various policy interventions. These consist of capital grant schemes and tax-related measures, which include corporate taxation and depreciation allowances. In turn, the impact of each policy intervention is incorporated in the expression for the market cost of capital so that in equilibrium, the after-tax marginal product of capital equals the cost of investing in this unit of capital.

Impact of Corporate Taxation

Consider a firm which is subject to corporate taxation at a rate $0 < \tau < 1$. In Ireland companies are allowed to deduct from their corporate tax liability all payments of interest other than interest treated as distribution (Revenue, 2013). Therefore, the effective after-tax real interest rate to the firm subject to corporate taxation at rate τ is given by $r' = i(1-\tau) - \pi$, where *i* is the nominal interest rate and π is inflation rate. This after-tax real interest rate r' is unambiguously below the real interest rate r faced by a firm not subject to corporate taxation. Therefore, the effective after tax user cost of capital to a firm with a corporate tax liability, C_τ, is given by:

$$C_\tau = q\frac{r' + \delta - \Gamma}{1-\tau}, \text{ where } r' = i(1-\tau) - \pi \qquad (15)$$

It is important to note that the overall impact of corporate taxation may be to reduce the user cost of capital below market cost because taxation reduces the real interest rate compared to the no tax case. To illustrate, suppose that interest is not tax deductible ($r' = r$. Then the user cost of capital to a firm is given by Cx below, and is unambiguously higher than the market cost of capital C_{Mkt} by a factor $\frac{1}{1-\tau}$:

$$C_x = q\frac{r + \delta - \Gamma}{1-\tau} = C_{Mkt} \times \frac{1}{1-\tau}.$$

However, when interest is tax deductible ($r' < r$), and the after tax cost of capital is given by C_τ in equation 15 above, the increase in the cost of capital of $\frac{1}{1-\tau}$ is, at least partially, offset by the reduction in the after-tax real interest rate r' created by interest tax deductibility. In fact, it is possible that this reduction in r' more than offsets the increase $\frac{1}{1-\tau}$ in the cost of capital that would occur if interest was not tax deductible. In this case the cost of capital is actually below market cost [6]:

$$\mathrm{C}_{\tau} < \mathrm{C}_{\mathrm{Mkt}} \Leftrightarrow \frac{\mathrm{r}' + \delta - \Gamma}{\mathrm{r} + \delta - \Gamma} < 1 - \tau$$

Impact of Capital Grants

Consider a company whose investment project is approved for a capital grant at rate g in its first year. Effectively, this means that proportion g of the investment expense is subsidised. If the capital grant is the only applicable policy intervention, the user cost of capital, C_g, is unambiguously reduced below the market cost by rate g:

$$C_g = q(r + \delta - \Gamma)(1 - g) < C_{Mkt}, \text{ where } r = i - \pi \qquad (16)$$

Impact of Depreciation Tax Allowances

Depreciation allowances consist of an initial allowance and a stream of annual allowances. Because depreciation allowances serve to reduce the firms' tax bill, they are only available to companies with corporation tax liabilities. An initial allowance A is the proportion of non-grant capital expenditure than can be offset against corporation tax immediately. Annual depreciation allowances refer to the rate α of straight-line annual write-down against tax of the proportion of the historical value of capital assets for which an initial allowance was not already claimed, (1-A), until the historical cost of the project is fully written down for accounting purposes.

Consider a firm which at the beginning of year t invests in an asset. The firm is entitled to an initial allowance at rate A of total expenditure when the expenditure is incurred in year t. Thereafter, the firm is also entitled to a stream of straight line annual depreciation tax allowances at rate α on the proportion 1-A of the cost of the investment project until expenditure is fully written down in year T. The present value of such a stream of depreciation tax allowances, which can be set against tax τ at the start of year t, when the project is incurred, is given in equation 17:

$$P = \tau\left(A + (1 - A)\left(\sum_{j=1}^{T-1} \frac{\alpha}{(1+i)^j} + \frac{1-\alpha(T-1)}{(1+i)^T}\right)\right) \qquad (17)$$

To illustrate, assume that A=30% and α=15%. The depreciation tax allowances are shown in Table 1. The project is fully written down for tax purposes in year 7 (T=7). Note that at the

[6] The results presented in section 5.2 show that taxation indeed reduced the cost of investing in industrial buildings below market cost in some years over the period 1985 to 2010.

end of the sixth year 90 per cent of the project cost is already written down. Therefore, annual allowance of 10 per cent (and not 15 per cent) can be claimed against tax in year 7.

Assuming that nominal interest rate i=10%, the present value P of tax relief due to depreciation allowances calculated using equation 17 is 0.793τ.

Therefore, the user cost of capital $C_{\tau D}$ to a firm which can avail of depreciation tax relief specified in equation 17 is given in equation 18:

$$C_{\tau} = q\frac{r'+\delta-\Gamma}{1-\tau}(1-P)^{7};$$

$$\text{Where } r' = i(1-\tau)-\pi, P = \tau\left(A+(1-A)\left(\sum_{j=1}^{T-1}\frac{\alpha}{(1+i)^{j}}+\frac{1-\alpha(T-1)}{(1+i)^{T}}\right)\right) \quad (18)$$

Table 1: Depreciation tax allowances over the life of the project when initial allowance A=30% and annual depreciation allowance α=15%.

Year	A (% of total cost)	1-A (% of total cost)	α (% of net cost 1-A)	Cumulative α (% of 1-A)
1	30	70	15	15
2	-	-	15	30
3	-	-	15	45
4	-	-	15	60
5	-	-	15	75
6	-	-	15	90
7	-	-	10	100

2.3. Aggregate Impact of Policy Interventions

It follows from the analysis of the individual impacts of policy interventions above that the effective user cost of capital is firm and project specific: it depends on whether the company incurs tax liability, and the characteristics of the project which determine whether the firm is eligible for a capital grant. On this basis, there are four viable combinations of company and project characteristics, which give rise to different effective costs of capital:

1) A company is affected by all policy interventions, i.e. it is a capital grant recipient and subject to corporate taxation, and can therefore avail of tax allowances. Its user cost of capital C_{ALL} is given in equation 19:

$$C_{ALL} = q\frac{r'+\delta-\Gamma}{1-\tau}(1-g)(1-\mathrm{P});$$

$$\text{where } r' = i(1-\tau)-\pi, P = \tau\left(A+(1-A)\left(\sum_{j=1}^{T-1}\frac{\alpha}{(1+i)^{j}}+\frac{1-\alpha(T-1)}{(1+i)^{T}}\right)\right). \quad (19)$$

[7] It should be noted that this method of incorporating the impact of depreciation tax allowances overestimates their effects on the cost of capital because it implies that the firm is entitled to the allowance on the current value of the entire capital stock.

2) A company is ineligible for a capital grant $(g = 0)$, but is subject to corporate taxation and can therefore avail of tax allowances. Its user cost of capital $C_{\tau P}$ is given in equation 20:

$$C_{\tau P} = q\frac{r' + \delta - \Gamma}{1-\tau}(1 - \mathrm{P});$$

$$\text{where } r' = i(1-\tau) - \pi, P = \tau\left(A + (1-A)\left(\sum_{j=1}^{T-1}\frac{\alpha}{(1+i)^j} + \frac{1-\alpha(T-1)}{(1+i)^T}\right)\right). \quad (20)$$

3) A company is unprofitable and therefore has no taxation liability $(\tau = 0 \Rightarrow A, \alpha = 0$. It is, however, eligible for a capital grant at rate g. Its user cost of capital, Cg, is given in equation 16:

$$C_g = q(r + \delta - \Gamma)(1-g), \text{where } r = i - \pi. \quad (16)$$

4) A company is unprofitable $(\tau = 0 \Rightarrow A, \alpha = 0)$ and ineligible for a grant $(g = 0)$. Its user cost equals market cost of capital in equation 14b above:

$$C_{Mkt} = q(r + \delta - \Gamma), \text{where } r = i - \pi. \quad (14b)$$

It is worth noting that a company not liable to corporate tax, and therefore unable to avail of depreciation tax allowances (case 3 and case 4), may still be able to benefit from these tax allowances indirectly by engaging in leasing agreements with companies that are able to avail of depreciation allowances (case1 and case 2) and are willing to pass a part of these benefits to the lessee. The higher the proportion of tax benefits which lessors are willing to transfer to lessees, the closer the cost of capital achievable by lessees is to that of the lessors[8].

3. Literature Review[9]

In the past several authors estimated the cost of capital to Irish industry. All studies were based on the neoclassical theory of investment behaviour discussed above. In this section, the results of these studies are reviewed. For clarity, a common notation of the components of the user cost of capital, given in Table 2[10] below, is used throughout the alternative formulations of the user cost of capital in the literature review.

8 For a more detailed discussion of leasing agreements and the associated cost of capital see Ruane & John (1984).

9 This section draws on Kearney (2001) Appendix B.3.

10 Notation in this section (Table 2) corresponds to the notation in the preceding section describing the theoretical framework.

Table 2: Notation of Components of the User Cost of Capital

Symbol	Definition
i	Nominal interest rate
r	Real interest rate
$\boldsymbol{\delta}$	Depreciation rate
q	Price of investment good
p	Price of output
$\dot{q}/q$	Nominal capital gain on the price of investment good
$\boldsymbol{\Gamma}$	Real capital gain on the price of investment good
$\boldsymbol{\tau}$	Corporate tax rate
g	Capital grant rate
A	Initial allowance
α	Annual depreciation allowance

The first study is by Geary, Walsh and Copeland (1975), updated by Geary and McDonnell (1979). They use the formulation of the market cost of capital, c_1, as:

$$c_1 = q(i + \delta)$$

They also estimate another variant of the user cost of capital, c_2, which allows for full deduction of initial capital allowance A and interest i against tax τ :

$$c_2 = q((1 - \tau A)i + \delta)$$

As discussed in section 2.1, in the original Jorgenson (1963) paper it was assumed that capital gains on the price of investment good are 'transitory' and do not affect the long-run demand for capital. However, this pre-ceded the era of high inflation in the 1970s, and in their papers Geary et al. drop the assumption that capital gains are transitory, and estimate variants of the cost of capital c_3 (1975 paper) and c_4 (1979 paper), allowing for the impact of both initial allowances and nominal capital gains:

$$c_3 = q\left((1 - \tau A)\left(i - \frac{\dot{q}}{q}\right) + \delta\right),$$

$$c_4 = q\left((i(1 - \tau A) + \delta) - \left(1 + i(1 - \tau A)\right)\frac{\dot{q}}{q}\right)$$

Due to nominal capital gains, their estimates of the cost of capital using variant c_4 were negative in the years 1974 and 1975. Overall, their results indicated that the cost of capital in Ireland, however measured, has risen less quickly than the cost of labour in the period 1953 to 1975, and the effect of government tax and grant policies was to raise the cost of labour relative to the cost of capital over the period.

FitzGerald (1983) uses the basic formula

$$c_5 = q\frac{(r + \delta)(1 - \mathrm{g} - \tau A)\left(1 - \tau(z + y)\right)}{1 - \tau}$$

where z and y are the present value of the tax shield on depreciation and interest paid (including the effects of initial allowances A), respectively. He argues that the Geary et al.

(1975) formulation c_1 leads to an upward bias in the estimated cost of capital because it includes nominal rather than real interest rate.

FitzGerald estimates separate cost of capital series for exporting manufacturing firms, which faced a zero corporate tax rate, and non-exporting firms, which faced a reduced 10 per cent corporate tax rate, over the period 1957 to 1980. The estimated results indicated that the cost of capital was higher for exporting firms than non-exporting firms because exporters could not exploit the full range of allowances available. He pointed out, however, that this result must be viewed with caution. Firstly, tax incentives only applied to fixed assets and not to working capital, which lead to an overestimation of the tax shield. Secondly, at the margin, the tax savings on profits from new investment due to the tax shield cannot exceed the tax savings from a zero tax rate. Thirdly, the interest tax shield applies only to debt financing. Finally, measured capital includes the factor 'enterprise' which unambiguously benefits from a zero tax rate.

