Analysis of the dynamic effects of Corporation Tax reductions

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Executive Summary

- Since 2010 the Government has committed to increase the transparency and sophistication of its modelling of the effects of policies. It has published policy costings and distributional impacts for the first time, and in recent Budgets and Autumn Statements has continued to improve the modelling underpinning each.

- As part of this, HMRC has been developing a Computable General Equilibrium (CGE) model, capable of modelling the dynamic macroeconomic effects, and subsequent Exchequer revenue effects of a major policy change.

- The model has been peer reviewed by leading academics in the relevant field, who found that *'The basic design of the HMRC model for the UK economy meets at large the key requirements for state-of-the-art applied tax policy analysis'*. Similar models are used by the Congressional Budget Office in the United States.

- This report shows the results of applying the CGE model to the Corporation Tax reductions announced since 2010. The main rate of Corporation Tax has been reduced from 28 per cent in 2010 to 20 per cent by 2015-16; the biggest percentage points fall in a single parliament since the 1980s. The Small Profits Rate has also been reduced from 21 per cent to 20 per cent. By 2016-17 when all the cuts have been implemented they will constitute savings to business of £7.8bn a year.

- The modelling suggests that the tax reductions will increase investment by between 2.5 per cent and 4.5 per cent in the long term (equivalent to £3.6 billion – £6.2 billion in today's prices) and GDP by between 0.6 per cent and 0.8 per cent (equivalent to £9.6 billion - £12.2 billion). Lower Corporation Tax will also increase the demand for labour which in turn raises wages and increases consumption. Given the share going to labour this equates to between £405 and £515 per household.

- The modelling shows increased profits, wages and consumption all add to higher tax revenues. As a result, the cost of the policy falls by between 45 per cent and 60 per cent in the long term.

- The CGE model is subject to some uncertainty. This is principally around the parameters included, for which sensitivity analysis is carried out. Economic uncertainty, not captured by the model, could also impact on the results in the short term. Nevertheless, the results are broadly consistent with the wider academic literature which finds that reductions in Corporation Tax boost investment leading to higher GDP and partial revenue recovery.

- The CGE model is not a short-term forecasting model. Its strength is in modelling the long-term economic effects of policies rather than short-term economic fluctuations, so it is too early to test the CGE model results against real data. Economic trends since 2011 suggest headwinds to investment are now easing and the recovery is taking hold. As business confidence grows business investment is expected to grow strongly, in line with the academic evidence and modelled results presented in this paper.

Chapter 1 – Introduction

1.1.　Since 2010 the Government has committed to increase the transparency and sophistication of its modelling of the effects of policies. It has published policy costings and distributional impacts for the first time and over recent Budgets and Autumn Statements has continued to improve the modelling underpinning each. Publishing details of HMRC's Computable General Equilibrium (CGE) is another step in this direction.[1]

1.2.　CGE models have been used since the early 1970s to analyse the economic effects of changes in taxation.[2] Governments and institutions such as the World Bank, OECD and IMF, use CGE models in some form. Similar models are used by the Congressional Budget Office in the United States.[3]

1.3.　HMRC's CGE model contains a detailed representation of the UK tax system. It is capable of modelling the dynamic macroeconomic effects, and subsequent Exchequer revenue effects, of major policy changes. The model has been peer-reviewed by leading academics in the relevant field. The peer review concluded that *'CGE models are obviously a prime candidate for the quantitative impact assessment of tax policy reforms. They provide a comprehensive analytical framework to capture direct and indirect tax interaction and revenue recycling effects'*, and that *'The basic design of the HMRC model for the UK economy meets at large the key requirements for state-of-the-art applied tax policy analysis.'* [4]

1.4.　In 2010 the Government published the Corporate Tax Road Map, which stated the Government's ambition to make the UK's Corporation Tax regime the most competitive in the G20.[5] The Road Map aimed to provide certainty to business. It set out a package of policies, including the introduction of a Patent Box and reforms to the UK's Controlled Foreign Company (CFC) rules, which have since been introduced.

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[1] https://www.gov.uk/government/publications/computable-general-equilibrium-cge-modelling

[2] See for example Shoven, J.B., and Whalley, J. 1972. *"A General Equilibrium Calculation of the Effects of Differential Taxation of Income from Capital in the U.S."* Journal of Public Economics

[3] See for example *"Macroeconomic Impacts of Stylized Tax Cuts in an Intertemporal Computable General Equilibrium Model"* - http://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/57xx/doc5741/2004-11.pdf . Also *"Corporate Tax Incidence: Review of General Equilibrium Estimates and Analysis"* - http://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/115xx/doc11519/05-2010-working_paper-corp_tax_incidence-review_of_gen_eq_estimates.pdf

[4] https://www.gov.uk/government/publications/computable-general-equilibrium-cge-modelling

[5] https://www.gov.uk/government/publications/the-corporation-tax-road-map

1.5.   The Road Map set out principles for corporate tax reform, including reducing existing distortions. According to the OECD, Corporation Tax is one of the most distortive taxes.[6] So reducing it should have a greater positive effect on overall economic activity than reducing other taxes. For the same reason there should be a higher recovery of the static cost of the tax, than would be the case with other taxes.

1.6.   In the Road Map the Government said it would reduce the main rate of Corporation Tax from 28 per cent to 24 per cent. Since publication in 2010 the Government has announced a series of further reductions. As of November 2013, the main rate of Corporation Tax has been reduced from 28 per cent to 23 per cent. It will fall further, to 21 per cent in April 2014, and to 20 per cent in April 2015. The Small Profits Rate (SPR), for firms earning profits of less than £300,000 per annum, has also been reduced. In June 2010 the Government reversed a planned increase in the SPR from 21 per cent to 22 per cent, and cut it to 20 per cent. The annual cost to the Exchequer by 2016-17, when all Corporation Tax rate reductions have fully taken effect, will be £7.8 billion.

