The Macro-Economic Impact of Changing the Rate of Corporation Tax

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Abstract

This paper considers the impact of changes in the rate of corporation tax in Ireland affecting the business and financial services sector. A model is estimated that relates services exports and output to world activity, competitiveness and the rate of corporation tax. This model indicates that a reduction in the rate of corporation tax in the 1990s stimulated exports and, even allowing for profit repatriations by foreign firms and replacement of lost tax revenue, it resulted in an increase in domestic output. The increase in profitability suggests that some of the increased output involved relocation of profits to Ireland by multinational firms.

Key words: Corporation tax; Ireland; Services Sector

JEL Classification: F2; H25

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1 Introduction

The dramatic turnaround in Ireland's economic fortunes in the 1990s occasioned much analysis and commentary, as evidenced by the wealth of the literature summarised in (Honohan and Walsh, 2002). One of the factors frequently cited as being important has been the low rate of corporation tax (Barry, 2003). However, this corporation tax regime was introduced in the 1950s for the manufacturing sector while the very rapid growth in that sector, and consequently in the economy, did not take place until the 1990s. Thus the role of the tax regime in the success story, while significant, is not self-evident.

Because the low tax rate for the manufacturing sector was in place on a continuous basis over such a long period it is not feasible using time series methods to estimate its impact directly. However, in the early 1990s this low tax regime was extended to the rest of the economy, in particular to the business and financial services sector. This policy change constitutes a natural experiment which allows us to consider the before and after periods and to derive an estimate of the broader macro-economic impact of this tax change.

Since the late 1990s there has been a dramatic rise in the importance of the business and financial services sector within the Irish economy. The structure of the sector is illustrated in Figure 1 which shows the share of value added accounted for by each of the three sub-sectors which make up the market services sector. The Figure illustrates that the business and financial sector accounts for around 67 per cent of total value added in the sector.

Figure 1 about here

As illustrated in Figure 2, both the financial and the business components of other market services have steadily increased their value added share of GDP over the last thirty five-years. The financial services sub-sector alone accounted for around 11 per cent of GDP in 2006.

Figure 2 about here

The business and financial sector is responsible for a significant share of the growing exports of services from the economy. As a result, the sector is today exposed to competitive pressures from outside Ireland whereas in 1970s it was driven by purely domestic factors. While services exports accounted for 14% of all exports in 1990, by 2005 they accounted for 37% of the total. With the growth of the tradable services sector, it is now a key channel through which the growth in world trade impacts on Ireland (Fitz Gerald *et al.*, 2008).

There is an extensive literature on the influence of corporation tax on investment and growth. Taxation affects the volume and location of Foreign Direct Investment (FDI) through its effect on after-tax returns. While the estimates of the elasticity of investment to taxation differ considerably in magnitude, there is a broad consensus in the literature that countries with lower rates of tax on corporate profits attract higher levels of foreign investment. For Ireland, there is certainly evidence that low rates of corporation tax succeeded in attracting higher levels of FDI than would have been possible in the absence of such a favourable tax regime and that this high level of

inward investment played an important role in stimulating economic activity (Barry, 2003). In addition there is evidence that the favourable Irish tax regime encouraged highly profitable firms to locate in Ireland with a view to lowering their worldwide tax liabilities.

In the light of these findings from the literature, and with some evidence of convergence in corporation tax rates internationally, this paper examines the wider economic impact of the fall in corporation tax rates affecting the business and financial services sector in Ireland from 40 per cent in 1994 to 12.5 per cent by 2003. The paper first examines the impact of the tax change on the sector itself before examining the broader macro-economic implications.

The paper is organised as follows: Section 2 outlines the evolution of Ireland's corporation tax system since the late 1950s, from the introduction of a zero rate of tax on profits from export sales in manufacturing in 1957 to the implementation of a standardised 12.5 per cent rate for all sectors from 2003. Section 3 reviews the international empirical evidence on the impact of taxation on foreign direct investment and growth, highlighting in particular the available evidence for Ireland. Section 4 develops a model of the business and financial services sector. The results from estimating the model are shown in Section 5. Section 6 considers the broader economic significance of these results by embedding the small model of the business and financial services sector into the *HERMES* model of the Irish economy and conclusions are drawn in Section 7.

2 Corporation Tax in Ireland

After decades of economic stagnation, Ireland belatedly began opening up its economy to international trade from the late 1950s. Initially a key element of the policy of promoting export-led growth involved changes to the corporation tax system for the manufacturing sector. Starting in 1956 a system of Export Sales Tax Relief (ESR), originally called export profits tax relief, was introduced halving the rate of corporation tax applicable to profits generated on export sales. The initial 50 per cent exemption from corporation tax of profits from manufactured exports was extended to full exemption in 1957 – a zero rate of tax.[1] The standard rate of corporation tax applying to all non-manufacturing activities remained at between 40 and 50 per cent.

This corporation tax regime remained in place until 1980 when it was replaced by a 10 per cent corporation tax rate applied to all enterprises in the manufacturing sector. This change to the corporation tax regime was introduced in order to comply with the EU requirement under the Treaty of Rome for non-discrimination between production for the home market and that for exports to other EU states.[2]

The Irish government, with European Commission approval, announced the establishment of the Irish Financial Services Centre (IFSC) in 1987. In effect this meant that from 1989 the 10 per cent manufacturing rate of corporation tax was extended to companies engaged in internationally traded financial services activities in the centre of Dublin.

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[1] An almost identical relief was introduced for approved activities carried out within the Shannon Free Airport Zone. This relief, applying, to the customs free zone at Shannon Airport, was extended and modified in line with the regime for manufacturing.

[2] The 10 per cent rate was also extended to the Shannon customs-free airport zone.