Ruane and John (1984) provide an excellent synthesis of the range of cost of capital formulae applicable to firms facing different tax and financing options, and the analysis in this paper largely draws on their theoretical framework. Their basic market cost of capital formula is:

$$c_6 = \frac{q}{p}(r + \delta - \Gamma).$$

In their framework, the lower bound for the cost of capital is achievable by firms who can exploit the full range of allowances and grants, and is given by the following expression:

$$C_{min} = \frac{q}{p}\frac{(r' + \delta - \Gamma)(1 - g - A\tau - P(1 - A)\tau)}{1 - \tau},$$

where $r' = i(1 - \tau) - \pi$ is the real after-tax interest rate, τ is corporate tax rate, and $P = -\frac{\alpha}{(r'+\pi+\alpha)}\left(e^{-T(r'+\pi+\alpha)} - 1\right)$ is the present value of the stream of annual depreciation allowances α.

The upper bound for the cost of capital applies to firms who pay no tax and therefore have no access to tax benefits, and is given by the following expression:

$$c_{max} = \frac{q}{p}(r + \delta - \Gamma)(1 - g).$$

In addition, they define formulae for the cost of capital under leasing, and for firms who sell their output on both the domestic and the export markets.

Their results indicate that there is a wide range of variation in the marginal cost of capital bounded by c_{min} and c_{max} for different firms in the manufacturing sector. In all cases, the net effect of the range of fiscal and financial incentives has been to subsidise capital rather than labour. They found that the fiscal incentives, such as tax-saving from interest tax deductibility and depreciation allowances, had a greater effect than financial incentives (capital grants) on the cost of capital.

Frain (1990) defines the real cost of capital as

$$c_7 = \frac{q}{p}\left(i + \delta - \frac{\dot{q}}{q}\right)\frac{1 - g - \tau(z + y)}{1 - \tau},$$

where z and y are the present value of the tax shield on depreciation and interest paid, respectively (including the effect of initial allowances A).

In his definition of the cost of capital Frain incorporated the fact that after 1986 the tax allowances on investment in plant and machinery were deductible net of grants (this was always the case for investment in buildings) so that the cost of capital was then given by:

$$c_{1986} = \frac{q}{p}\left(i + \delta - \frac{\dot{q}}{q}\right)\frac{(1 - g)\big(1 - \tau(z + y)\big)}{1 - \tau}.$$

He estimates a set of different cost of capital series for investments with lives of five, ten, twenty and forty years over the period 1960 to 1989. He found that a 1 per cent rise in both nominal and real interest rates in 1989 caused the market cost of capital to rise by 0.9 per cent. He emphasises the importance of the system of capital grants as an investment incentive in reducing the cost of capital. Optimally the tax system should be designed to be neutral with respect to the investment decision while his estimates indicate that the cost of capital was negative in some years in the 1970s and 1980s for firms paying the full corporate tax rate[11]. This was because the Irish tax system overcompensated by a combination of grants and interest and depreciation tax shields which were in excess of tax liability.

4. Data

This section contains a description of the data used to construct the estimates of the user cost of capital based on the theoretical framework described in section 2.

Real Interest Rate

According to the neoclassical theory of optimal capital accumulation, the discount rate i is the discount rate which a firm uses to decide whether to undertake an investment project; in other words i is the rate the company uses to discount its net cash flows generated by the investment project. Theoretically, this interest rate should correspond to the cost of funds. The assumption in this paper is that at the margin, investments in manufacturing machinery and equipment and industrial buildings were debt financed, so that the discount rate used should be the interest rate on loans approved for such projects. Therefore, the nominal interest rates used were average annual rates on category AA loans[12], which include loans extended to the manufacturing sector as well as borrowers from the primary, construction, and services sectors.

---

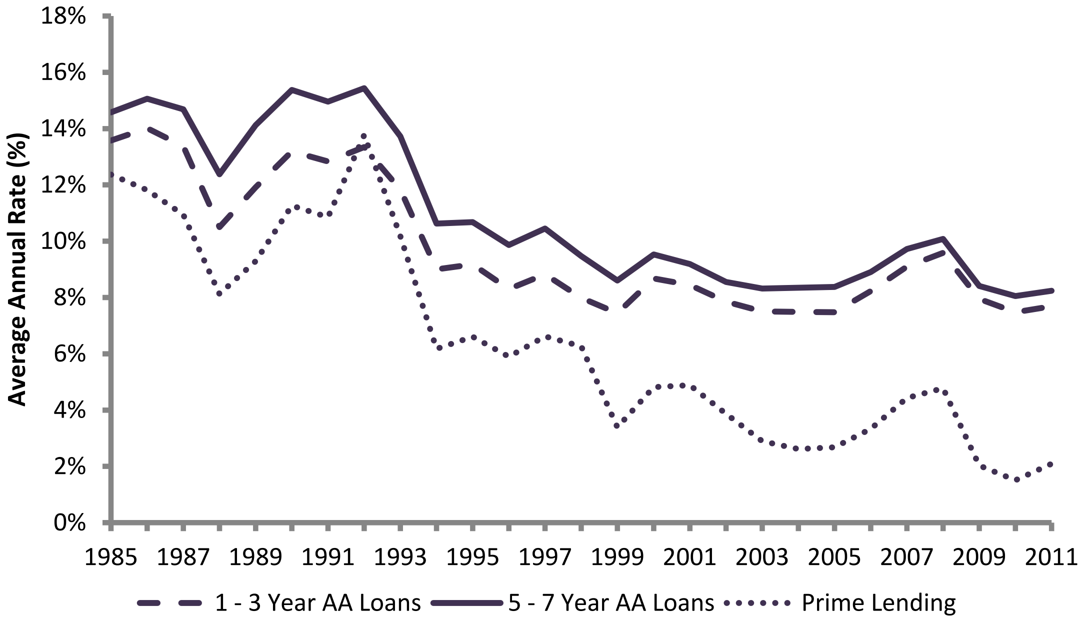
11 In practice this includes very few firms since all manufacturing firms qualified for the 10 per cent tax rate.

12 This dataset was provided by the Central Bank of Ireland.

It is also assumed that the term of loans extended for investment in machinery and equipment is shorter than for investment in industrial buildings. To capture this difference in loan terms, rates on one to three year loans were used for manufacturing machinery and equipment, while rates on 5 to 7 year loans were used for industrial buildings.[13] These are charted against the clearing banks' prime lending rate in Figure 1 below.

The figure shows a general decline in lending rates over the period 1985 to 2011. By 2011 the rates on AA loans fell by more than 6 percentage points from approximately 14 per cent in 1985, while the prime lending rate declined from 12 per cent in 1985 to only two per cent in 2011. Overall, this suggests that while the cost of debt to AA borrowers declined over the period, the premium they paid over the prime lending rate had increased from approximately two percentage points in 1985 to 6 percentage points in 2010. The graph also shows that the maturity premium in the AA category declined. At about 2 percentage points difference it was highest in the late 1980s and early 1990s, and then declined steadily to a mere 0.5 percentage point difference between 2007 and 2011.

Figure 1: Average Annual Rates (%) on AA Loans and Prime Lending



Source: *Central Bank of Ireland, ESRI Databank.*

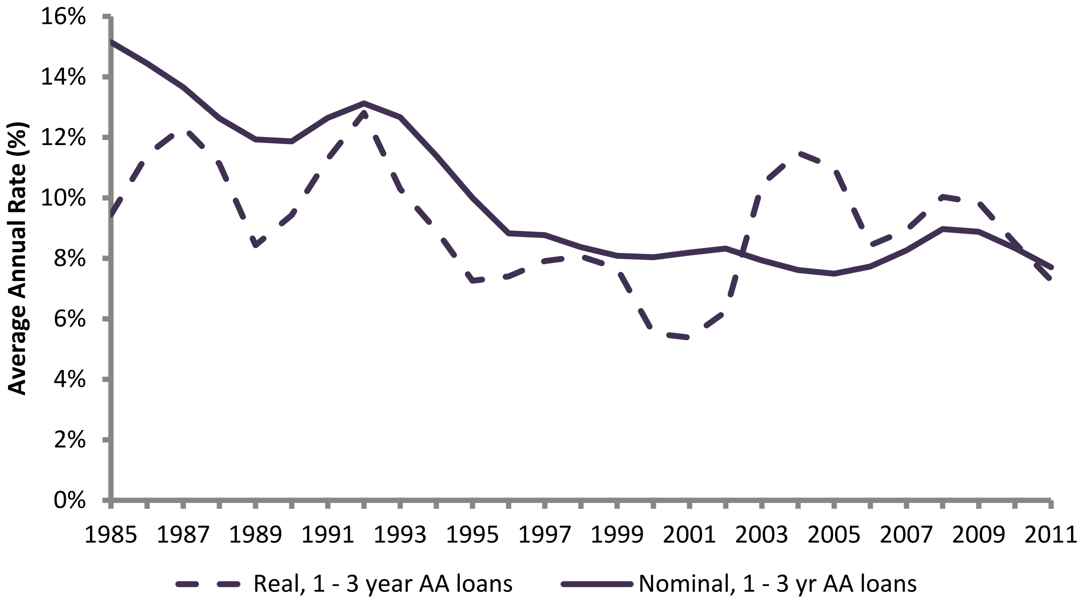
Inflation in manufacturing output prices (CSO, 2012d) was used to generate real cost of financing series from the nominal interest rates described above. It is assumed that firms' real interest rate expectations were adaptive; that is, firms are assumed to form

13 Arguably, loans extended for investments in industrial buildings include mortgages with maturities longer than 7 years. However, 5-7 year loans are the loans with the longest maturity in our dataset with rates on category AA loans. We use this dataset because rates on category AA loans include loans extended to the manufacturing sector, and are therefore the most representative interest rates for the manufacturing sector. However, in section 6.1 we perform a sensitivity test to interest rates using rates on loans with terms over 5 years which were extended to non-financial corporations in the euro-area by credit institutions resident in Ireland.

expectations about real interest rates based on real interest rates they observed in the current and previous periods. In particular, the real interest rate series were smoothed using three year moving average.[14] While this is a simple representation of expectations, it captures a significant element of investment behaviour, particularly during the Celtic Tiger period, where investors expected credit conditions of the past to continue in the future.

The smoothed real and nominal financing cost series are shown in Figures 2A and 2B. They show that between 1985 and 2002 the real financing cost was below the nominal cost. The real financing cost is above nominal cost between 2003 and 2010, before returning to a level slightly below nominal cost in 2011. The increase above nominal rate is particularly large in 2003, 2004 and 2005 because of the 8.1 per cent fall in prices recorded in 2003, as a result of a dramatic decline in prices of several types of manufacturing output (CSO, 2004)[15].