1.7.   Modelling policy changes in the CGE model is a complex activity, and providing robust analysis requires an in-depth understanding of how the model works. It is not possible to simply run the CGE model for each and every policy option. It is best suited to policies with clear dynamic effects. The Corporation Tax reductions are a good modelling choice, since they are central to the Government's drive to stimulate growth and investment through supply-side reforms. HMRC has therefore used the CGE model to estimate the effects of these reductions, giving a new insight into the long-term effects of this policy on the economy and public finances.

1.8.   The remainder of this report is set out as follows:

*   Chapter 2 compares Corporation Tax in the UK with other major economies, it discusses the methodology used for Government costings of the Corporation Tax reduction;
*   Chapter 3 describes the macroeconomic and fiscal effects of the Corporation Tax reduction, as suggested in theory and supported in academic literature;
*   Chapter 4 shows the CGE modelling results on the effect of a Corporation Tax rate reduction on the economy and public finances;
*   Chapter 5 assesses the implications in short-term economic trends since the initial Corporation Tax cuts were made for growth and investment;
*   Chapter 6 presents conclusions.

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[6] 'Corporate income taxes are the most harmful for growth as they discourage the activities of firms that are most important for growth: investment in capital and productivity improvements.' – *Tax Policy Reform and Economic Growth, page 22* OECD 2010

Chapter 2 – Direct effects of a reduction in Corporation Tax rates

2.1.   This chapter starts by setting out the international context in which the Government Corporation Tax reforms have been taken forward. It then discusses the methodology, certified by the Office for Budget Responsibility (OBR), used to cost the direct effects of a reduction. These costings are an important input into the CGE modelling of the Corporation Tax cut.

A comparison of international Corporation Tax rates

2.2.   As noted in Chapter 1, reducing the rate of Corporation Tax is one of a series of measures the Government has taken to improve the competitiveness of the UK corporate tax regime and to ensure the UK is an attractive location for foreign investment.

2.3.   There has been a downward trend in Corporation Tax rates in many countries over the past three decades. Chart 2.1 illustrates this for OECD countries. Corporate rates have fallen from nearly 50 per cent in the early 1980s to around 25 per cent in recent years. There has not been a reversal of this downward trend in Corporation Tax rates following the financial crisis, despite many advanced economies needing to undertake fiscal consolidations.

2.4.   The UK Corporation Tax rate fell below the OECD average after substantial reductions in the 1980s (although the tax base widened, mainly because of a tightening of capital allowances). From 1999 the UK rate remained unchanged at 30 per cent for almost ten years while rates in the OECD continued to fall. UK rates were reduced from 30 per cent to 28 per cent in 2008. In 2012 the UK rate fell below the OECD average again. Overall, between 2010 and 2015 the UK rate will fall eight percentage points, giving the UK the joint lowest Corporation Tax rate in the G20. (See Chart 2.2).

Chart 2.1. Corporate income tax rates 1981 – 2013
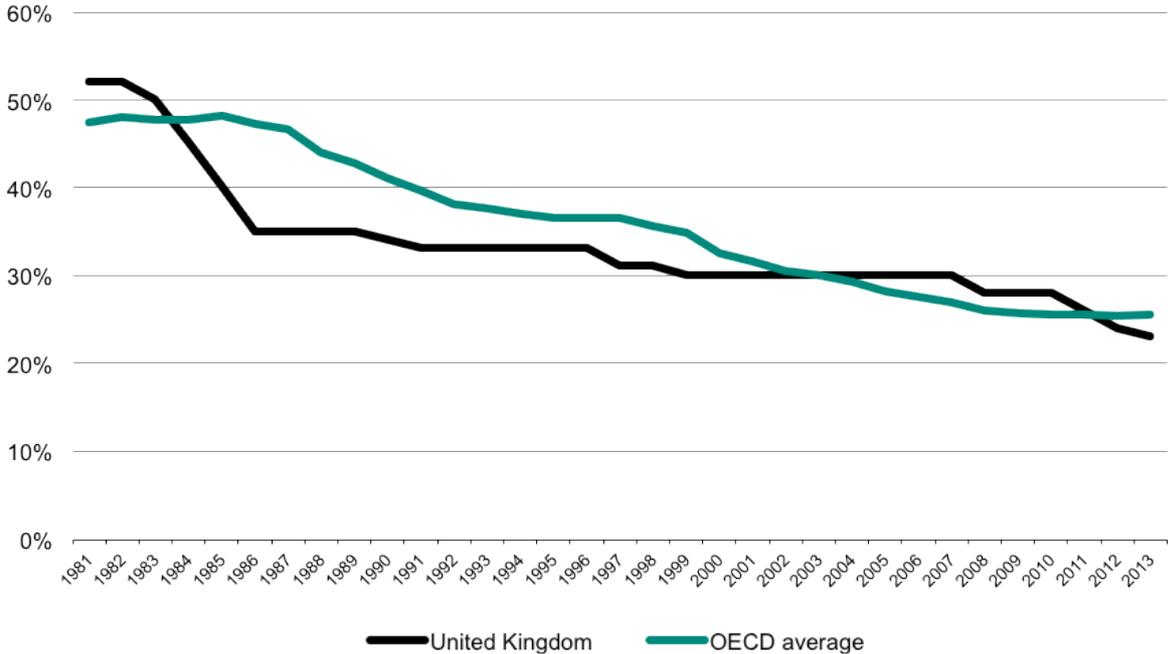
Source: OECD Taxbase