In 1996, to comply with EU rules, the Irish government decided to move to apply a rate of 12.5 per cent on corporate profits across all activities from 2003. This meant that the rate of corporation tax applicable to activity in the bulk of the business and financial services sector fell gradually from 40 per cent in 1994 to 32 per cent in 1998 and finally to 12.5 per cent by 2003.[3] This common rate of tax of 12.5 per cent today also applies to all new firms in the sectors covered by the previous 10 per cent rate. The 12.5 per cent rate applies to trading profits generally, whether arising from the manufacture and sale of goods or otherwise.[4] Companies that were claiming the relief before July 1998 may still avail of the 10 per cent rate until 2010. All IFSC companies moved to the 12.5 per cent rate from January 2006.

Figure 3 about here

The effect of these changes was to extend the attraction of Ireland for mobile firms in the business and financial services sector. It also meant that such firms could benefit from a strategic use of tax planning by locating highly profitable activities in the business and financial services sector in Ireland (through transfer pricing). This possibility had already been available to firms in the manufacturing sector. This change in the tax regime proved particularly attractive to firms in the financial sector. As shown in Figure 3, the profit rate in the financial services sector rose well above its historic norm in recent years whereas the profit rate in the rest of the business services sector has shown no such trend[5]. Over the same period the profit share in other countries such as France, Germany, U.K. and the Netherlands did not show a similar rise suggesting that the change in behaviour in Ireland was unusual. The increase in the profit rate in Ireland is thus indicative of a growth in the importance of transfer pricing.

Further evidence of the impact of the change in the corporation tax regime can be seen in Table 1, which gives an estimated breakdown of the yield from corporation tax from various sectors of the economy since 1994. The table shows that in spite of the reduction in the tax rate over the period, tax revenue from companies in the business and financial services sector (other than IFSC companies) accounted for 29 per cent of the total corporation tax yield in 2005, compared to 20 per cent in 1994, in spite of the reduction in the tax rate.

These changes to the corporation tax regime have coincided with major changes in the structure of the Irish economy. Between 1980 and 2000 the manufacturing sector grew dramatically in size and importance so that by 2000 industrial exports accounted for just under three quarters of all exports and gross industrial output amounted to 85 per cent of the value of GNP. Gorg and Ruane (1999) report that Ireland's share of US FDI increased considerably since 1983, reaching a peak in 1994 with Ireland's share, measured as a percentage of GDP, being more than seven times the average for the EU. The low rate of corporation tax attracted highly profitable firms to Ireland and also incentivised multinational firms to channel as much of their profits as legitimately possible through their Irish operations. This is evidenced by a very high

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[3] This excludes activity in the IFSC which had benefited from the low rate of tax since 1989.

[4] A higher corporation tax rate of 25 per cent has been applied to passive income, income from a foreign trade, also since 2003.

[5] Due to the absence of more refined national accounts data the figure for profits used here includes self-employed earnings but excludes income from rent.

profit rate in the manufacturing sector in recent years (Honohan et al, 1998). This issue is discussed further in Section 3.

Table 1 about here

Although the statutory corporation tax rate is higher now than in the past for many manufacturing firms (12.5 per cent versus 10 per cent since 1980 or zero for some exporters up to 1980), it is still low by international standards and undoubtedly has played a role in Ireland's relative success at attracting inward FDI. Honohan and Walsh (2002) include Ireland's low corporation tax rates as an important feature of Ireland's long standing and enthusiastic encouragement of inward FDI. Ruane and Ugur (2005) refer to the neutralising of sectoral biases in the corporate tax system as a landmark event in Ireland's growth phase since the early 1980s. Leddin and Walsh (2003) argue that the low corporate tax rate acted as a powerful magnet for foreign investment.

3 Previous Research

Changes in corporation tax policy generate both real and financial responses. The real responses include the effect of taxation on investment, output, employment and growth while the financial responses include the impact of taxation on profits and transfer pricing. This paper reviews the relevant elements of an extensive empirical literature on how taxation of companies can affect these variables. In this section we examine some of the literature on the macroeconomic impact of changes in the corporation tax rate, initially focusing on the real macroeconomic effects before outlining some of the evidence on the likely financial responses.

The purpose of this paper is to examine the macroeconomic impact of changing the corporation tax rate. As noted, one of the key channels through which the corporation tax rate is likely to affect the economy is through its impact on the level of FDI and there is a considerable empirical literature which addresses this topic, particularly in the context of investment in the US and investment abroad by US firms. More recent studies of this type, such as that by Deloitte (1996), have confirmed the conclusions of earlier surveys that, while tax policy is a factor in the foreign investment decision of multinationals, it is only one of a number of considerations which influence their decision.

The literature also contains studies based on time-series econometric evidence of the impact of corporate tax policy on FDI. Hartman (1984) examined the effect of taxation on inward foreign direct investment to the US using the average tax rate, which captures the impact of tax on total profits. Hartman's results show a positive correlation between both the after-tax rate of return realised by foreign investors in the US and the ratio of FDI to US GNP. Boskin and Gale (1987) using a larger sample and updated average tax rates and rates of return series conclude that Hartman's results on the effect of taxes on FDI are robust, i.e., that the tax rate effects on the international location of investment are important.

Devereux and Griffith (2003) have examined the impact of tax on investment using the effective average tax rate. They find strong evidence that the effective average - but not marginal - tax rate is a significant variable in determining location of investment. While the magnitude of the effect varies between countries, a one percentage point fall in the effective average tax rate in the UK would increase the probability of a US firm choosing to locate in the UK by 1 per cent.

Hines (2003) tests the hypothesis as to whether lower tax rates could be expected to promote higher foreign direct investment in the context of both the EU generally and Ireland in particular[6]. For Europe, Hines reports that, after controlling for country size and wealth, European countries receive significantly more foreign investment from the US than do other countries. Hines reports that Ireland's corporate tax rate in 1999 was well below the rate predicted by his model taking into account Ireland's population, income and European Union membership.