Figure 2A: Real and Nominal Interest Rates (%) on 1-3 year AA Loans, 3-year Moving Average

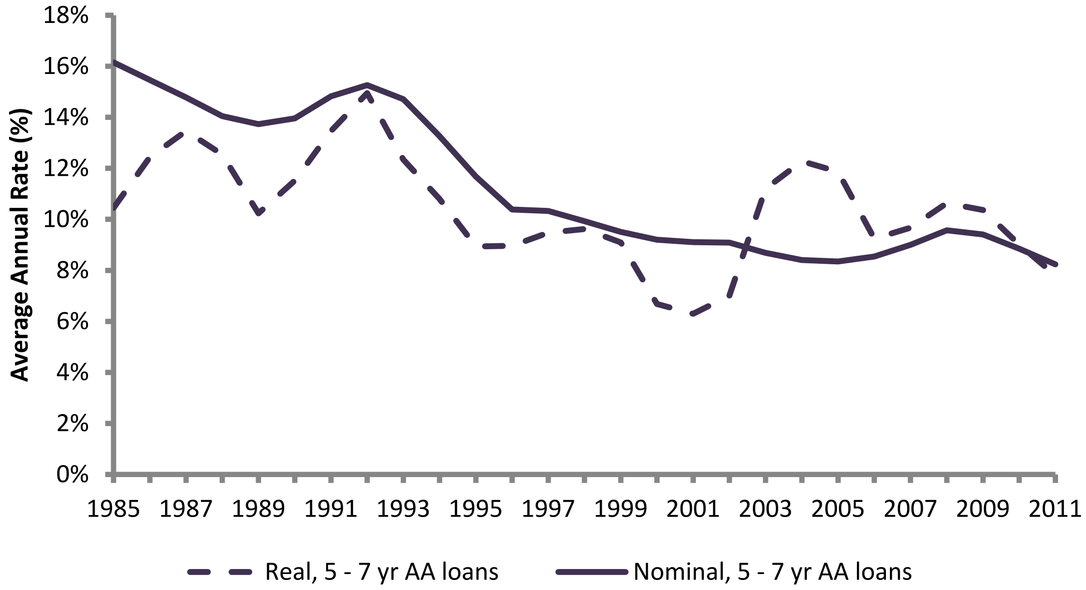


Source: *Central Bank of Ireland, Authors' own calculation based on data from the Central Bank of Ireland and the CSO.*

14 Alternative assumptions, where expectations are formed over a different period of time, would change these results. A sensitivity test with respect to the period over which expectations are formed is discussed in section 6.2.

15 The major contributors to the 8.1 per cent fall in prices of manufacturing output in 2003 were 'Office machinery & equipment' (-18.8 per cent),'Radio, television and communication equipment' (-11.6 per cent), 'Basic chemicals' (-11 per cent) and 'Chemicals, chemical products and man-made fibres' (-10 per cent) (CSO, 2004).

Figure 2B: Real and Nominal Interest Rates (%) on 5-7 year AA Loans, 3-year Moving Average

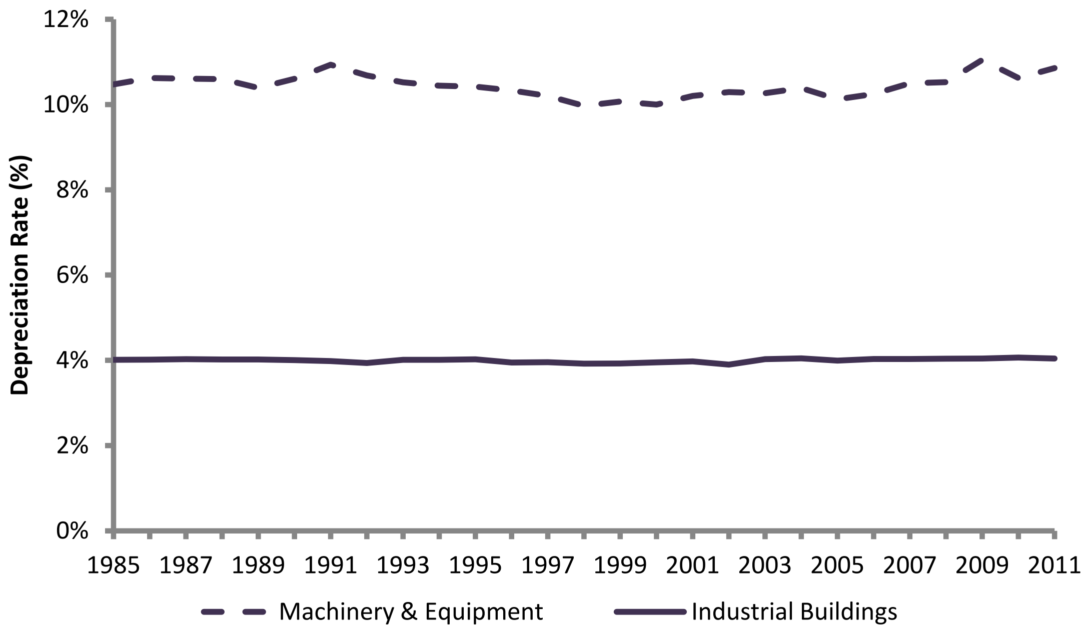


Source: *Central Bank of Ireland, Authors' own calculation based on data from the Central Bank of Ireland and the CSO.*

Depreciation Rate

Depreciation rates were fairly constant over the period 1985 to 2011 for both types of assets, as shown in Figure 3. Machinery and equipment, which has a relatively short useful life compared to industrial buildings, depreciated on average at approximately 11 per cent per annum, much faster than industrial buildings, which depreciated at approximately 4 per cent per annum.

Figure 3: Depreciation Rate (%) on Machinery & Equipment and Industrial Buildings

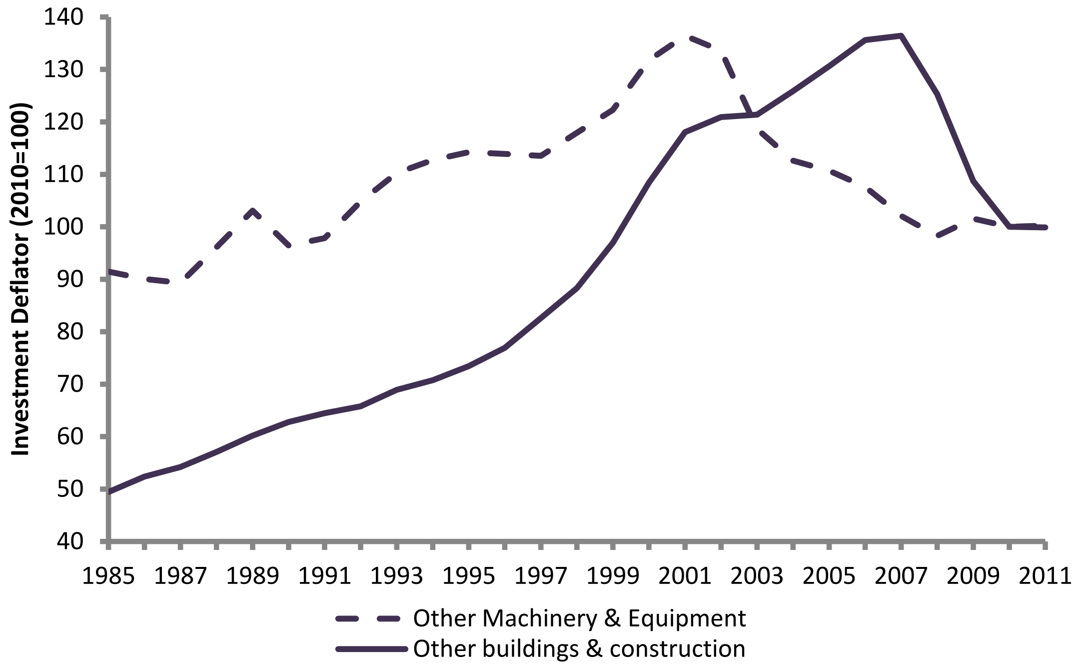


Source: *Authors' own calculation based on the Estimates of Capital Stock, CSO.*

Price of Investment

The price of investment as measured by the investment deflator is illustrated in Figure 4 below. Between 1985 and 2001, the price of machinery and equipment increased by 49 per cent. It then declined by 27 per cent over the period 2001 to 2011 relative to the price in 2001. In 2007 the price of industrial buildings[16] was 2.8-times higher than in 1985. The property price bubble collapsed in 2008, and by 2011 the price of industrial buildings was 27 per cent lower compared to the peak in 2007, and 8 per cent lower than the price in 2000.

Figure 4: Price of Investment (2010 = 100) in Other Machinery & Equipment and Other Buildings & Construction



Source: *National Income and Expenditure, CSO.*

Real Capital Gains

Nominal capital gains/losses are defined as annual changes in the price of investment. In order to generate real capital gains series, changes in prices of manufacturing output (CSO, 2012d) were used to deflate nominal capital gains, and the assumption of backward-looking expectations was applied to the real capital gains series using three year moving average. As already discussed, in our view this simple representation of expectations captures a

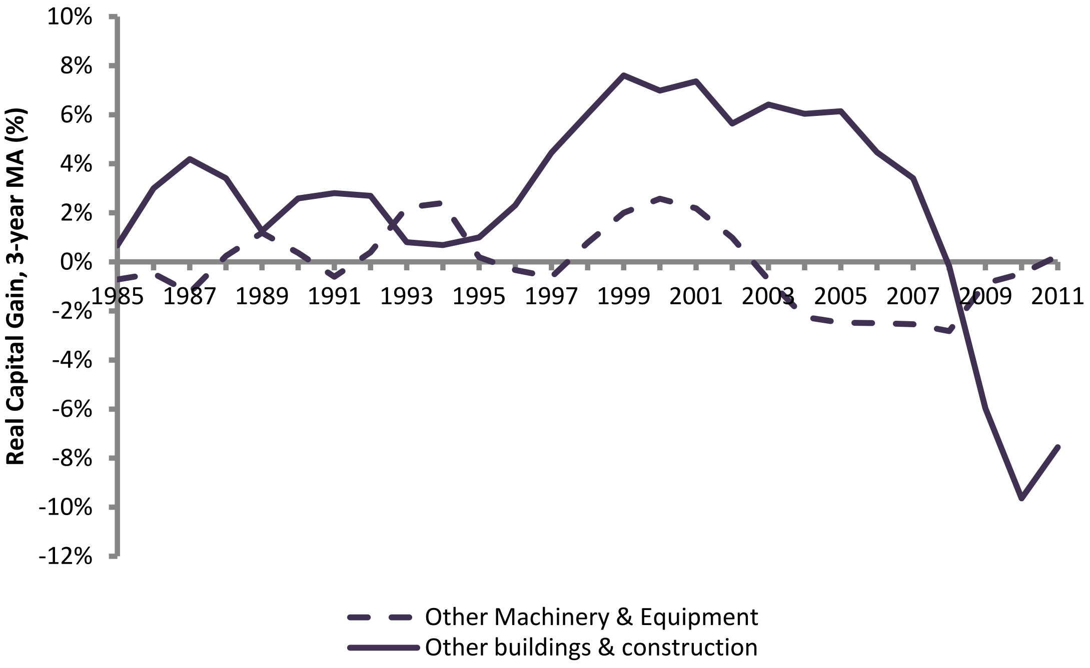
---

16 The investment deflator for industrial buildings is the deflator for 'Other building and construction including land rehabilitation' based on data in Tables 15 and 17 of the National Income and Expenditure accounts (CSO, 2012b, 2012c). This deflator excludes costs associated with the transfer of land & buildings. Therefore, the deflator refers to both buildings and the associated land, but excludes transaction costs related to transfers of these buildings and land.

significant element of investment behaviour during the Celtic Tiger period, where it was expected that capital gains of the past would continue in the future[17].

The smoothed real capital gain series are shown in figure 5. Changes in prices of machinery and equipment fluctuated around zero over the period, while industrial buildings consistently recorded real capital gains until 2009, when a real capital loss of 6 per cent occurred for the first time since the beginning of the period in 1985[18]. Furthermore, real capital gains/losses on industrial buildings were larger than on machinery and equipment, particularly during the Celtic Tiger period of the late 1990s and early 2000s, and during the subsequent collapse in property prices post 2008.

Figure 5: Real Capital Gains/Losses (%) on Other Machinery & Equipment and Other Buildings & Construction, 3-year Moving Average



Source: *Authors' own calculation based on data from the CSO.*

Corporate Taxation

Over the period 1985 to 2010, companies in the manufacturing sector in Ireland were taxed at an effective rate of 10 per cent[19]. From January 2011, this reduced 'manufacturing' tax increased to the standard 12.5 per cent rate for all projects (Revenue, 2012a).