## Chart 2.2. Main corporation tax rates in the G20 (2015 based on announced plans)
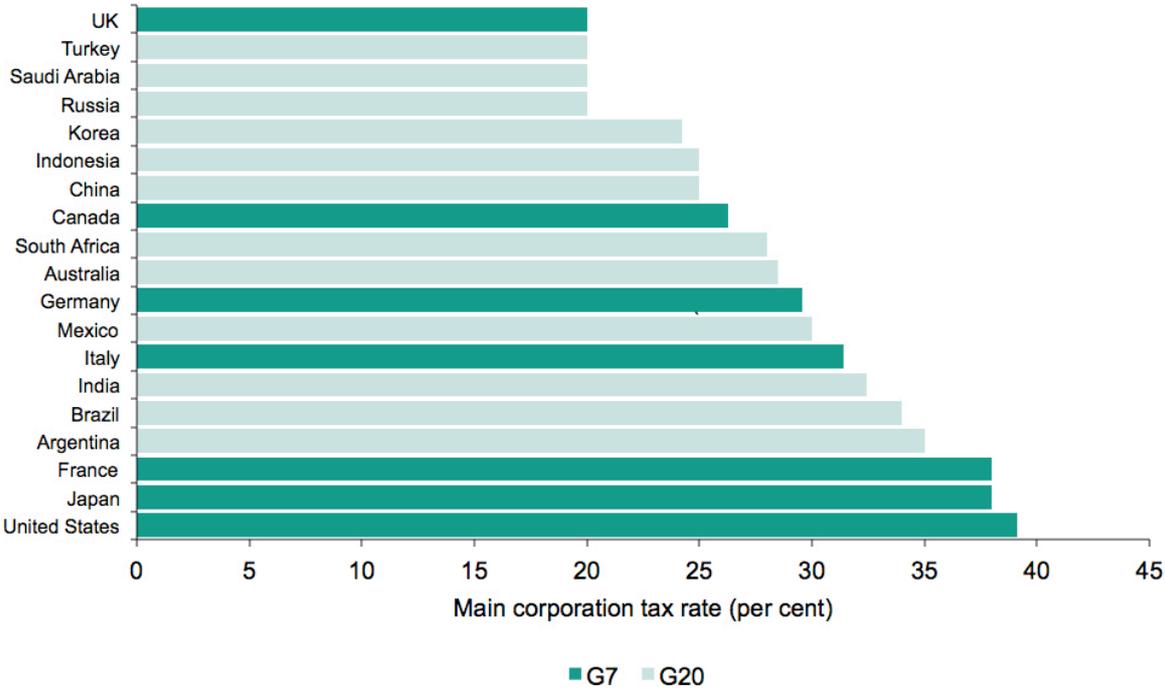
Sources: International Bureau of Fiscal Documentation database, Deloitte Global Tax Rates 2013, KPMG Global Tax Rates 2013, PWC Worldwide Tax Summaries, OECD Tax database

The direct effects of a Corporation Tax reduction

2.5.   Chart 3 shows UK onshore Corporation Tax receipts, net of tax credits, from 1999-2000 to 2011-12, and future receipts from 2012-13 to 2017-18, as projected by the OBR in their Economic and Fiscal Forecast at Budget 2013.

Chart 2.3. Net corporation tax receipts (actual and projected), £billions
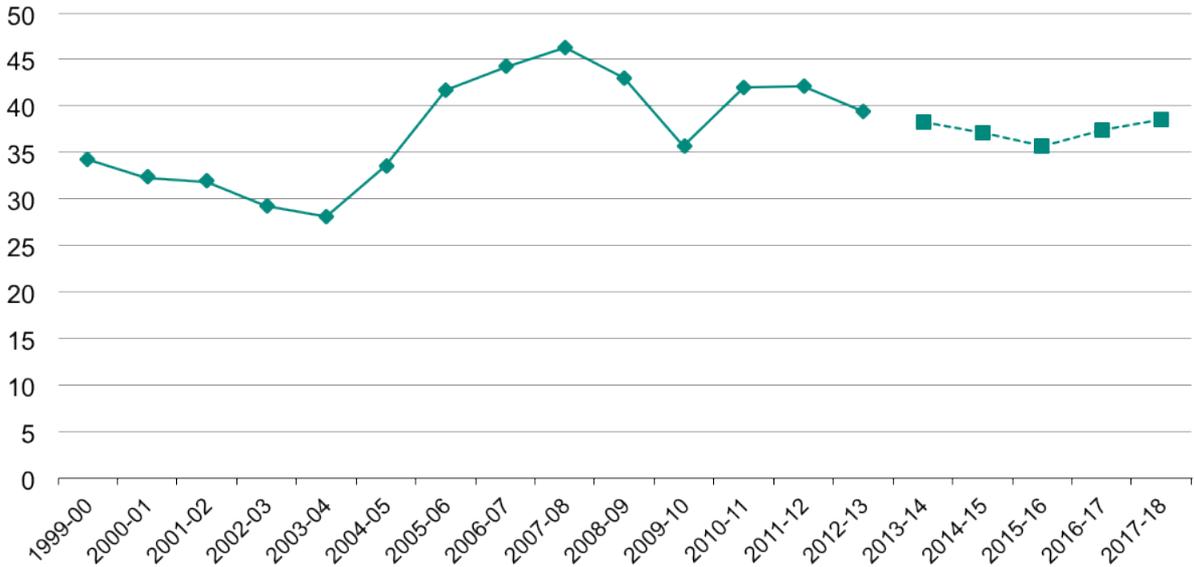
Sources: HMRC Corporation Tax Statistics, Table 11.1A (October 2013)
OBR Economic and Fiscal Outlook, Supplementary Fiscal Table 2.5 (March 2013)

2.6.   Receipts fall initially as the main rate falls against a backdrop of flat or slowly rising profits, but then pick up again after 2015-16 in line with increasing profits as the economy grows.

2.7.   The Government's costings are based on forecasts of profits of companies paying Corporation Tax. The costings assume a behavioural response to account for changes in the incentives for multinational companies to shift profits in and out of the UK. A reduction in the Corporation Tax rate reduces the incentives to shift profits out, protecting the Corporation Tax base. So the Exchequer cost of a reduction in the rate of Corporation Tax is less than if there had been no behavioural response.