These studies provide evidence that taxes affect firms' investment and location decisions, although there is uncertainty as to the magnitude of this effect. Thus while low taxes are not the sole reason for the large volume of FDI in Ireland, it is reasonable to expect that more foreign direct investment has come to Ireland than would have been the case in the absence of the favourable tax climate.

Given this evidence from the literature, we would expect *a priori* the reduction in the corporation tax rate applying to the business and financial services sector in Ireland to have a positive impact on economic activity. The evidence presented in Section 2 provides some tentative support for this hypothesis, which is tested formally in Sections 6 and 7 of this paper.

Given the positive impact of FDI on growth, it is likely that countries will wish to act strategically to attract inward investment. Recent research also suggests that countries have increasingly competed with each other to attract inward flows of capital by reducing their tax rates on corporate profits and that, as a result, there is likely to be a degree of convergence between corporate tax rates across countries.

Devereux et al (2008) have examined whether tax competition has given rise to convergence in tax rates. They observe that the average rate of corporation tax amongst OECD countries in the early 1980's was nearly 50 per cent. By 2001 this had fallen to less than 35 per cent. They develop a theoretical model with two forms of tax competition: over statutory tax rates for mobile profit and over effective marginal tax rates (EMTRs) for capital. Using their theoretical model Devereux et al found strategic interaction (competition) between countries in both forms of tax rate, but especially in the statutory rate. They conclude that the relaxation of capital controls has led to more intense competitive pressure which has driven down equilibrium corporate tax rates and given rise to a degree of convergence in corporation tax rates in different countries.

This would imply that the initial benefits to Ireland from reducing its corporation tax rate are likely to be eroded over time as other countries reduce their corporation tax rates towards Irish levels.

In addition to its impact on real economic variables, such as investment and economic growth, there is also evidence in the literature that changes in the corporation tax rate can give rise to significant financial responses. A number of authors have noted that, in addition to the impact on investment and economic growth, another important factor in considering the impact of taxation on international investment patterns is the ability of multinational firms to adjust the reported location of their taxable profits (Hines et al, 1994). There are two main ways in which multinationals can shift profits

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[6] Hines (2003) also looks at the determinants of statutory tax rates in a large sample of countries and finds that Ireland's 24 per cent statutory corporate tax rate in 1999 was considerably below the 33 per cent rate predicted on the basis of its population, income and European Union membership.

from high tax countries to low tax countries: through the financing structure of affiliates and through the prices that are used for intra-firm international trade in goods and services. The empirical literature suggests that both channels are important vehicles for profit shifting (Bartelsman and Beetsma, 2003). A low corporation tax regime, such as exists in Ireland, offers multinational companies an incentive to engage in transfer pricing. Transfer pricing entails the invoicing of a company's purchases from other branches of the parent company at prices lower than would arise in the case of arm's length trades, and the invoicing of its sales to other branches of the parent company at prices higher than would otherwise arise (Barry, 2002).

A number of authors have provided evidence suggestive of tax-motivated transfer pricing. Grupert and Mutti (1991) find that high tax rates reduce the reported after-tax profitability of local operations. Hines and Rice (1994) also find that the profits of foreign affiliates are sensitive to corporate tax rates. Clausing (2003) finds that intrafirm trade balances of US parents with their foreign affiliates improve when foreign effective tax rates increase, which is suggestive of pricing practices that move taxable profits out of high-tax jurisdictions.

There is evidence that the low profits tax available to activities located in Ireland acts as an incentive for foreign firms to locate their high profitability activities in their Irish operations. In a study on invisible entrepôt activity in Irish manufacturing, Honohan et al. (1998) identified four sub-sectors that remit unusually large profits out of Ireland. These sectors together accounted for over one-third of gross manufacturing output in Ireland in 1995. Honohan et al. attribute the explanation for this invisible entrepôt activity to the use of transfer pricing and other forms of tax planning behaviour by Multinational Corporations (MNCs) who use the favourable Irish tax regime to lower their worldwide tax liabilities. By 2005, almost 90 per cent of all profits made in Ireland in the manufacturing sector were repatriated abroad, this translated into over 15 per cent of GDP in that year.[7] The increase in the share of profits in value added in the business and financial services sector illustrated in Figure 3 indicates that the use of transfer pricing practices may not be exclusive to firms in the manufacturing sector in Ireland. Lane and Ruane (2006) note that the corporation tax paid by the foreign-owned multinational sector in 2002 corresponded to 55.8 per cent of total corporation tax revenue and 9.4 per cent of total tax revenue in that year.

Thus in addition to the impact on investment and output, the literature indicates that changing the corporation tax rate can have a significant impact on profits and therefore government revenue. This is an important consideration in modelling the impact of the fall in the corporation tax rate in Ireland and is discussed further in later Sections of this paper.

In the light of this evidence of the likely impact of corporate taxation on investment, growth and transfer pricing, Section 5 examines the role that changes in the corporation tax rate have played in the development of the business and financial services sector in Ireland and, more widely, in the changing structure of the Irish economy.

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[7] It is precisely because of the magnitude of these repatriations that it has become customary in Ireland to use GNP rather than GDP as a measure of production.

4 Modelling the Business and Financial Services Sector

A change in the corporation tax rate will impact on the Irish economy through a number of different channels. Firstly, the reduction in the cost of capital will make Ireland a more attractive location in which to produce, raising the output of Irish firms and of foreign firms locating in Ireland. To the extent that the increased output and related profitability accrues to foreign owned firms some of the after tax profits will flow back out of Ireland to the foreign owners as profit repatriations. While the increase in output will produce more tax revenue, the reduction in the tax rate on existing business will tend to reduce revenue. The net effect on revenue will depend on the sensitivity of output to the change in tax rate. Finally, the reduction in the tax rate may give rise to transfer pricing and higher measured profitability of activity in Ireland, resulting in an increase in revenue from the enhanced profits located in Ireland.