17 A sensitivity tests with respect to alternative assumptions about real capital gain expectations is discussed in section 6.2.

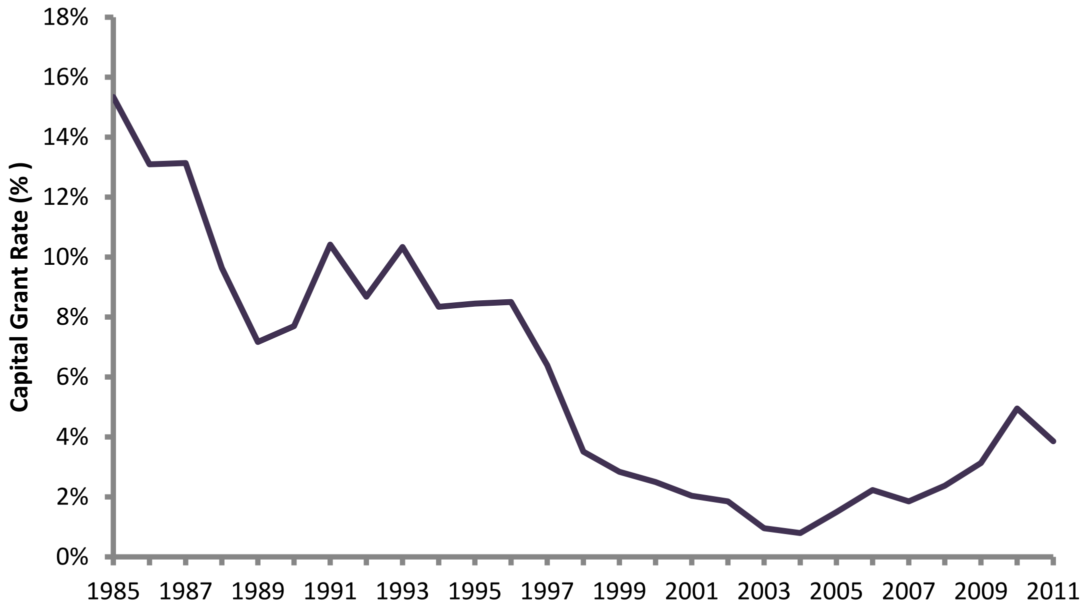
18 Capital gains on industrial buildings encompass capital gains on both buildings and the associated land on which buildings are on – see footnote 17.

19 For projects established after 22 July 1998, a 12.5 per cent tax rate applied from 1 January 2003, however, existing projects which were eligible for the 10 per cent tax rate remained to be taxed at this rate until the end of 2010 (Revenue, 2012a).

Capital Grants

In Ireland capital grants to manufacturing firms are provided by the Industrial Development Agency, Forbairt, Forfás, Udaras na Gaeltachta, the Shannon Free Airport Development Company and the Institute for Industrial Research and Standards. The data on the amount of capital grants provided by these agencies is available from the National Income and Expenditure Accounts (CSO, 2012b, 2012c)[20]. The 'average' capital grant rate, shown in Figure 6, was then calculated as a proportion of gross investment in manufacturing products from the National Income and Expenditure Accounts (CSO, 2012b, 2012c). The figure shows that capital grants were reduced from 15.3 per cent in 1985 to just over 7 per cent in 1989. They averaged approximately 8.5 per cent over the period 1990 to 1997, before declining to an average of just above 2.5 per cent over the period 1998 to 2011. At less than one per cent of gross investment in manufacturing products, they were the lowest in 2003 and 2004.

Figure 6: Average Annual Capital Grant Rate to Manufacturing Industry (% of Gross Investment in Manufacturing Products)



Source: *National Income and Expenditure, CSO.*

Initial and Annual Depreciation Allowances

An initial allowance is the proportion of capital expenditure than can be offset against corporation tax immediately, and is therefore available only to companies with corporation

[20] Based on the National Accounts, the amount of capital grants provided by the Industrial Development Agency, Forbairt, Forfás, Udaras na Gaeltachta, the Shannon Free Airport Development Company and the Institute for Industrial Research and Standards, is the exhaustive list of capital grants available to manufacturing firms.

tax liabilities. In Ireland, initial allowances apply to a proportion of qualifying non-grant capital expenditure, and can be set off against corporation tax in the accounting period in which the expenditure is incurred (Revenue, 2012b). A wear-and-tear allowance (annual depreciation allowance) is the rate of annual write-down of value of capital assets for accounting purposes based on the historical cost of the asset. In Ireland, firms are entitled to straight-line annual depreciation allowances on the proportion of capital expenditure for which an initial allowance was not already claimed $(1 - A)$, but rates vary depending on the type of capital asset (Revenue, 2012b).

The construction of time series which measure the impact on an 'average' investment project undertaken by manufacturing firms in Ireland is not straightforward. First, in a particular year, there is no single allowance which all manufacturing firms can set against their tax bill; rather a set of schemes and situation-specific rules exist, which govern the allowance applicable to a particular investment project. For example, in a particular year, the rate of capital allowance that a firm can set against tax depends on, inter alia, the type of the capital asset (machinery or building), purpose of the capital asset (e.g. factory, food production facility, road vehicle, etc.) and the location of the asset (e.g. operations in the Custom House Docks Area and the Shannon Airport Area generally qualify for higher rates than operations elsewhere)[21]. Second, a particular scheme might be in existence only for a part of the period 1985 to 2011, and several coexisted over the same period of time[22]. Third, the possibility of aggregating the data to an average allowance is limited because data on the proportion of projects to which a particular allowance applied are, to our knowledge, not available.

The data in this paper were obtained from the ESRI databank (ESRI, 2012), where time series measuring the average initial and annual allowances available to manufacturing firms were constructed from a number of sources, including the Taxes Consolidation Act 1997 Notes for Guidance (Revenue, 2012b).

The rates of initial allowance on machinery and equipment and industrial buildings are shown in Figure 7A. The entire capital expenditure on machinery and equipment was allowable against tax immediately for expenditures incurred in 1985, 1986 and 1987. This allowance was then reduced gradually to 1992, when just over 6 per cent of expenditure on machinery was allowable against tax immediately. One half of expenditure on industrial buildings was allowable against tax immediately between 1985 and 1990. The initial allowance on industrial buildings between 1990 and 1993 was the same as that on machinery and equipment: it was gradually reduced from 50 per cent in 1990 to zero in 1993. While initial allowances on machinery and equipment were discontinued from 1993

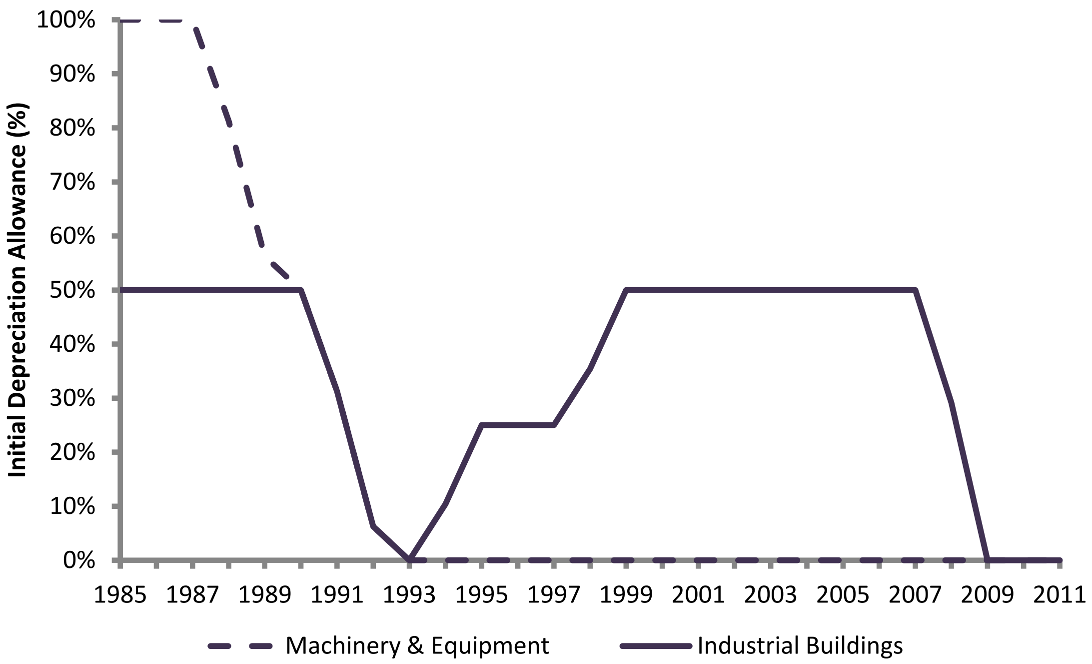
[21] For details on the law governing capital allowances see the section 'Principal Provisions Relating to Relief for Capital Expenditure – Section 268 - 321' of the *Taxes Consolidation Act 1997 Notes for Guidance (Finance Act 2012 Edition)* available at http://www.revenue.ie/en/practitioner/law/notes-for-guidance/tca/index.html

[22] A summary of commercial schemes for various building projects see http://taxpolicy.gov.ie/wp-content/uploads/2011/06/10.13-ANNEXES.pdf

on, between 1993 and 1999 initial allowances on industrial buildings gradually increased back to 50 per cent level. They remained at 50 per cent until 2007, and were finally discontinued in July 2008 (Revenue, 2012c).

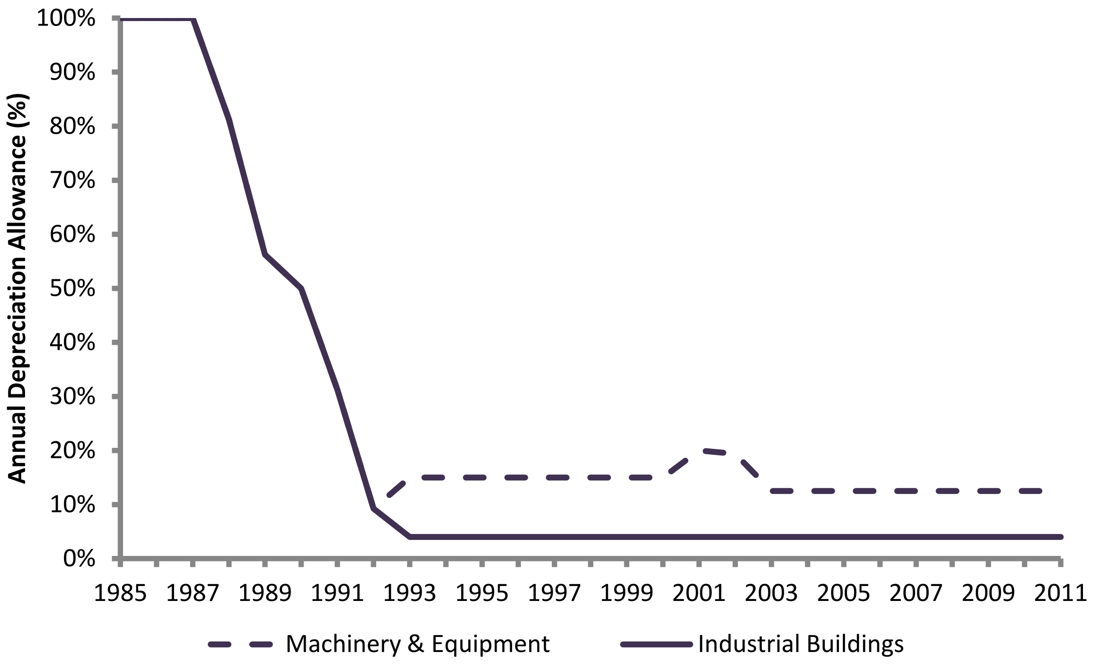
Between 1985 and 1992 the same rate of annual write-down of the historical cost applied to machinery and equipment and industrial buildings, as shown in Figure 7B below. The entire cost could be written down in a year between 1985 and 1987; then this rate was gradually reduced to just over 9 per cent in 1992. From 1993 onwards, industrial buildings could be written down over 25 years or at a rate of 4 per cent of historical cost per annum, and machinery and equipment could be written down over 6.6 years or at an annual rate of 15 per cent of historical cost over the period 1993 to 2000, 5 years or 20 per cent of historical cost per annum in 2001 and 2002, and 8 years or 12.5 per cent of historical cost per annum thereafter.