2.8.   HMRC estimates that a one percentage point decrease in the Corporation Tax rate would lead to an increase in the size of the tax base of 0.83 per cent. The underlying methodology includes two key assumptions about (a) the proportion of profits that are **mobile**, and could therefore be shifted, and (b) the **semi-elasticity** of mobile profits, that is the extent to which mobile profits will shift.

2.9.   As with all Government costings, it is the OBR's responsibility to certify formal costings of the direct effects of Corporation Tax reductions for inclusion in their forecasts. These direct effects are accompanied by behavioural effects where appropriate, and the OBR are responsible for deciding whether to adjust their economic forecast for the indirect effects of policies.[7]

2.10.   The CGE model can be used to estimate the wider dynamic macroeconomic effects of individual policies. The next chapter considers such effects resulting from the Corporation Tax reduction.

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[7] For more information on how the OBR has adjusted its economic forecast for changes in corporation tax, see OBR, June 2010 Budget forecast; OBR, March 2012 *Economic and Fiscal Outlook*, Box 3.1; OBR, December 2012 *Economic and Fiscal Outlook*, Box 3.3; OBR, March 2013 *Economic and Fiscal Outlook*, Box 3.1

Chapter 3 – Theory and supporting literature on the dynamic macroeconomic effects of Corporation Tax reductions

3.1.   This chapter looks at the theory behind how a change in the Corporation Tax rate might affect real economic activity and GDP, and subsequently feed back into tax receipts. It also considers the academic evidence supporting this theory.

3.2.   Chart 3.1 below shows the alternative channels through which a Corporation Tax reduction could affect GDP. A reduction in the Corporation Tax rate raises firms' post-tax earnings. Firms can then pass these higher profits on in a number of ways, each described below. The solidly-coloured boxes identify the effects that are captured by the CGE model. The shaded boxes represent effects that are not captured by the CGE model, meaning that modelling results are likely to underestimate the GDP effect that would result through these channels.

Chart 3.1. Channels through which a reduction in Corporation Tax affects GDP
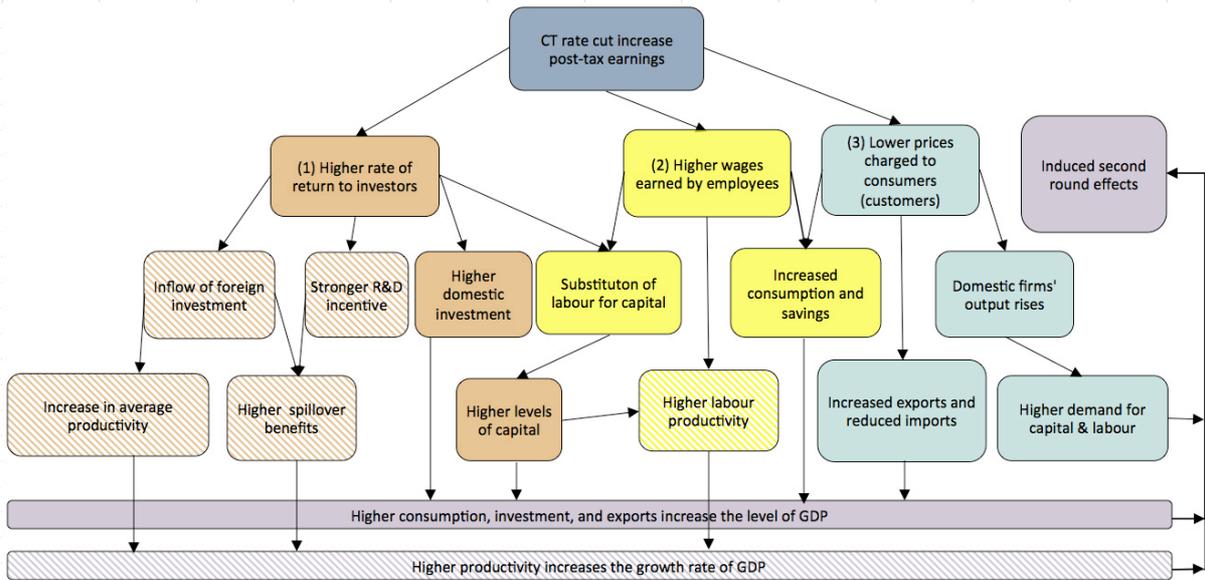
Investment

3.3.   An important route for a change in Corporation Tax rate to affect GDP is through investment (channel 1 in Chart 3.1). Studies are able to trace the impact of lower Corporation Tax on investment through the cost of capital, or through its impact on Tobin's *q*.[8, 9]

3.4.   A reduction in the Corporation Tax rate reduces the cost of capital for firms. This means that marginal investment projects are now more profitable and more likely to go ahead so long as sufficient financing is available. Such increased investment opportunities and higher returns should increase both domestic investment and foreign direct investment (FDI). Investment is a component of GDP so increased investment results in higher GDP.

3.5.   Increased investment affects GDP through its short-run effect on the level of demand in the economy and through its long-run effect on how much output the economy can supply. Investment is an expenditure component of GDP. This means that more investment leads to higher demand in the economy, feeding directly into the level of GDP in that period. Higher demand further increases GDP through a series of second-round increments as spending propagates through the economy.

3.6.   Increased investment also affects GDP through the capital stock.[10] A larger capital stock enables the economy to produce more output in the future, although it may take time for the effects of this larger capital stock to fully feed into a higher level of GDP. When new capital is installed it can be made more productive through 'learning by doing'. Significant improvements in learning rates can augment capacity and drive up the rate of return, leading to further increases in the level of GDP.

Wages and employment

3.7.   A reduction in the Corporation Tax rate could also affect the economy through other channels, such as through higher wages and employment (channel 2). Assuming labour is less mobile than capital, a reduction in the Corporation Tax rate increases demand for labour, in turn raising wages. This effect is somewhat offset by subsequent substitution of labour for capital. An increased reward to labour increases both consumption and savings, raising the level of GDP.