We develop a model below of the business and financial services sector that can take account of these different factors to arrive at an estimate of the final impact on output and tax revenue in Ireland of changes in the rate of corporation tax. The next Section uses this model to estimate the impact on output and tax revenue of the tax change that occurred between 1994 and 2003.

The data used in the estimation and simulation of our empirical model come from a number of sources. The data on exports of services, Irish wage rates, the level and price of output in the business and financial services sector and profits all come from the Central Statistics Office (CSO) National Income and Expenditure accounts and additional material supplied by the CSO. Data on US GDP and UK wage rates come from the OECD statistical compendium. Data on the rate of corporation tax are obtained from the Irish Revenue Commissioners. The detailed estimation results and econometric tests from the estimation of the model are shown in Appendix 1.

This model does not take account of the multiplier effects of a change in output and incomes in the business and financial sector on the rest of the economy nor can it take account of the need to replace any net change in tax revenue by compensating changes in other taxes. It also does not take account of the wider labour market effects of changes in employment in the sector. To take account of these wider effects the model of the business and financial sector is embedded in the HERMES model of the Irish economy (Bradley et al., 1993 and Bergin *et al.*, 2003). The results from using this extended model are described in Section 6.

In this paper we concentrate on the long run equilibrium representation of the model rather than its short-run dynamics. Unless otherwise specified the equations are estimated using data for the period 1970 to 2005. Three of the six stochastic equations are specified below in long-run form with an error correction model (ECM) determining its short-run values. However, in simulating the model we concentrate on its long run equilibrium properties. Further details on the econometric testing of the estimated equations 1-5 are also given in Appendix 1, including details of the ECM models.

As discussed in Section 3, it is possible to distinguish between real and financial responses to changes in tax policy. Tax policy affects the macro economy through its impact on output and exports and also through its impact profits and transfer pricing. In deciding on the specification of our model of the business and financial services

sector it was necessary to distinguish between these real and financial responses to the change in the corporation tax rate in Ireland.

The first three behavioural equations in our model are used to estimate the real responses to the tax change of exports, output and employment in the business and financial services sector. The remaining two behavioural equations are used to capture the financial responses of profits and transfer pricing to the policy change.

The model of the full services sector was first outlined in Bradley, Fitz Gerald and Kearney (1991). In the earlier version of the services model output in the business and financial services sector was determined by a suitably weighted measure of final demand reflecting the fact that domestic demand was the key mechanism driving the sector. Because the business and financial services sector is now a major exporter[8] and subject to competition from outside Ireland the latest specification of the business and financial services sector mirrors that of the manufacturing sector with Irish output of business and financial services being sensitive to world demand and Ireland's competitiveness broadly defined.

The internationalisation of business services means that the sector is now exposed to world trade, which is a key driver of exports. In the first equation Ireland's exports of business and financial services, X_s, are driven by world activity, Q_w. In our model, we use US GDP as a proxy for world activity[9]..

The creation of the single EU market for financial services was important to the development of the sector in Ireland as it allowed firms to gain access to a new market place for cross border financial products. The second explanatory variable is a dummy variable D which is given a value of zero up to 1989 and one thereafter. This dummy variable is designed to capture the impact of the completion of the EU single market, which removed many non-tariff barriers between member counties and abolished capital controls, on Ireland's exports of business services.

Given the extreme openness of the Irish economy and the high proportion of services exports in total exports, we include as our third explanatory variable Irish wage rates, W_i, relative to those in the UK, W_u, as a measure of Irish cost competitiveness[10]. Any gain in competitiveness results in an increase in output and market share. Any loss of competitiveness reverses this process.

The final explanatory variable in equation 1 is the rate of corporation tax, t. This variable is included in the model to measure the impact of the reduction in Ireland's rate of corporation tax affecting the sector on the level of activity in the business and financial services sector.

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[8] In 2007, exports of business and financial services accounted for almost 40 per cent of total exports, up from 20 per cent in 2000.

[9] A number of alternative variables which could be considered as reasonable proxies for world activity were experimented with in the model, including OECD and Euro area GDP. However none of these alternatives proved significant

[10] A number of alternative specifications were tested including Irish wage rates relative to those in Germany, however none of these proved significant in estimation.

The T statistics are shown below in parenthesis.

$$\log(X_s) = 14.6 + 3.80 \log(Q_w) + 0.92 d \cdot \log(Q_w) - 1.29 \log\left(\frac{w_i}{w_u}\right) - 2.21 t \tag{1}$$

$$\qquad\quad (21.8)\ (15.3) \qquad\quad (4.9) \qquad\qquad (5.7) \qquad\quad (4.9)$$

$$\bar{R}^2 = \quad 0.9930 \qquad \text{S.E.} = 0.1080 \qquad \text{Estimation period: 1970-2005}$$

Exports of business and financial services, X_s, are very sensitive to the growth in world output, as shown by the high elasticity with respect to world activity in equation 1. As reflected in the value of the coefficient on the dummy variable, d, the completion of the EU internal market resulted in a significantly higher elasticity of services exports relative to world activity since 1989. This EU policy change was important for Ireland as it freed up trade in services within the European Union. The estimated elasticity of business and financial services exports with respect to world activity implied by this equation is between 3.8 and 4.7. The elasticity with respect to domestic wage rates is -1.3 indicating that the international competitiveness of the sector is important.