Figure 7A: Average Initial Allowance to Manufacturing Firms (% allowable against corporate tax bill)



Source: *ESRI Databank.*

Figure 7B: Average Annual Depreciation Allowance to Manufacturing Firms (% allowable against corporate tax bill)



Source: *ESRI Databank.*

5. Estimates of User Cost of Capital in Irish Manufacturing Industry: 1985 - 2011

In this section, empirical estimates of the user cost of capital based on expressions in section 2 and data described in section 4 are presented. The user cost is estimated for two types of capital assets: machinery and equipment[23] and industrial buildings. On average, these capital assets comprised 98 per cent of total net capital stock[24] in manufacturing industries over the period 1985 to 2011: machinery and equipment accounted for 52 per cent of net capital stock, industrial buildings were 46 per cent of net capital stock, and the remainder consisted of intangible fixed assets[25].

5.1. Estimates of Market Cost of Capital

Estimates of the average annual market cost of capital and their factor decomposition[26] based on equation 14b are shown in Table 3 for machinery and equipment, and Table 4 for

---

23 Machinery and equipment includes 'Other machinery and equipment incl. office machinery and hardware' and 'Transport equipment'.

24 The net capital stock is the value of stock of assets adjusted for depreciation and retirement of fixed assets (CSO, 2012).

25 Intangible fixed assets include computer software.

26 Decomposition: $c = q(r + \delta - \Gamma) = (q \times r) + (q \times \delta) - (q \times \Gamma)$.

industrial buildings. The market cost of investing in machinery and equipment increased from an average of 19.92 over the period 1985 to 1989 to an average of 23.58 over the period 2005 to 2008. It then declined to 19.88 over the period 2009 to 2011. It was primarily driven by the real cost of financing and the depreciation cost; real capital gains did not have a major influence.

The market cost of investing in industrial buildings fluctuated around 7 during the period 1985 to 2004, before it increased dramatically to an average of 17.36 over the period 2005 to 2011. Throughout the period its largest component was the real cost of financing. The cost of depreciation was the second largest component between 1985 and 1994 and 2005 and 2008, while over the period 1995 to 2004 and 2009 to 2011 the value of real capital gains more than offset the cost of depreciation[27].

The relative impact of real capital gains on the market costs of capital is also illustrated in Figures 8A and 8A, which in addition to the market cost of capital solid line) also show the market cost of capital if real capital gains were zero (dashed line). While the market cost of machinery and equipment was not severely influenced by real capital gains (Figure 8A), during the Celtic Tiger period of the late 1990s and early 2000s this distortion was severe in the case of industrial buildings (Figure 8B).

As already discussed in section 2.1, it is important to note that by incorporating the impact of capital gains in the estimates of the user cost of capital, we are assuming that firms could realise capital gains on the price of their fixed assets, either through a sale of the asset, or through borrowing against the value of the asset. While the extent to which manufacturing firms engage in the sale of fixed assets is uncertain[28], given the generally loose credit conditions during the Celtic Tiger Period, it seems reasonable to assume that over this period, when real capital gains had a substantial impact on the cost of capital, firms could borrow against the value of the assets.

---

[27] For the explanation of the decomposition of the market cost of capital refer to footnote 27.

[28] Firms might deem it more efficient to invest in new assets because assets of another firm might not be suitable for their operations. For example, if Intel's plans to produce future generation chips in its Kildare plant go ahead, Intel is expected to invest more than €1 bn in the new production facilities (and not purchase the facilities from another firm) (RTE, 2012).

Table 3: Decomposition[29] of Market Cost of Investing in Machinery and Equipment (q: 2010=100)

	1985 - 1989	1990 - 1994	1995 - 1999	2000 - 2004	2005 - 2008	2009 - 2011
Average market cost of Mach. & Eqpt.	19.92	21.03	20.28	21.74	23.58	19.88
of which:						
$\boldsymbol{q \times r}$	9.87	11.00	8.92	9.66	10.06	8.60
$\boldsymbol{q \times \delta}$	9.90	11.10	11.87	12.94	10.82	10.91
$\boldsymbol{q \times \Gamma}$	0.15	-1.06	-0.50	-0.86	2.70	0.37
of which (as % of market cost):[30]						
$\boldsymbol{q \times r}$	50%	52%	44%	44%	43%	43%
$\boldsymbol{q \times \delta}$	50%	53%	59%	60%	46%	55%
$\boldsymbol{q \times \Gamma}$	1%	-5%	-2%	-4%	11%	2%

Table 4: Decomposition[31] of Market Cost of Investing in Industrial Buildings (q: 2010=100)

	1985 - 1989	1990 - 1994	1995 - 1999	2000 - 2004	2005 - 2008	2009 - 2011
Average market cost of Ind. Bdgs.	7.28	9.78	7.25	7.48	14.32	21.41
of which:						
$\mathbf{q \times r}$	6.46	8.38	7.72	10.44	13.64	9.36
$\mathbf{q \times \delta}$	2.20	2.65	3.31	4.73	5.31	4.16
$\mathbf{q \times \Gamma}$	-1.38	-1.25	-3.78	-7.69	-4.62	7.89
of which (as % of market cost):[32]						
$\mathbf{q \times r}$	89%	86%	107%	140%	95%	44%
$\mathbf{q \times \delta}$	30%	27%	46%	63%	37%	19%
$\mathbf{q \times \Gamma}$	-19%	-13%	-52%	-103%	-32%	37%

29 For the explanation of the decomposition of the market cost of capital refer to footnote 27.
30 The sum of components might not add to 100 percent due to rounding.
31 For the explanation of the decomposition of the market cost of capital refer to footnote 27.
32 The sum of components might not add to 100 percent due to rounding.

Figure 8A: Market Cost of Investing in Machinery & Equipment with and without Real Capital Gains (q: 2010=100)

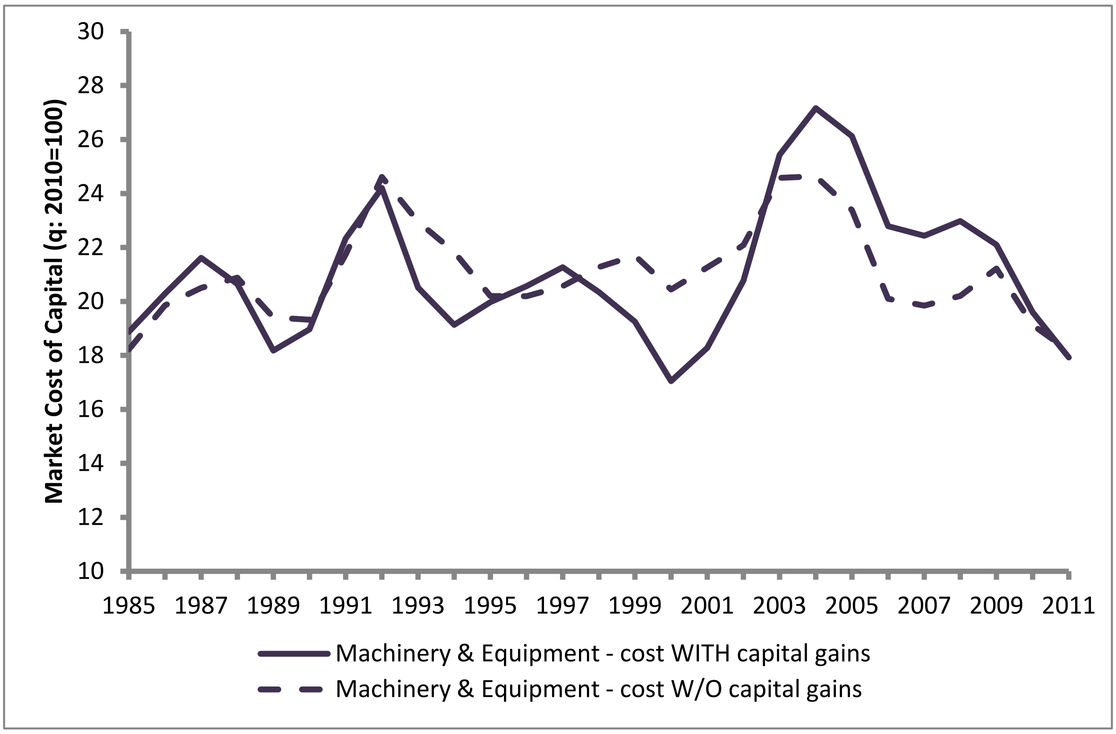
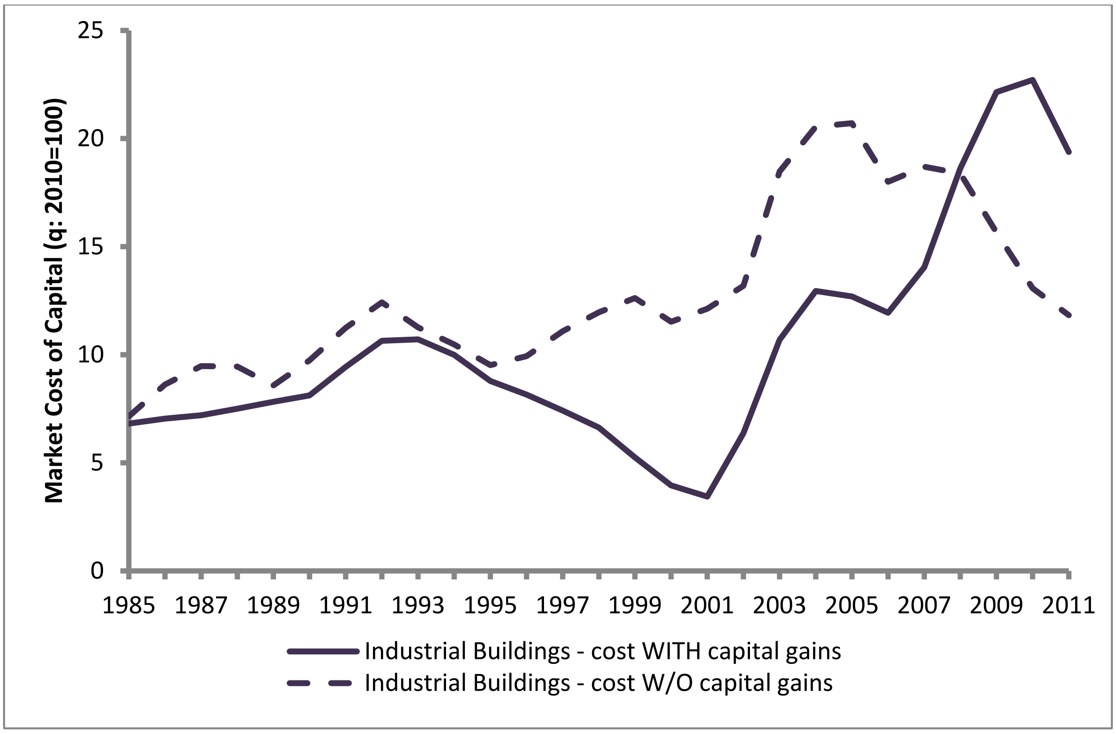