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[8] The cost of capital (or the rental price of an asset) is the unit cost for the use of that asset for one period. The cost of capital includes the cost of finance, depreciation of the capital good, the relative change in the price of the capital good and the impact of corporate taxes. The cost of capital falls when either the corporate tax rate falls or capital allowances increase.

[9] Tobin argued that investment is likely to depend on *q*, the ratio of the stock market value of existing capital goods relative to their replacement costs. A fall in the corporate tax rate will increase the expected future return on capital leading to higher investment.

[10] As the capital stock increases the level of depreciation will also rise. Capital stock will stop expanding once deprecation equals investment.

Prices

3.8.   The lower cost of capital and higher returns could also translate into lower prices of corporate sector output charged to consumers (channel 3). The extent that firms pass on the reduction in the burden of Corporation Tax to consumers, through lower prices, depends on how easy it is for consumers to switch goods produced by the corporate sector for those not produced by the corporate sector, such as imported goods. The extent of the reduction in price depends on the openness of the economy (more open, less change in price) and market power of the firms (more market power, higher changes in price). Lower prices could further raise domestic consumption, reduce demand for imports and increase demand for exports. An increase in household consumption combined with an improvement in the UK's trade balance would increase the level of GDP.

Productivity

3.9.   Although not captured by the CGE model, lower Corporation Tax rates could also boost productivity growth and therefore GDP growth (shown in the shaded boxes in Chart 3.1). Productivity growth occurs when an improvement in education or technology in one period drives a further increase in the next period, for example high tech firms spark innovation which improves efficiency further. This affects the growth rate of GDP as firms are able to produce a higher value of output for the same input from one period to the next. A decrease in Corporation Tax rates may affect productivity by incentivising research and development (R&D) and high-tech foreign investment, increasing labour productivity and wages.

Receipts

3.10.   The macroeconomic effects set out above are likely to have a positive effect on receipts. Stronger growth will eventually generate tax revenues that recoup a proportion of the revenue lost directly from a lower Corporation Tax rate. Once the additional investment projects resulting from the Corporation Tax reduction have been completed, this will boost profits leading to additional Corporation Tax receipts. Higher consumption will generate extra Value Added Tax (VAT) and excise duty receipts. Also higher wages and employment will increase income tax and National Insurance Contributions (NICs) receipts. The evidence on the economic impacts and extent of the revenue recouped is discussed in the literature reviewed below.

Literature review

3.11.   This section provides a brief summary of some of the main academic evidence to support the theory of how Corporation Tax cuts affect the economy. Most of the literature covers the effect of Corporation Taxes on investment; although some deals with the effect on wages. In addition some literature analyses the effect of Corporation Tax reductions and subsequent dynamic macroeconomic effects on receipts.

Corporation Taxes and investment

3.12.   There have been a number of studies looking at the relationship between Corporation Taxes and investment. Some of the most relevant papers are summarised in Table 3.1. Generally, the papers suggest that reductions in Corporation Taxes boost investment, although there is a wide range of estimates of the magnitude.

3.13.   Bosworth (1985) finds that although tax changes affect the cost of capital, other factors, like financing costs, can have much larger effects making it difficult to observe the effect from corporate tax changes. However, many other more recent studies like Cummins et al. (1996) and Djankov et al. (2008), which both look at a wider sample of countries, find that corporate tax changes do have significant impacts on investment.

3.14.   For the UK, a number of studies (Bond et al. (1993) and Wallis (2012)) find that Corporation Tax changes have a significant effect on investment. Wallis suggests that the June Budget 2010 Corporation Tax reforms could lead to an additional £13 billion of investment over the following six years. If, like in Wallis and in Bond et al., tax changes have a significant effect on the cost of capital, we would expect them to have a significant effect on investment and on the level of the capital stock.

Table 3.1: Sample of papers on Corporation Taxes and investment

Author(s) (year of study)	Country	Impact of Corporation Taxes on investment	Additional points
Bosworth (1985)[11]	US	Finds evidence that rental price of capital affects investment but taxes are only small part of rental price.	• Looks at impact of 1981-82 Tax Act on investment. • Finds that for many categories of equipment, taxes are a small component of the rental cost and are overwhelmed by changes in the other factors. • Finds little correlation between the growth in specific categories of investment and the relative size of tax reduction by asset.
Cummins, Hassett and Hubbard (1994)[12]	US	Find that long-lasting changes in Corporation Taxation can have significant effects on investment.	• Use major US tax reforms as natural experiments to assess impact of net return on investment. • Use both tax-adjusted q and user cost of capital approach. • Find that after every major tax reform pattern of investment changes significantly.
Cummins, Hassett and Hubbard (1996)[13]	14 OECD countries	Find statistically significant investment responses to tax changes in 12 out of 14 countries.	• Use firm level panel data and tax-adjusted q model. • Find that using tax reforms as instruments leads to significantly improved estimates of determinants of investment. • For the UK including tax reform instruments leads the coefficient on average q to jump from 0.062 to 0.589.
Bond, Denny and Devereux (1993)[14]	UK	Find that a 1-2 per cent fall in the cost of capital can permanently increase investment by around five per cent.	• Use cost of capital approach. • Looks at impact on investment from the 1992 Autumn Statement temporary capital allowance changes and the permanent post-1986 Corporation Tax changes.
Ellis and Price (2004)[15]	UK	Find user cost elasticity of about -0.45	• Estimate a long-run investment equation using a measure of the capital stock constructed by the Bank. • Find strong evidence of effect from user cost of capital.