The coefficient on the corporate tax rate is highly significant, with the expected negative sign. This implies that the reduction in the corporate tax rate from 40 per cent in 1994 to 12.5 per cent in 2003 accounted for an increase in exports of services of over 60 per cent. With the share of services that are traded rising very rapidly, especially within the EU (indicated by the elasticity with respect to world activity), the fall in the corporate tax rate had a very big impact on Irish trade.

$$Q_i = 4627.7 + 0.23 X_s + 0.93 D \tag{2}$$

$$\qquad\quad (4.2) \quad\ \ (8.1) \qquad (5.2)$$

$$\bar{R}^2 = \quad .9971 \qquad \text{S.E.} = 552.64 \qquad \text{Estimation period: 1985-2005}$$

In the second behavioural equation in the model the desired level of output in Ireland in the business and financial sector, Q_i, is a function of exports of business and financial services, X_s, and domestic demand weighted by input-output coefficients, D, (McCarthy, 2005). The weights on the components of domestic demand reflect the business and financial services content of consumption. This equation is included in the model to determine the effect of the reduction in the tax rate on output in the business and financial services sector. When simulated as a model these two equations (1 and 2) suggest an elasticity of output in the business and financial sector with respect to world activity of 1.16. While firms producing in the sector for the domestic market are not greatly affected by Ireland's competitiveness relative to the outside world, as reflected in equation 1 competitiveness does affect exports and, hence, the output of the sector.

The third behavioural equation in the model determines employment in the business and financial services sector. Together equations 1-3 determining exports, output and employment in the business and financial services sector are used to estimate the real response of the economy to the change in the tax rate. Employment in business and financial services L, is defined as a function of wage rates in the sector, w_i, relative to wage rates abroad (the UK), the level of output from the sector Q_s and time. As in equation 1, the relative wage rate term is used as a measure of Irish competitiveness,

which together with the level of output determines employment in the sector. In the long run employment is quite sensitive to the real wage. The elasticity of employment with respect to output is 0.65. Similar to equations (1) and (2), this equation is specified in long-run form. Again, the result of the ADF test applied to the residuals from equation (3) validates the use of the ECM (appendix 1).

$$\log(L) = -35.2 - 0.51\log\left(\frac{w_i}{w_u}\right) + 0.65\log(Q_s) + .02(time) \qquad (3)$$

$$(-5.3) \quad (-7.4) \qquad\qquad (8.6) \qquad (4.8)$$

$\bar{R}^2 = .993$ S.E.=(.0354) Estimation period: 1970-2005

The remaining behavioural equations in our model are concerned with estimating the financial responses to the change in the corporate tax rate. The evidence discussed in Section 3 indicated that corporate taxation can significantly influence transfer pricing behaviour, profitability and hence government revenue. To capture these effects we estimate two equations determining profit repatriations and the profit rate in the business and financial services sector. As shown in equation 4, profit repatriations (Y) are a function of profits in the high tech manufacturing sector (Π_m), which are here treated as exogenous, profits in the business and financial sector (Π_s) and a time trend, t. (Here the profits of the sector have been adjusted to exclude imputed rent, R.) This accounting relation assumes instantaneous adjustment and is, therefore, expressed as a short run equation in the model. This specification is chosen as it reflects the heavy concentration of foreign firms in both sectors and the high propensity of such firms to export large proportions of their total profits as outlined in Section 3. The estimation results are shown below. The equation suggests that over 90 per cent of the profits in the high tech manufacturing sector are repatriated abroad. This is consistent with the fact that 82 per cent of gross output in manufacturing in 2005 came from foreign owned firms and also accords with the findings of Honohan et al. (1998) discussed in section 3.[11] The coefficient on profits in the business and financial sector at 0.48 implies that, at the margin, almost half of the profits arising in the sector are repatriated abroad.[12] The equation is adjusted for autocorrelation.

$$Y = 406316.9 + 0.92\Pi_m + 0.48\Pi_s - 204.7(time) \qquad \rho = -0.65 \qquad (4)$$

$$(3.3) \qquad (30.7) \qquad (18.2) \qquad (-3.3) \qquad\qquad (-2.8)$$

$\bar{R}^2 = .998$ S.E.=347.65 Estimation period: 1990-2005

Figure 3 identified a sharp rise in the profit rate in the financial sector which coincided with the reduction in the tax rate. The final behavioural equation in the model, 5, explains the profit rate in the business and financial services sector as a function of the wage rate in Ireland relative to that in the UK (in a common currency) and of the tax rate. This specification implies that the price deflator for output in the sector (P_s) is set as a mark-up on labour costs. The output (value added) in the sector in current prices is obtained by multiplying the volume of output Q_s by the deflator P_s.

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[11] CSO, *Census of Industrial Production, 2005*. Dublin: The Stationery Office.

[12] This is broadly consistent with disaggregated data from the CSO which indicates that Irish banks' profit share of value added in the financial intermediation sector was around 50 per cent in 2005.

When wage rates in Ireland rise relative to Ireland's competitors (proxied by the UK) this has a negative effect on the profit rate. The inclusion of the rate of corporation tax is designed to capture the increase in the attraction for transfer pricing with the fall in the tax rate (relative to competitor countries). This reflects the pattern of behaviour manifested in Figure 3, which applies particularly to the financial sector.

$$\frac{\Pi_s}{Q_s.P_s} = 0.92 - 0.073\left(\frac{w_i}{w_u}\right) - 0.249t \qquad \rho = -0.65 \qquad (5)$$

$$\qquad\qquad (11.1) \qquad (-2.9) \qquad (-7.5) \qquad\qquad (3.1)$$

$$\bar{R}^2 = .83 \qquad\qquad S.E.=.012 \qquad\qquad \text{Estimation Period: 1970-2005}$$

This equation has been adjusted for autocorrelation. The coefficient on the tax rate is well determined. It suggests that the rate of profit in the business and financial sector rose as a result of the tax change between 1994 and 2003 by almost 7 percentage points[13]. Much of this change in the before tax rate of return was probably due to the enhanced scope for transfer pricing, especially within the financial sector.