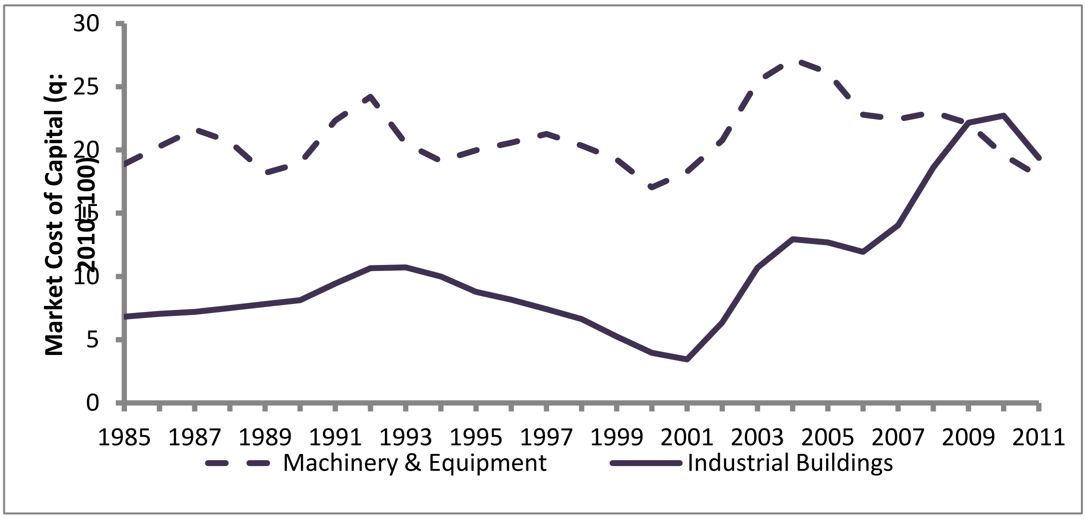
Figure 8B: Market Cost of Investing in Industrial Buildings with & without Real Capital Gains (q: 2010=100)



Finally, Figure 9 shows that the market cost of investing in industrial buildings was lower than the cost of investing in machinery and equipment until 2008, indicating that over this period, the marginal product of machinery and equipment was higher than the marginal product of industrial buildings. The reversal of the relationship between the two market costs post-2008 coincided with the collapse in property prices[33], and the decomposition of the difference between the two market costs in Table 5[34] shows that the difference between real capital gains became a major driver of the difference between the two market costs during the Celtic Tiger period, and during the crisis period post 2008. It is also important to note that the difference between the costs of investing in the two types of capital assets is the smallest during the period 2008 to 2011 compared with the differences over the period prior to 2008.

Overall, the results show that compared to the prices of machinery and equipment, which did not enjoy large real capital gains, the boom in property prices during the Celtic Tiger period significantly reduced the cost of investing in industrial buildings. Similarly, real capital losses post 2008 significantly increased the cost of investing in industrial buildings, bringing it above the cost of investing in machinery and equipment. Naturally, industrial buildings and machinery and equipment are complements in the production process, and therefore the decisions of firms about the allocation of their investments across capital assets are not determined solely by the relative price of capital assets. However, the results suggest that the large difference in the relative cost of machinery and equipment and industrial buildings during the Celtic Tiger period could have affected investment allocation decisions of firms at the margin, making industrial buildings a relatively more attractive investment opportunity.

Figure 9: Market Cost of Machinery & Equipment and Industrial Buildings (q: 2010=100)



---

[33] Real capital losses on the prices of industrial buildings of 6 per cent and 9.6 per cent and 7.6 per cent occurred in 2009, 2010 and 2011, respectively, for the first time over the period starting in 1985 (see Figure 5 in section 4).

[34] $\Delta c = c_M - c_B = q_M(r_M + \delta_M - \Gamma_{\mathrm{M}}) - q_B(r_B + \delta_B - \Gamma_{\mathrm{B}}) = (q_M r_M - q_B r_B) + (q_M \delta_M - q_B \delta_B) + (\Gamma_{\mathrm{B}} - \Gamma_{\mathrm{M}}) = \Delta(q \times r) + \Delta(q \times \delta) + \Delta(q \times \Gamma)$; where c_M and c_B are market costs of machinery and equipment and industrial buildings, respectively.

Table 5: Decomposition of Difference between Market Cost of Investing in Machinery and Equipment and Industrial Buildings[35]

	1985 - 1989	1990 - 1994	1995 - 1999	2000 - 2004	2005 - 2008	2009 - 2011
Average difference between market costs of mach. & eqpt. and ind. bdgs. (Δc)	12.64	11.25	13.04	14.26	9.26	-1.54
of which:						
$\Delta(\mathbf{q} \times \mathbf{r})$	3.41	2.62	1.20	-0.78	-3.58	-0.76
$\Delta(\mathbf{q} \times \boldsymbol{\delta})$	7.71	8.44	8.56	8.21	5.51	6.74
$\Delta(\mathbf{q} \times \boldsymbol{\Gamma})$	1.52	0.18	3.28	6.83	7.32	-7.52
of which (as % of average difference Δc):						
$\Delta(\mathbf{q} \times \mathbf{r})$	27%	23%	9%	-5%	-39%	50%
$\Delta(\mathbf{q} \times \boldsymbol{\delta})$	61%	75%	66%	58%	60%	-439%
$\Delta(\mathbf{q} \times \boldsymbol{\Gamma})$	12%	2%	25%	48%	79%	490%

5.2. Estimates of Individual Impacts of Policy Interventions on Market Cost of Capital

The individual impacts of policy interventions on the user cost of investing in machinery and equipment and industrial buildings, estimated based on the framework developed in section 2.2 and data described in section 4, are summarised in Table 6.

Firstly, as discussed in section 2.2, the impact of capital grants is always to reduce the user cost below market cost. As capital grants declined substantially over the period, their impact on user cost also declined from 12 per cent between 1985 and 1989 to 4 per cent between 2009 and 2011. At 2 per cent below market cost the impact of capital grants was the lowest over the period 2005 to 2008.

It can also be seen in table 6 that taxation in the case of machinery and equipment was the only intervention which consistently increased user cost above market cost throughout the period. Otherwise, the impact of policy interventions was to reduce user cost below market cost. Capital grants had the largest impact until 1999 in the case of machinery and equipment, and until 1994 in the case of industrial buildings. Tax-related interventions dominated thereafter.

Overall, Table 6 shows that tax-related policy interventions were in general more favourable in the case of industrial buildings. The only exception is the effect of taxation and depreciation allowances over the period 2009 to 2011, which was to reduce the user cost of investing in machinery and equipment below the market cost by 1 per cent, while increasing

---

[35] See footnote 35 for derivation of the difference between the two market costs.

the user cost of industrial buildings above the market cost by 2 per cent. Therefore, in addition to an already low market cost of investing in industrial buildings during the Celtic Tiger period (as discussed in section 5.1 above), policy interventions further exacerbated this difference in the relative attractiveness of the two types of assets as investment opportunities at the margin.

Table 6: Summary of Individual Impacts of Policy Interventions on User Cost of Investing in Machinery & Equipment and Industrial Buildings

Impact of:		User cost as proportion of market cost (%)					
		1985 - 1989	1990 - 1994	1995 - 1999	2000 - 2004	2005 - 2008	2009 - 2011
Capital Grants	Mach. & Eqpt. / Ind. Buildings	88	91	94	98	98	96
Taxation[36]	Mach. & Eqpt.	104	104	105	106	107	107
	Ind. Buildings	99	100	97	91	102	107
Taxation & Depreciation Allowances	Mach. & Eqpt.	94	97	98	98	100	99
	Ind. Buildings	90	94	92	84	95	102

5.3. Estimates of Effective User Cost of Capital

The estimates of a range of effective user costs of capital to different types of manufacturing firms, classified by the extent to which they are affected by the policy interventions as discussed in section 1.3, are summarised in Table 7.

The results show that on average the effective user cost was below market cost. Compared to market cost, the reduction due to tax-related policy interventions (cases 1 and 2) was higher for the user cost of industrial buildings than the cost of machinery and equipment, except over the period 2009 to 2011. This corresponds to the results in section 5.2.

For both types of assets, the lowest cost of capital was incurred by companies which were affected by all policy interventions, i.e. companies with a corporation tax liability that could avail of all grants and taxation allowances (case 1). The market cost was the upper bound for the user cost of capital, and was incurred by unprofitable companies which were ineligible for a grant (case 4). Other companies fall within categories between the two ends of the spectrum, and therefore their effective costs of capital lie between the minimum effective cost incurred by companies qualifying for all policy interventions and the market cost.

[36] Taxation may sometimes reduce the cost of capital below market cost due to interest tax deductibility – see discussion of the impact of corporate taxation in section 2.2.

Table 7: Summary of Effective User Cost of Capital in Possible Scenarios

Case	Applicable interventions	Inapplicable interventions	Average Effective User cost as proportion of market cost (%)						
				1985 - 1989	1990 - 1994	1995 - 1999	2000 - 2004	2005 - 2008	2009 - 2011
1	All policy intervention	None	Mach. & Eqpt.	83	88	92	96	98	95
			Ind. Buildings	79	86	86	83	93	98
2	Taxation, Depreciation Allowances	Capital grant	Mach. & Eqpt.	94	97	98	98	100	99
			Ind. Buildings	90	94	92	84	95	102
3	Capital grant	Taxation, Depreciation Allowances	Mach. & Eqpt. / Ind. Buildings	88	91	94	98	98	96
4	None	All policy interventions	Mach. & Eqpt. / Ind. Buildings	100					

6. Sensitivity Tests

6.1. Sensitivity to Interest Rates of the Estimated Cost of Investing in Industrial Buildings

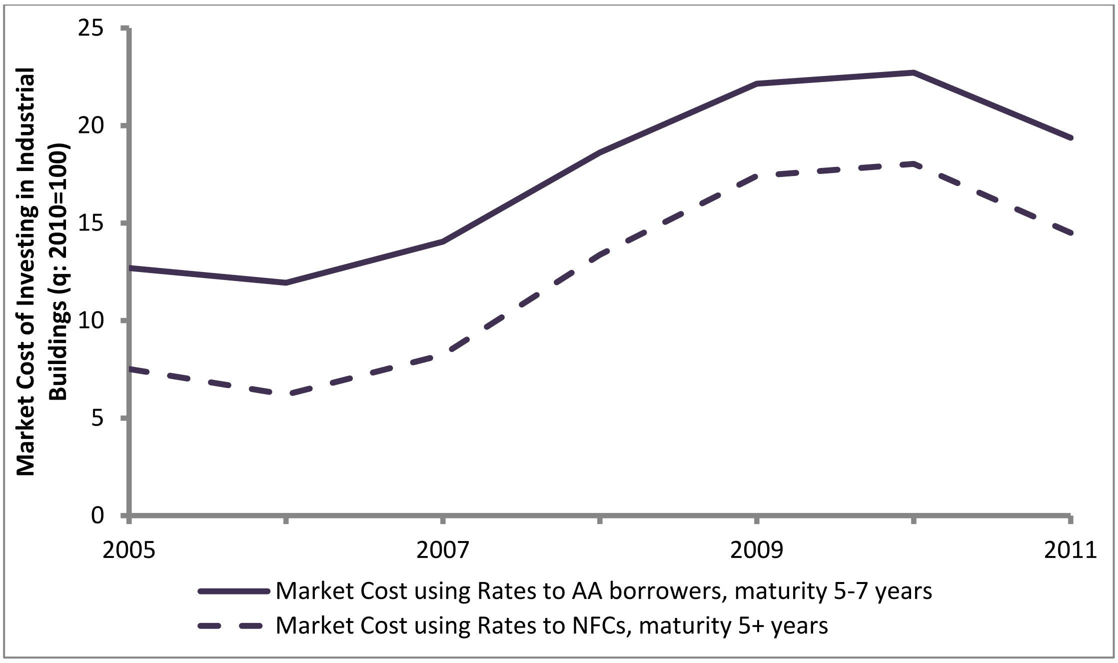
The estimated cost of investing in industrial buildings from section 5.1. is based on the interest rates charged on category AA loans with maturities of 5 to 7 years, described in section 4. Arguably, loans extended for investments in industrial buildings include mortgage type loans with maturities longer than 7 years. We used rates on 5 to 7 year loans to construct the baseline estimates in section 5.1. because these are the loans with the longest maturity in our dataset with rates on category AA loans, and we use this dataset because category AA loans include loans extended to the manufacturing sector, and are therefore the most representative interest rates for the manufacturing sector.