[11] Bosworth, B. P. (1985). *"Taxes and the Investment Recovery"*. Brookings Papers on Economic Activity, Volume 1985, No. 1, 1-45

[12] Cummins, J. G., Hassett, K. A. and Hubbard, G. (1994). *"A Reconsideration of Investment Behaviour Using Tax Reforms as Natural Experiments"*. Brookings Papers on Economic Activity, Volume 1994, No. 2. 1-74

[13] Cummins, J. G., Hassett, K. A. and Hubbard, G. (1996). *"Tax Reforms and Investment: A Cross-Country Comparison".* Journal of Public Economics, Volume 62, No. 2. 237-273

[14] Bond, S., Denny, K. and Devereux, M. (1993). *"Capital Allowances and the Impact of Corporation Tax on Investment in the UK". Fiscal Studies*, Volume 14, No. 2, 1-14

[15] Ellis, C. and Price, S. (2004). *"UK Business Investment and the User Cost of Capital".*

The Manchester School, supplement 2004, 72-93

Author(s) (year of study)	Country	Impact of Corporation Taxes on investment	Additional points
Barnes, Price and Sebastia-Barriel (2008)[16]	UK	Find user cost elasticity -0.4.	• Use three decades of firm panel data. • Elasticity estimated using both time averages and pooled mean group panel methods.
Smith (2008)[17]	UK	Find user cost elasticity close to -0.4	• Use both aggregate data and industry level data. • Dynamic panel methods are used for industry level approach. • Both give elasticity estimates close to -0.4.
Djankov et al. (2008)[18]	Various	Find ten per cent increase in the effective corporate tax rate reduces investment to GDP ratio by two percentage points.	• Use a large cross-section of data. • Results robust to including different variables.
Wallis (2012)[19]	UK	Finds tax policy can have significant impact on investment. User cost elasticity in range of -0.14 and -0.27.	• Finds tax changes can have large impact on user cost of capital. 1984 Corporation Tax reform increased the user cost of capital by 6.7 per cent. • User cost elasticities not out of line with those in other literature, especially given downward bias expected in macro level estimates. • Given this tax changes can have big impact on long-run level of capital and therefore investment.

Corporation Tax and wages

3.15. Whether a cut in the rate of Corporation Tax will increase the returns to capital and investment, increase wages and employment, or both, is a question of where the *economic incidence* of the tax lies. The economic incidence dictates how the reduction in the burden of the tax is split. A number of studies have attempted to answer this question, either empirically or using different types of CGE models. Some of the key papers are summarised in Table 3.2 below.

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[16] Barnes, S., Price, S. and Sebastia-Barriel, M. (2008). *"The elasticity of substitution: evidence from a UK firm-level data set"*. Bank of England Working Paper, No. 348

[17] Smith, J. (2008). *"That elusive elasticity and the ubiquitous bias: is panel data a panacea?"*. Bank of England Working Paper, No. 342

[18] Djankov, Ganser, McLiesh, Ramalho, Shleifer, (2008) *"The Effect of Corporate Taxes on Investment and Entrepreneurship"*, American Law & Economics Association Annual Meetings, paper 80.

[19] Wallis, G.E; (2012) *"Essays in understanding investment"*, Doctoral thesis, University College London

3.16.   Early studies on corporate taxes in the vein of Harberger (1962)[20] found that the bulk of the incidence of corporation tax falls on capital. The emergence of multinational firms and investors has led economists to extend Harberger's closed economy model to open capital markets. Most studies following this approach find that the incidence of corporation tax principally falls on labour.[21] The key mechanism is that when capital is internationally immobile, its price is determined by the world market. If one (small) country cuts its corporation tax it cannot change the world price of capital, and hence capital does not bear the burden of the tax reduction. Arulampalam et al. (2010) suggest an alternative mechanism where workers engage in bargaining over the extra profits generated from lower corporation tax and ask for a higher wage.

Table 3.2: Sample of papers on Corporation Taxes and wages

Author(s) (year of study)	Country	Impact of Corporation Taxes on investment	Methodology
Arumpalam, Devereux and Maffini (2009)	9 EU countries including UK 1996-2003	£1 reduction in Corporation Tax increases median pre-tax wages by 59 pence	Empirical estimate using cross-company variation in Corporation Tax liabilities over time in a wage bargaining framework
Felix (2007)	Around 20 high income countries 1979-2002	10% reduction in rate of Corporation Tax increases mean gross wages by 7% (similar across unskilled and skilled labour)	Empirical estimate using cross-country variation in Corporation Tax rates over time in augmented wage equations
Gravelle (2010)[22]	Large economy (based on US) and rest of the world	Around 60% of Corporation Tax burden falls on capital and 40% on labour in the long run	Estimate derived from four pre-existing CGE model-based studies, adjusted for consistency using plausible elasticities from the empirical literature

3.17.   A recent wave of studies (Gravelle (2010), Gravelle and Smetters (2006)[23], Randolph (2006)[24], and Harberger (2008))[25] suggest that capital can still bear a higher proportion of the burden of corporation tax even with international capital mobility. Gravelle (2010) argues that

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[20] Harberger, Arnold C., 1962, *"The Incidence of the Corporation Income Tax"*. Journal of Political Economy 70(3), June, pp. 215-240

[21] Arulampalam, Devereux, and Maffini (2010), *"The Direct Incidence of Corprate Income Tax on Wages"* ; Hassett and Mathur (2006), *"Taxes and Wages";* Felix (2007), *"The Direct Incidence of Corporate Income Tax on Wages"*

[22] Gravelle (2010), *"Corporate Tax Incidence: Review of General Equilibrium Estimates and Analysis"*

[23] Gravelle, J and Smetters, K,(2006) *"Does the Open Economy Assumption Really Mean that Labor Bears the Burden of a Capital Income Tax?"*

[24] Randolph, William C., (2006). *"International Burdens of the Corporate Income Tax."*

[25] Harberger, A (2008), *"Corporation Tax Incidence: Reflections on what is Known, Unknown and Unknowable"*

international product substitution, location-specific rents, country size, the degree of substitution between labour and capital, and the capital intensity of the sectors bearing the tax are also important factors in determining the tax incidence. She finds that with reasonable assumptions regarding these factors, capital bears a higher proportion of the corporation tax burden. Harberger (2008) argues that international tax competition can also mitigate the importance of international capital mobility. Evidence on the incidence of corporation tax is still undecided among economists. Nevertheless, as the UK economy is relatively small in global terms (about three per cent of GDP)[26], and has open capital markets, Corporation Tax could be expected to have a significant impact on the labour market as well as investment.