The 5 behavioural equations above are used in the model to estimate the real and financial responses to the change in the tax rate. We define a number of identities in order to close our model:

$$\Pi_s = Q_s P_s - w_i L \qquad (6)$$

Equation 6 determines the profits of the sectors as the residual when the wage bill is subtracted from the value added in the sector.

$$GNP = Q_s - \frac{Y}{P_y} - F \qquad (7)$$

Equation 7 determines the volume of GNP as the sum of the volume of value added arising in the business and financial sector, Q_s, less the value of profit repatriations deflated by the appropriate deflator, p_y, and the sum of the other components of GDP, F. Ultimately this is the welfare measure which is used to estimate the extent of the positive (or negative) impact on the economy of changes in the rate of corporation tax.

$$\bar{t} = w_1 t' + w_2 t \qquad (8)$$

The average effective marginal rate of corporation tax in the sector, $\bar{t}$, is the weighted average of the special rate which applied to the International Financial Services Sector (IFSC) from the end of the 1980s, t', and the standard rate of corporation tax, t, which applied to the bulk of the sector, which was reduced after 1994. The weights are derived from the data in Table 1.

$$C = a + \bar{t}\left(\Pi_s - R\right) \qquad (9)$$

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[13] This is derived by multiplying 27.5 (the amount of the fall in the tax rate) by the coefficient on the tax rate in equation 5 .249, which equals 6.8%.

Corporation tax paid by the sector, C, is equal to the weighted average tax rate, $\bar{t}$, multiplied by the profits in the sector less rents.[14] Income from rent R (including imputed rent) is generally not chargeable to corporation tax. The variable *a* captures the effects of capital allowances etc. and of the fact that the income of the self-employed in the sector (included in profits) is also not chargeable to corporation tax.

$$\log(p_y) = a_1 \log(p_p) + a_2 \log(p_s)$$ (10)

The deflator for profit repatriations, p_y, is a weighted average of the deflator for profit repatriations from manufacturing[15], p_p, and the deflator for value added in the business and financial services sector, where the weights are derived from the equation determining profit repatriations (4) above.

5 Simulation Results – Business and Financial Sector

Using the model set out in the previous Section we can estimate the impact of the change in corporation tax on the economy. Here we consider the direct impact on the business and financial services sector. As discussed earlier, this simulation does not allow for government action to offset any net change in corporate tax revenue and it takes no account of the knock-on effects of changes in this sector on the wider economy, such as its effect on wage inflation and on the level of demand for the output of sectors other than the business and financial sector. The first simulation thus provides a lower bound estimate of the impact of the reduction in the corporation tax rate. The results for this model of the business and financial services sector are set out in the first column of Table 2. In order to capture the wider macroeconomic effects, the model of the business and financial services sector is embedded in the HERMES macro-economic model. This modified macro-economic model is used in Section 6 to look at the economy-wide effects and these are set out in the second column of Table 2.

Table 2 about here

We consider only the long-term impact of the change in tax rates using the long run formulation of the model set out above. For 2005 we simulate the model holding the corporation tax rate unchanged at the 1994 level of 40 per cent. We can then simulate the model for 2005 with the historic value for the rate of corporation tax of 12.5 per cent. By comparing the results from the two simulations, we can estimate the impact of the fall in the corporation tax rate on the business and financial services sector. The long run equilibrium effects from the simulation of the model are shown in Table 2 using data for 2005

The first column of Table 2 indicates that the reduction in the corporation tax rate from 40 per cent in 1993 to 12.5 per cent had a significant long-run impact on exports of business and financial services. By 2005 they were 84 per cent higher than they would have been without this change. As a result of this increase in exports the output of the business and financial services sector was 13 per cent higher in real terms. The impact on employment in the sector was somewhat lower at 8 per cent. However, this

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[14] In the national accounts rents are included in the sector. Without an appropriate volume series it is not possible to purge them from the data used here.

[15] Here taken to be the standard national accounts deflator for net factor income.

does not take account of any wider labour market effects, especially on wage rates and consumption. This latter issue is dealt with in the next Section where a full macro-economic model is used.

In addition to the increase in output in the sector, the change in tax rates encouraged some relocation of profits to Ireland so that the deflator for output in the sector rose by 14.5 per cent, reflecting the higher profit rate. The effect of this increase in the deflator, combined with the increase in output, was to raise profits (excluding rent) by 63 per cent. The profit rate[16] in the sector (excluding rent) rose from 49 per cent to 60 percentage points of value added. This is a measure of the effect of transfer pricing, which is additional to the wider output effect.

When account was taken of the profit repatriations by foreign firms, the addition to GNP from the increased output in the sector amounted to around 2.5 percentage points of GNP.[17] The profit repatriations offset about a quarter of the volume increase in the output of the sector.

Corporation tax revenue from the sector is affected through three different channels. The reduction in the tax rate saw a substantial reduction in tax revenue from the existing activity in the sector. The increase in output arising from the lower tax rates generated additional profits and hence corporation tax revenue, which partly offset the loss from existing activity. In addition, the exploitation of the opportunities for transfer pricing also enhanced tax revenue. When taken together these effects resulted in a net reduction in corporation tax revenue from the sector of almost €1.5 billion in 2005, or 1.2 per cent of GNP.

If the profit rate had remained unchanged (i.e. there had been no change in transfer pricing) the loss of tax revenue would have been just under €3.5 billion or 2.7 per cent of GNP. Thus transfer pricing accounted for an increase in revenue from corporation tax in Ireland of around €2 billion as a result of a relocation to Ireland of around €6.3 billion in profits. Transfer pricing was, thus, important in offsetting much of the cost of the tax reduction in the business and financial services sector.

When considering the business and financial services sector on its own it is not possible to reach conclusions about the overall macro-economic impact of the tax change. These results indicate that the stimulatory effects of the change in the tax rate on output and employment in the business and financial services sector must be balanced against the significant loss of revenue to the government.