However, in this section we re-calculated the estimates of the market cost of investing in industrial buildings with interest rates on loans with terms over 5 years extended to non-financial corporations in the euro-area by credit institutions resident in Ireland. These rates are available from 2003 onwards from the Central Bank of Ireland (2012). They were converted into real terms using inflation in prices of manufacturing output, and backward-looking expectations were applied to the real rates using three-year moving average. All other inputs remained the same as in the baseline case.

The variation in the estimates calculated using different sets of interest rates is similar, as shown in Figure 10 below. However, the level of estimates is highly sensitive to real interest rates. The estimates calculated using rates on loans extended to NFCs with maturities of more than 5 years are, on average, approximately 55 per cent of the baseline[37] estimates for the period 2005 to 2008, and approximately 75% of the baseline estimates over the period 2008 to 2011.

[37] Baseline estimates are the estimates of the market cost if investing in industrial buildings from section 5.1., i.e. calculated using interest rates on category AA loans with maturities of 5 to 7 years.

Figure 10: Market Cost of Investing in Industrial Buildings Using Alternative Real Interest Rates



6.2. Sensitivity of Estimates to Assumptions about Expectations

The baseline estimates of the user cost of capital presented in section 5 embed an assumption of adaptive, backward looking expectations of firms about the real cost of financing and real capital gains. As discussed previously, this simple assumption seems reasonable, particularly in the context of investment behaviour during the Celtic Tiger period, when it was expected that credit conditions and capital gains of the past would continue in the future.

This assumption is applied using three year moving average, however, an alternative assumption where expectations are formed over a different period of time would change the results. In order to examine the sensitivity of the estimates to this assumption, the estimates of the user cost of capital were recalculated using five year and seven year moving averages for real interest rates and real capital gains. Because the alternative assumptions produce a similar pattern of variation across all effective costs (in each of the cases 1-4 discussed in section 5.3), only the sensitivity of the market cost of capital (Case 4) is discussed here.

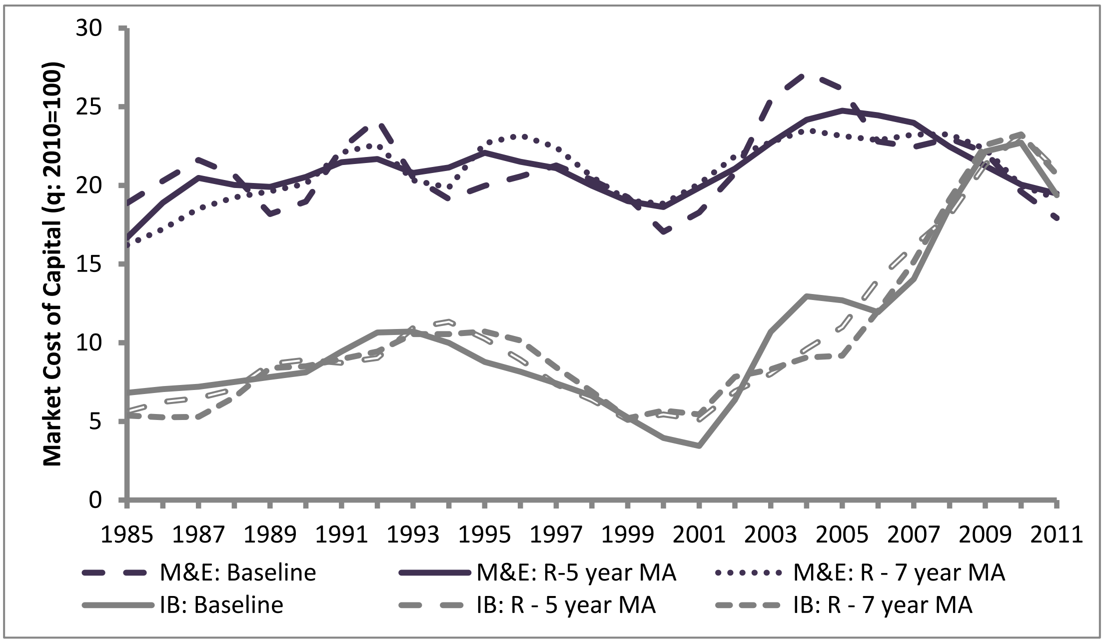
Impact of Alternative Assumptions about Real Interest Rate Expectations

The market cost of investing in machinery and equipment and industrial buildings when adaptive, backward looking real interest rate expectations are imposed using three-year (baseline), five-year and seven-year moving averages, are shown figure 12[38]. Smoother estimates are produced when moving average is calculated over a longer period, but overall all market cost estimates follow a similar pattern regardless of the assumption about real interest rate expectations.

In the case of the market cost of investing in machinery and equipment, the five-year moving average assumption did not cause a large deviation from the baseline case in which the assumption is imposed using three-year moving average, as shown in Table 8. The seven-year moving average assumption created a larger difference: the market cost of investing in machinery and equipment using this assumption deviated from the baseline market cost by -8 per cent between 1985 and 1989, and by 6 per cent between 1995 and 1999.

On the other hand, significant deviations from the baseline market cost of investing in industrial buildings occurred with both alternative assumptions about real interest rate expectations, as shown in Table 8. In particular, when five-year moving average assumption is used, the market cost was 7 per cent below baseline market cost over the period 1985 to 1989, and 9 per cent above baseline cost between 2000 and 2004. When seven-year moving average assumption is used the market cost of industrial buildings was 16 per cent below baseline market cost between 1985 and 1989 and approximately 15 per cent above baseline market cost between 1995 and 2004.

Figure 11: Market Cost of Investing in Machinery & Equipment and Industrial Buildings Using Alternative Backward-Looking Expectations for Real Interest Rates



[38] The assumption that real capital gains are formed based on a memory of 3 years is unchanged.

Table 8: Comparison of Market Cost of Capital (Case 6) Using Different Backward-Looking Expectations about Real Interest Rates

Real Interest Rate Expectation:		Market cost using expectations (1) and (2) as of baseline[39] market cost						
			1985 - 1989	1990 - 1994	1995 - 1999	2000 - 2004	2005 - 2008	2009 - 2011
1	Backward-looking, 5-year MA	Mach. & Eqpt.	97%	101%	102%	100%	102%	102%
		Ind. Buildings	93%	100%	104%	109%	104%	102%
2	Backward Looking, 7-year MA	Mach. & Eqpt.	92%	100%	106%	100%	98%	103%
		Ind. Buildings	84%	98%	113%	115%	96%	104%

Impact of Alternative Assumptions about Real Capital Gain Expectations

The market cost of investing in machinery and equipment and industrial buildings when adaptive, backward looking expectations about real capital gains are imposed using three-year (baseline), five-year and seven-year moving average, are shown figure 12[40].

The variants of the market cost of machinery and equipment do not display large differences. The alternative estimates of the market cost of capital (using five- and seven-year moving averages of real capital gains) differ from baseline market cost of capital by a maximum of 7% (Table 9).

The variants of the market cost of investing in industrial buildings display larger differences. When five-year moving average is used, the market cost exceeds the baseline market cost by 17 per cent between 1995 and 1999, and is 18 per cent below the baseline market cost between 2008 and 2011. When seven-year moving average is used, the market cost is above the baseline market cost by 24 per cent and 16 per cent over the periods 1995 and 1999 and 2000 and 2004, respectively. It is 30 below baseline market cost between 2008 and 2011 (Table 9).

[39] Baseline market cost is the estimate of the market cost as presented in Section 4.1 (expectations applied using 3-year moving average)

[40] The assumption that real interest rate expectations are formed based on a memory of 3 years is unchanged.

Figure 12: Market Cost of Machinery & Equipment and Industrial Buildings using Alternative Backward-Looking Expectations about Real Capital Gains

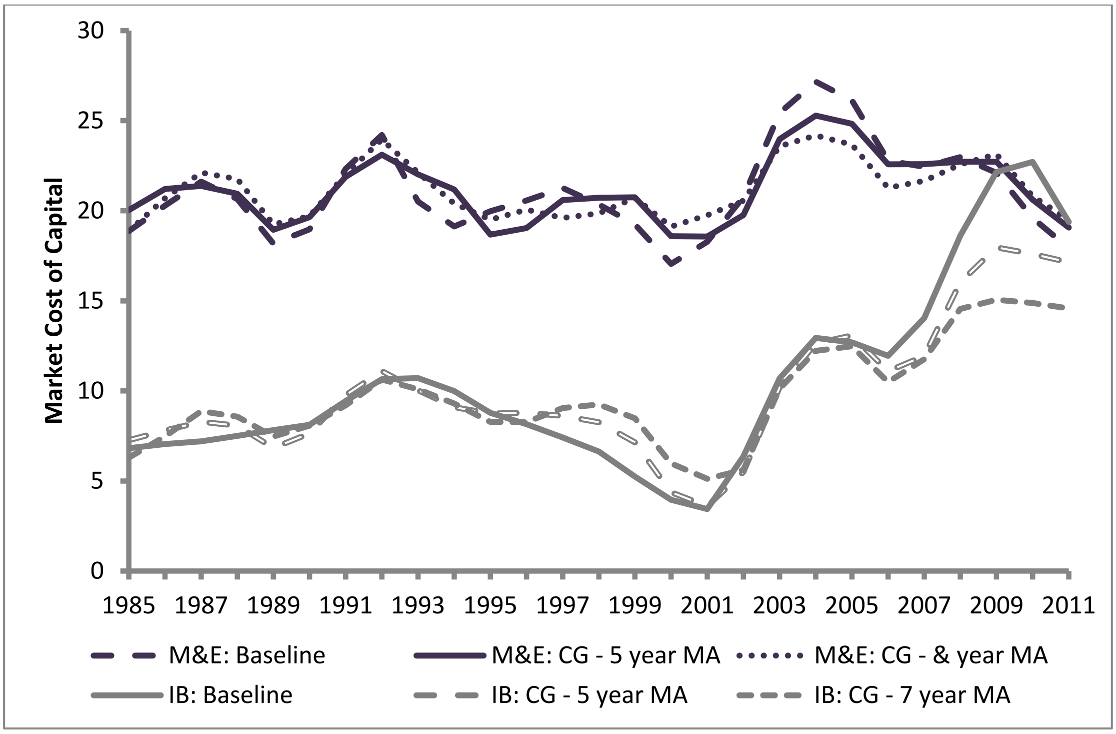


Table 9: Comparison of Market Cost of Capital (Case 1) Using Different Backward-Looking Expectations about Real Capital Gains

Real Capital Gain Expectation:		Market cost using expectations (1) and (2) as of baseline[41] market cost						
			1985 - 1989	1990 - 1994	1995 - 1999	2000 - 2004	2005 - 2008	2009 - 2011
1	Backward-looking, 5-year MA	Mach. & Eqpt.	103%	103%	99%	99%	98%	105%
		Ind. Buildings	105%	97%	117%	99%	92%	82%
2	Backward Looking, 7-year MA	Mach. & Eqpt.	103%	103%	99%	100%	95%	107%
		Ind. Buildings	106%	97%	124%	116%	87%	70%

[41] Baseline market cost is the estimate of the market cost as presented in Section 5.1 (expectations applied using three year moving average).