Corporation Tax and receipts

3.18.   There have been a number of papers that attempt to estimate the effect of a reduction in Corporation Tax on government tax receipts. Table 3.3 summarises the most relevant papers.

3.19.   The academic literature finds that a reduction in capital taxes or specifically Corporation Taxes partly pays for itself through higher growth. The magnitude of the effect varies, with academic studies in Table 3.3 finding that 45 per cent to 90 per cent of tax reductions are self-financing.

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[26] 2012 figures. Source IMF World Economic Outlook October 2013 – Table A

Table 3.3. Sample of papers that evaluate the dynamic revenue effects of capital tax changes

Author(s) (year of study)	Country	What proportion of tax reduction is self-financing	Additional points
Mankiw and Weinzierl (2006)[27]	Model uses conventional parameter values in line with US.	45 to 50 per cent of capital tax rate cut is paid for by higher growth.	• Paper uses neoclassical growth model to consider the revenue effects of changes in tax rate. • Starting value of tax is important. If starting value of capital tax rate was 0.4 rather than the 0.25 that they use, then 75 per cent of the tax cut would be paid for by higher growth.
Trabandt and Uhlig (2010)[28]	US and EU-14 economy	For UK 73 per cent of capital tax rate cut is paid for by higher growth.	• Paper also uses neoclassical growth model. • Find that fiscal effect is indirect; following cut in capital taxes, greatest contribution to total tax receipts comes from increase in labour income taxation.
Strulik and Trimborn (2012)[29]	Calibrated for the US	70-90 per cent of Corporation Tax rate cut is paid by higher growth. 50-68 per cent of capital tax rate cut is paid by higher growth.	• Deviate from existing literature by explicitly modelling a corporate sector, the firms' investment and finance problem, and a detailed set of capital taxes. • In order to take adjustment dynamics into account, they compute the net present value of revenue (these are the lower values in the range for the adjacent box).
Varney (2007)[30]	Impact of Northern Ireland corporation tax rate cut on UK as a whole.	Results suggest that after 20 years around 60 per cent of cutting Northern Ireland Corporation Tax cut to 12.5 per cent is self-financed.	• Report looks at impact on domestic investment using cost of capital approach, assuming user cost elasticity of -0.4. • Report also takes account of foreign direct investment and profit shifting (including adjusting for displacement from rest of UK).

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[27] N. Gregory Mankiw and Matthew Weinzierl, (2006) *"Dynamic scoring: A back-of-the-envelope guide",* Journal of Public Economics, Volume 90, Issues 8–9, Pages 1415-1433

[28] Trabandt, M. and H. Uhlig, (2010), *"How far are we from the slippery slope? The Laffer curve Revisited"*, Discussion paper, European Central Bank.

[29] Holger Strulik, Timo Trimborn, (2012) *"Laffer strikes again: Dynamic scoring of capital taxes",* European Economic Review, Volume 56, Issue 6, Pages 1180-1199

[30] Sir David Varney (2007), *"Review of Tax Policy in Northern Ireland"*

Chapter 4 – Modelling Corporation Tax rate reductions using the HMRC CGE model

4.1.   This chapter explains how the CGE model has been used to simulate the effects of the reductions in the rate of Corporation Tax. It summarises the results in terms of increased economic activity (output, investment, wages, consumption) and the extent to which this leads to the costs of the tax reduction being recovered. The Corporation Tax reductions are the only policy changes from the Corporation Tax Road Map that are modelled. Other changes affecting businesses, such as changes to the Controlled Foreign Companies regime and introduction of the Patent Box, are not modelled because they add to the complexity of the results. Including the additional impact of these reforms would be expected to add to the impacts on investment and GDP.

4.2.   The CGE model does not explicitly incorporate international capital mobility, suggesting it is likely to underestimate the GDP impact and recovery rate. To address this, an off-model adjustment is made, which provides a proxy for the increase in foreign direct investment (FDI), for which there is good empirical evidence.

4.3.   However there are also reasons why the effects of the Corporation Tax reductions could be lower than predicted by the model. Factors that could affect the modelling are:

•   uncertainties around the various parameters included in the model, for example the cost of capital adjustment, the elasticity of substitution between capital and labour, or the inter-temporal elasticity of substitution between current and future consumption;

•   economic uncertainty – risks that could hamper investment;

•   uncertainty regarding possible international tax competition.

To address this uncertainty, we provide some sensitivity analysis at the end of this chapter.

Headline results

4.4.   Table 4.1 below summarises the results, which are expressed as increases in GDP against the baseline, and in terms of the percentage of the static cost that is recovered. The results compare the full CGE results with the off-model FDI adjustment. The range of results is consistent with the range suggested by the literature.

4.5.   The CGE model suggests that investment will be 2.5 per cent higher than baseline after 20 years, which equates to about £3.6 billion in today's prices. For GDP the increase will be 0.6 per cent, which in 2012-13 terms is equivalent to an increase in GDP of £9.6

billion, or £405 per household given the share going to labour.[31] The model also predicts that about 45 per cent of the static cost of the Corporation Tax reduction will be recovered in tax revenue from increased economic activity.

4.6.   Applying the FDI adjustment suggests that investment will be higher than baseline by 4.5 per cent (or £6.2 billion), that GDP will be higher by 0.8 per cent, equivalent to £12.2 billion or £515 per household given the share going to labour.[32] The adjustment also suggests that about 60 per cent of the static cost of the tax reduction will be recovered. These results are discussed in more detail following the model description below.