6 Full macro-economic impact

The *HERMES* macroeconomic model of the Irish economy was originally developed as part of an EU-wide system of macro-econometric models. This set of models was specifically designed to deal with supply side issues (CEC, 1993). Since it was first developed in the late 1980s the Irish version of the *HERMES* model has been extensively modified to deal with the special characteristics of the Irish economy. An outline of the latest version of the model is given in Bergin *et al.,* 2003.

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[16] Here defined as profits as a share of value added at current prices.

[17] To the extent that the profit repatriations arise from increased transfer pricing, showing up as an increase in the market services deflator, they are assumed to have no impact on the "volume" of profit repatriations included in the national accounts aggregate "net factor income from abroad".

The manufacturing sector of the *HERMES* model is described in Bradley, FitzGerald and Kearney, 1993, and it shows that the output of the manufacturing sector is sensitive to Ireland's external competitiveness. The *HERMES* model of the Irish economy also incorporates a labour market where elastic labour supply means that the bulk of the incidence of labour taxes falls on employers (Curtis and FitzGerald, 1994). Thus any increase in labour taxes to compensate for lost revenue from corporation taxes results in an increase in wage rates and a loss of external competitiveness.

The model of the business and financial sector, set out in Section 4, has been embedded in the *HERMES* macro-economic model. This modified version of the macro-economic model is used to look at the full effects of the change in the rate of corporation tax in Ireland. In undertaking this analysis the assumption is made that any loss of revenue from a reduction in corporation tax rates is made good through higher taxes on labour, leaving government borrowing unchanged as a share of GNP.

Two simulations of the *HERMES* model are undertaken in order to clarify the effects on the economy due to the tax change: one simulation with the corporation tax rate held at 40 per cent and one where it is cut to 12.5 per cent. We focus in this section on the direct effect of the change in the corporate tax rate. We abstract from ongoing changes in the Irish economy by simulating the effects of the tax change where the economic structure is held constant at its 2005 level.[18] This allows the isolation of the direct effects of the tax change from other exogenous changes that were taking place in the economy over time. The results from these simulations are shown in column 2 of Table 2.

Consistent with the findings from simulating the business and financial service sector model on its own, the full *HERMES* model indicates that the reduction in the corporation tax rate had a significant positive effect on output in the economy, although the magnitude and composition of the effects differ. In particular, the tightening of the labour market and the assumed funding of the loss of revenue from corporation tax through increased taxes on labour resulted in wage rates being 4.2 per cent higher than in the base. This caused a loss of external competitiveness so that the increase in the volume of services exports was only 74 per cent compared to the 84 per cent increase shown in column one of Table 2. In addition, the loss of competitiveness adversely affected the manufacturing sector, resulting in a loss in output of 2.3 per cent and a loss of employment in that sector of 4.4 per cent. While this reduction in output and employment in the manufacturing sector is far outweighed by the significant rise in activity in the business and financial services sector, these results indicate the existence of a potential "crowding out" effect in the manufacturing sector.

While the loss of competitiveness adversely affected services exports, the multiplier effects of the increased output and incomes in the economy resulted in an increase in demand for the output of the business and financial services sector (and of other sectors in the economy). In the long run its output was raised by 15 per cent above the base (of no change in corporation tax rates) with an increase in employment of over 7 per cent. This is a bigger increase than was suggested by the services sector model indicating that the positive impact of increased domestic demand more than offset the

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[18] This is implemented by replicating the exact values of the exogenous variables from 2005 for each of the subsequent twenty years. When the model is simulated the economy stabilises at a fairly unchanging level of output and prices.

limited reduction in exports of services (compared to the case where wage rates were unchanged).

Even when the loss of output in the manufacturing sector is taken into account, the reduction in corporation tax rates is estimated to have increased the level of GNP in 2005 by over 3.7 per cent compared to the base case. Over the previous decade (1995-2005), since the reduction in corporation tax rates in the services sector began, the level of GNP in Ireland rose by 87 per cent. Thus, while the increase in output arising from the change in corporation tax regime was significant, it was not the main factor driving increased output in Ireland over that period.

7 Conclusion

In this paper, we examine the macroeconomic impact of the fall in the corporation tax rate applying to the business and financial services sector. We first build and estimate a sub-model of the sector and use it to examine the direct effect of the change in the tax rate on output and tax revenue. The results from the estimation of the sub-model of the business and financial services sector indicate that the fall in the tax rate had a significant positive long-run impact on the sector. By 2005, the level of exports and output from the sector were substantially higher than they would have been in the absence of any change in the corporation tax rate. The reduction in the tax rate made Ireland a more attractive location for high profit companies, as evidenced by the increase in the profit rate in the sector. The reduction in the tax rate also saw a substantial reduction in tax revenue from the existing activity in the sector. Without the increase in transfer pricing which accompanied the fall in the tax rate, the extent of the loss in tax revenue would have been much more severe.

This sub-model does not take account of the multiplier effects of this change in output, employment and incomes in the business and financial services sector on the rest of the economy. It also does not take into account the need to replace any net change in corporate tax revenue by compensating changes in other taxes, and the wider labour market effects of such changes. In order to obtain an estimate of the wider effects of the change in the tax rate, the model of the business and financial services sector is embedded into the *HERMES* model of the Irish economy. We then determine the full long-run effects of the tax change on the assumption that any loss of tax revenue from corporation taxes was made good by a change in taxes on labour.

The results from the simulation of the modified *HERMES* model indicate that the substantial loss of tax revenue, consequent on the tax change, required significantly higher taxes, here assumed to be taxes on labour. This rise in the tax on labour caused wage rates to increase. In turn this offset some of the positive effects of the reduction in corporation tax rates on Ireland's external competitiveness. Nonetheless the change in the corporate tax regime is estimated to have added around 3.7 per cent to the level of GNP by 2005.