7. Conclusion

This paper provides estimates of the marginal user cost of debt-financed capital to Irish manufacturing industry over the period 1985 to 2011. The estimates are based on the concept of the user cost of capital, which is broadly defined as a measure of the economic cost to a firm of its usage of capital goods and services over a given time period. The estimates are provided for two types of capital assets, machinery and equipment and industrial buildings, and incorporate policy interventions aimed at influencing investment behaviour of manufacturing firms in Ireland. These include corporate taxation, capital grants and depreciation allowances. The cost of capital depends, inter alia, on the extent to which a particular investment project is affected by the policy interventions, and the paper provides separate estimates of the user cost of capital for four viable combinations of policy interventions.

The estimates are used in two ways. Firstly, together with the cost of labour, the estimates are used as an input in an analysis of the impact of factor prices on the decision by firms to employ different combinations of inputs in a production process which is relevant for an understanding of the process of economic growth. Secondly, the estimates are used in modelling investment in the manufacturing sector.

However, it is important to note that a firm's capital structure usually consists of both debt and other financing sources. In particular, enterprise surveys conducted in 2005 (The World Bank, 2012) and 2012 (Department of Finance, 2012) suggest that the most important investment financing source was internal funds[42]. Debt financing was the single most important external source of investment financing for Irish private sector enterprises, accounting for approximately 50% of total external financing sources. In 2012 this is followed by trade credit (19%), equity (15%), new debt issues (4%), debt from non-bank financial institutions (4%), and informal lenders (8%) (Department of Finance, 2012). In this respect, the estimates in this paper refer to the cost of the single most important external source of investments financing for manufacturing firms in Ireland. Nevertheless, the estimates are only partial estimates of the overall cost of capital to manufacturing firms, and further studies should focus on the estimation of the cost of capital for other types of financing, and the integration of the cost of debt and the prices of alternative financing into a single estimate.

The estimates of the cost of capital incorporate real capital gains/losses on the price of investment assets, thereby assuming that firms could realise these capital gains. This assumption seems plausible as during the Celtic Tiger period, when real capital gains had the largest impact, credit conditions were generally loose and firms could borrow against the value of their assets. However, if in the future real capital gains occur while credit conditions remain tight, thereby preventing firms to borrowing against the increased value of their

[42] Internal funds/retained earnings accounted for 50% of overall investment financing in 2005 (The World Bank, 2012) and 74% of investment financing in 2012 (Department of Finance, 2012).

assets, the framework used in this paper will need to be modified to account for the impact of such credit constraints.

The results show that real capital gains did not have a large impact on the cost of investing in machinery and equipment, but they created a large downward distortion in the cost of investing in industrial buildings during the Celtic Tiger Period. This result highlights the fact that the property price bubble during the Celtic Tiger was not limited to commercial properties; rather the boom also applied to industrial building. While industrial buildings and machinery are not substitutes in the production process, and therefore the decisions of firms about the allocation of their investment across capital assets are not determined by the relative price of capital assets, it is possible that, at the margin, this severe and prolonged distortion due to real capital gains during the Celtic Tiger period altered the investment decisions of manufacturing firms in Ireland. Future research should determine whether this distortion led to an overinvestment in buildings, and if so, examine the extent of this overinvestment.

Finally, the results show that on average, policy interventions reduced the effective user cost of capital below the market cost. The lowest cost of capital was incurred by companies which were affected by all policy interventions, while the highest cost of capital, equal to the market cost, was incurred by firms which were not affected by any policy intervention. With the exception of the last three years, the reduction due to tax-related policy interventions was larger for the cost of investing in industrial buildings than the cost of investing in machinery and equipment. Assuming that the cost of capital matters for the investment decisions of firms, it appears that in addition to an already distorted cost of investing in industrial buildings due to real capital gains during the Celtic Tiger period, policy interventions exacerbated this difference in the relative attractiveness of the two types of investment assets as investment opportunities at the margin. This implies that if the tax-related policy system were to be (more) neutral with respect to investment decisions, it should be counter-cyclical; i.e. if during the Celtic Tiger period the taxation system was to counter some of the distortion due to capital gains it would have to have introduced measures that would have, at least partially, offset the capital gains.

8. References

Boadway, R. (1980). Corporate Taxation and Investment: A Synthesis of the Neo-Classical Theory. *The Canadian Journal of Economics.* 13 (2), 250-267.

Central Bank of Ireland (2012). *Table B.1.2. Retail Interest Rates – Loans, Outstanding Amounts.* [Online] Available from: http://www.centralbank.ie/polstats/stats/cmab/Pages/Retail%20Interest%20Rate%20Statistics.aspx [Accessed 11 January 2013].

CSO (2012a). *Estimates of the Capital Stock of Fixed Assets 2011*. [Online] Available from: http://www.cso.ie/en/media/csoie/releasespublications/documents/economy/2011/csfa2011.pdf [Accessed 10 January 2013].

CSO (2012b). *National Income and Expenditure 2011 – Detailed Tables.* [Online] Available from: http://www.cso.ie/en/releasesandpublications/nationalaccounts/ [Accessed 11 January 2013].

CSO (2012c). *Historical National Income and Expenditure Tables 1970-1995 Excluding FISIM.* [Online] Available from: http://www.cso.ie/en/releasesandpublications/nationalaccounts/ [Accessed 11 January 2013].

CSO (2012d). Wholesale Price Index from 1985 to 2011. CSO *StatBank.* [Online] Available from: StatBank [Accessed 11 January 2013].

CSO (2004). *Wholesale Price Index December 2003*. [Online] Available from: http://www.cso.ie/en/media/csoie/releasespublications/documents/prices/2003/wpi_dec2003.pdf [Accessed 10 January 2013].

Department of Finance (2012). *SME Credit Demand Survey, April – September 2012.* [Online] Available from: http://www.cso.ie/en/media/csoie/releasespublications/documents/prices/2003/wpi_dec2003.pdf [Accessed 6 February 2013]

Department of Finance (2011). *Impact Assessment of Legacy Property Reliefs*. [Online] Available from: http://taxpolicy.gov.ie/wp-content/uploads/2011/06/Property-Based-Reliefs-June-2011.pdf [Accessed 23 September 2012]

ESRI (2012). Databank of Economic Time-Series, Version NIE10, November 2012. Online] Available from: http://www.esri.ie/irish_economy/databank/ [Accessed 6 December 2012]

FitzGerald, J. D. (1983). *Comment on paper on the Cost of Capital in Ireland by Flynn and Honohan.* Mimeo: Draft Paper.

Frain, J. (1990). Borrow and Prosper: Notes on the User Cost of Capital. *Journal of the Statistical and Social Inquiry Society of Ireland.* XXVI, 151-189.

Geary, P. T. & McDonnell, E. (1979). The Cost of Capital to Irish Industry: Revised Estimates. *The Economic and Social Review.* 10 (4), 287-299.

Geary, P. T., Walsh, B. M. & Copeland, J. (1975). The Cost of Capital to Irish Industry. *The Economic and Social Review.* 6 (3), 299-311.

Jorgenson, D. W. (1967). The Theory of Investment Behavior. In: Ferber, R. (ed.). *Determinants of Investment Behavior.* [e-book] , UMI. pp. 129-188. Available from: http://www.nber.org/chapters/c1235.pdf [Accessed 26 January 2012].

Jorgenson, D. W. (1963). Capital Theory and Investment Behavior. *American Economic Review.* [Online] 53 (2), 247-259. Available from: http://www.jstor.org/stable/1823868 [Accessed 26 January 2012].

Jorgenson, D. W. & Stephenson, J. A. (1967). Investment Behavior in U.S. Manufacturing, 1947 - 1960. *Econometrica.* [Online] 35 (2), 169-220. Available from: http://www.jstor.org/pss/1909109 [Accessed 26 January 2012].

Jorgenson, D. W. & Yun, K. (2001). *Lifting the Burden: Tax Reform, the Cost of Capital, and U.S. Economic Growth.* Investment. Cambridge, the MIT Press.

Jorgenson, D. W. & Yun, K. (1991). *Tax Reform and the Cost of Capital.* Oxford, Clarendon Press.

Kearney, I. (2001). *Do Relative Factor Prices Matter? The Long Run Demand for labour in the Irish Manufacturing Sector.* Florence, European University Institute.

Revenue. (2013). *Corporation Tax Deductions*. [Online] Available from: http://www.revenue.ie/en/tax/ct/deductions.html [Accessed 10 January 2013].

Revenue. (2012a). *10 rate of Corporation Tax for Manufacturing Enterprises*. [Online] Available from: http://www.revenue.ie/en/business/incentives/tax-incentives-investors-ireland.html [Accessed 23 September 2012].

Revenue. (2012b). *Taxes Consolidation Act 1997 Notes for Guidance (Finance (No. 3) Act 2011 Edition): Principal Provisions Relating to Relief for Capital Expenditure - Sections 268 - 321.* [Online] Available from: http://www.revenue.ie/en/practitioner/law/notes-for-guidance/tca/index.html [Accessed 23 January 2012].

Revenue. (2012c). *Capital Allowances and Property-Based Incentive Schemes, Finance Act Changes*. [Online] Available from: http://www.revenue.ie/en/practitioner/tax-briefing/archive/63/tb02.htm [Accessed 17 December 2012].

RTE (2012). *Intel secures development to produce new generation chip*. [Online] Available from: http://www.rte.ie/news/2012/0523/intel-leixlip-kildare.html [Accessed 13 January 2013].

Ruane, F. P. & John, A. A. (1984). Government Intervention and the Cost of Capital to Irish Manufacturing Industry. *The Economic and Social Review.* 16 (1), 31-50.

The World Bank (2012). *Enterprise Surveys*. [Online] Available from: http://www.enterprisesurveys.org [Accessed 6 February 2013]

Year	Number	Title/Author(s) **ESRI Authors/Co-authors *Italicised***
2012		
	447	The US and Ireland Approach to Sentencing in Cartel Cases: the Citroen Case *Paul K Gorecki* and Sarah Maxwell
	446	The Incentive to Invest in Thermal Plants in the Presence of Wind Generation *Valeria Di Cosmo* and *Laura Malaguzzi Valeri*
	445	Employment Protection and Innovation Intensity *Gavin Murphy, Iulia Siedschlag* and *John McQuinn*
	444	Distance Effects, Social Class and the Decision to Participate in Higher Education in Ireland John Cullinan, Darragh Flannery, *Sharon Walsh* and *Selina McCoy*
	443	Sentencing in Criminal Cartel Cases in Ireland: the Duffy Judgment *Paul K. Gorecki* and Sarah Maxwell
	442	Currency intervention and the global portfolio balance effect: Japanese lessons *Petra Gerlach-Kristen,* Robert N McCauley and Kazuo Ueda
	441	Regulating Small Public Service Vehicles in Ireland: Is There a Problem of Oversupply? *Paul K. Gorecki*
	440	Combining Public Sector and Economic Reform *Frances Ruane*
	439	The Effect of Real Exchange Rate Changes on Labour Productivity Growth *Gavin Murphy* and *Iulia Siedschlag*
	438	Consumption in Ireland: Evidence from the Household Budget Survey *Petra Gerlach-Kristen*
	437	Simulating Demand for Electrical Vehicles using Revealed Preference Data *Áine Driscoll, Seán Lyons*, Franco Mariuzzo, and Richard S.J. Tol
	436	The Costs of Working in Ireland Niamh Crilly, *Anne Pentecost* and Richard S.J. Tol

For earlier *Working Papers* see

http://www.esri.ie/publications/search_for_a_working_pape/search_results/index.xml