In the literature discussed Section 3, there has been much debate about the effects of the tax regime in low tax rate countries on other countries with higher tax rates. In this context it is interesting to consider the effects of the tax change on transfer pricing and corporation tax revenue in Ireland. The results in this paper suggest that in 2005 around €6.3 billion in profits were relocated to Ireland through transfer pricing. These profits accounted for an increase in corporation tax revenue in Ireland of around €2 billion compared to what would otherwise have been the case. This gain in revenue in Ireland was about five per cent of the revenue from corporation tax in either Germany

or the UK in 2005. At the tax rates applying in Germany, the UK or the other countries affected by the change, the loss of revenue would have been more than twice as great as the gain in Ireland.[19] However, the loss of corporation tax revenue through the relocation of profits to Ireland was spread over quite a number of other countries so that it is unlikely that the change in Irish tax policy on its own would have warranted strategic action to cut tax rates elsewhere as Devereux, Lockwood and Redoanao (2008) suggest. Nonetheless the effects on tax revenue were likely to be quite noticeable in some key countries affected by the Irish tax change.

Acknowledgements

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[19] At the tax rates applying in Germany, the UK or the other countries affected by the change, the loss of revenue would have been more than twice as great. However, the Irish tax base is much wider than average so that the tax revenue lost in the origin countries would while substantially higher, would not have been as great as would be suggested by the difference in the formal corporate tax rates.

Appendix 1

In this Appendix we set out the results of the econometric tests from the estimation of the model of the business and financial services sector developed in Section 4. Three of the five stochastic equations in our model are specified in long-run form with an error correction model (ECM) determining their short-run values. According to the Engel Granger representation theorem, if two variables Y and X are cointegrated then the relationship between them can be expressed as an ECM (Gujarati, 2003). Thus in order to validate the expression of equations 1, 2 and 3 in our model as ECM's, it is necessary to first test for cointegration.

Here we use the Augmented Engel Granger (AEG) method to test for cointegration. This involves applying the Augmented Dickey Fuller unit root test to the residuals from the estimation of the long-run equations. In this case, rejection of the null hypothesis of a unit root indicates that the residuals are stationary and therefore that the equation in question can be expressed as a cointegrating regression.

One precaution should be noted in using this method, however. Since these residuals are estimates of the disturbance term, the distribution of the test statistic differs from the one for an ordinary data series. This means that the standard critical values reported by several econometrics packages, which are valid for unit root tests of a data series, are invalid when the series is based on estimated values. Davidson and MacKinnon (1993) have provided a set of asymptotic correct critical values for unit root tests based on estimated residuals. Seddighi et al (2000) report a subset of critical values based on Davidson and MacKinnon for various sample sizes up to 100 and these are the critical values used here.

The decision criteria for the AEG method are as follows. If the absolute value of the ADF test exceeds the critical value, we reject the null hypothesis of a unit root. This indicates that the residuals from the regression are stationary and therefore signifies the existence of a cointegrating relationship. The three equations specified in long-run form in our model are the equations for exports of business and financial services, output of business and financial services and employment. The results of the ADF tests applied to the residuals from the estimation of these three equations are shown in Tables A1.1-A1.3.

Table A1.1: Results of Unit Root Tests on Residuals from long-run Equations

Residuals from Equation:	**t - Statistic from ADF test**	**Critical Values**
Exports of services (X_s)	-5.17	-4.56
Output of services (Q_s)	-4.49	-3.59
Employment, services (L_s)	-5.25	-4.56

For each of the 3 equations estimated in long run form, the absolute value of the computed t-statistics from the ADF test on the residuals is greater than the critical value based on Davidson and MacKinnon (1993). This leads to rejection of the null

hypothesis of a unit root indicating that the residuals from the regressions are $I(0)$, i.e. they are stationary. This demonstrates that the variables in the 3 equations are cointegrated and therefore the representation of the relationship between them in our model by an ECM is valid. The estimated ECMs for the 3 equations are shown below. The significance of the coefficient on the ECM term in each equation supports the validity of the long run – short run model although in this paper we focus on the long run relationships. In each case Δ signifies the change in the variable while $^\wedge$ denotes a variable's long run estimated value. The t-statistics are shown in parenthesis.

$$\Delta \log(X_s) = -.71(\log(X_s(-1)) - \log(\hat{X}_s(-1))) \qquad \text{Eq. A.1}$$
$$(-3.26)$$

$R^2 = .81$ 　　　　　　　　 S.E.= .093 　　　　　　 Estimation period: 1990-2005

$$\Delta(Q_i) = 1.45\Delta F - .44(Q_i(-1) - \hat{Q}_i)) \qquad \text{Eq. A.2}$$
$$(9.67) \qquad (-2.44)$$

$R^2 = .96$ 　　　　　　　　 S.E.= .046 　　　　　　 Estimation period: 1971-2005

$$\Delta \log(L) = .59\Delta(Q_i) - .49\Delta \log\left(\frac{w_i}{w_u}\right) - 0.73(\log(L(-1)) - \log(\hat{L}(-1))) \qquad \text{Eq. A.3}$$
$$(3.85) \qquad (-5.76) \qquad (4.20)$$

$R^2 = .77$ 　　　　　　　　 S.E.= .027 　　　　　　 Estimation period: 1971-2005

The equations in the model are tested for the presence of autocorrelation using the Durbin-Watson (DW) test. The results of the test for equations A.4 and A.5 are shown in Table A1.2.

Table A1.2: Results of Tests for Autocorrelation in OLS residuals

Equation	Durbin-Watson Statistic	Decision
Profit repatriations A.4	3.21	Negative autocorrelation
Profit Share A.5	1.06	Positive autocorrelation

The results of the DW test indicate the presence of negative autocorrelation in the equation for profit repatriations and positive autocorrelation in the case of the profit share equation. As a result, equations (4) and (5) in the model are estimated using the Cochrane-Orcutt procedure in order to correct for the problem of autocorrelation in the residuals.

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