Table 4.1. Summary results

Steady state results (20 years)		
	CGE modelling	Adjusted for FDI
Difference in GDP level compared to baseline	0.64%	0.81%
Equivalent change in 2012-13 GDP	£9.6bn	£12.2bn
Share per household[33]	£406	£515
Difference in investment level compared to baseline	2.5%	4.5%
Equivalent change in 2012-13 investment	£3.6bn	£6.2bn
Tax recovery rate	46%	58%

Model description

4.7.   A Computable General Equilibrium (CGE) model is a large-scale numerical model that simulates the core economic interactions of different agents in the economy. It uses data on the structure of the economy, along with a set of equations based on economic theory, to estimate the effects that a policy change will have on the economy.

4.8.   Modelling policy changes in the CGE model is a complex activity, and providing robust analysis requires an in-depth understanding of how the model works. It also requires a number of steps to be completed – checking data and model calibration, coding the logic for policy scenarios of interest, and carrying out comprehensive sensitivity analysis to check robustness of simulation results with respect to changes in model assumptions and data.

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[31] The change in the return to labour following the Corporation Tax cuts as a share of the increase in Gross Value Added (GVA) is 77%. This is derived from the increase in wages combined with the initial share of labour in GVA. Although the increase in wages is proportionally lower than the increase in return to capital, labour is a larger share of GVA.

[32] In the FDI adjusted case the increase in wages is expected to be higher which would increase the share to labour, but this may be offset by the higher increase in foreign investment which leaves the labour share in this case indeterminate.

[33] 2012-13 GDP figure divided by estimated number of households for 2012-13.
http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-328237

4.9.   HMRC's CGE model is a single-country dynamic model. It is typically aggregated to 12 sectors and 15 household groups, although this can vary according to modelling requirements. The model is dynamic, so it can track the evolution of the economy over time as it reacts to policy changes, capturing the inter-temporal aspect of agents' decision making. For example, if businesses are expecting a Corporation Tax reduction in three years time, this will influence their decisions about investment today. There are a number of assumptions, grounded in economic theory, about various other interactions in the economy. Information on the CGE model assumptions can be found in the HMRC CGE Model Documentation.[34]

4.10.   CGE models capture the inter-dependencies of the economy, meaning that a policy change or shock affecting one part of the economy will spread out through multiple transmission mechanisms simultaneously and indirectly affect the rest of the economy via feedback loops. CGE models allow us to capture the effect on the whole economy from a shock or policy change impacting a sub-set of markets.

4.11.   Thus, a key strength of the HMRC CGE model is the ability to model the long run dynamic macroeconomic effects and relationships across tax bases of policy changes. The main interactions and indirect effects consist of:

•   inter-sectoral linkages - firms across sectors are interlinked through their use of intermediate inputs and factors of production, so a tax on one good/sector will feed through to others;

•   inter-institutional linkages – links between households, firms, exporters, importers and government;

•   inter-temporal dynamics – the model captures the inter-temporal decision making of economic agents.

4.12.   Many different variables can be reported, with percentage change in Gross Domestic Product (GDP) being the primary result. This GDP result can be disaggregated into individual components – consumption, investment, government spending and net exports – to see how these variables change over time.

4.13.   However, the CGE model is not a short-term forecasting model. It is set up to model the transition of the economy to a new long run equilibrium following a policy change. It does not take account of exogenous short-term shocks and economic fluctuations.

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[34] https://www.gov.uk/government/publications/computable-general-equilibrium-cge-modelling

4.14.   The CGE model does not capture all the possible productivity effects associated with higher investment. While it captures transitory productivity effects,[35] other productivity effects such as embodied innovation and technology spillovers are not captured. This means that the results presented are likely to underestimate the true long-run impact of a reduction in the Corporation Tax rate.

4.15.   More significantly, the CGE model does not explicitly model foreign direct or portfolio investment. Investment is currently modelled as if it were financed from domestic savings. Not modelling international capital mobility explicitly means that the following effects from a reduction in the Corporation Tax rate are not captured by the model:

- FDI may be more responsive to Corporation Tax changes than domestic investment (as the literature suggests);

- FDI may embody more technology and spillover effects than domestic investment, raising productivity;

- portfolio inflows from overseas investors attracted by higher post-tax returns may further reduce the user cost of capital, leading to further increases in investment;

- exchange rate effects following an inflow of investment;[36]

- on the other hand there will be more leakages from the economy in terms of profits repatriated abroad.

4.16.   So the CGE model is likely to underestimate the increase in investment, and thus the GDP effect and the tax recovery rate, of a given Corporation Tax reduction. This is the reason why an off-model adjustment is made – see paragraphs 4.32 to 4.36.

Modelling the Corporation Tax reduction

4.17.   The CGE model is used to estimate the magnitude of the economic and fiscal effects of the Corporation Tax rate reductions through the different transmission mechanisms discussed in Chapter 3. The tax reduction is implemented in the model by reducing the tax levied on profits in proportion to baseline revenues from each of the 12 sectors. Firms choose a time path of investment that maximises their present value of net income subject to investment generating the desired capital stock after accounting for depreciation.[37] Firms' behaviour epitomises Tobin's *q* theory (see paragraph 3.3 and Annex A) whereby they invest until the marginal cost of investment is equal to the present value of the future marginal revenue of capital.

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[35] Productivity effects arising from higher marginal productivity of labour, rebalancing capital productivity across sectors and capital stock accumulation.

[36] May not be significant as the change in FDI is likely to small in the context of the foreign exchange market.

[37] Investment expenditure depends on replacement cost of capital, capital allowances, VAT and cost of capital adjustment costs.

4.18. The dynamic macroeconomic effects of the Corporation Tax rate reductions are simulated since the baseline year of 2010, so it is important to consider other changes since 2010 which may affect the results. These can be grouped into two broad categories:

(i) factors having a significant bearing on investment in the short-term, such as the macroeconomic uncertainty over the period since 2010. This is not captured by the CGE model as it is deterministic and does not allow for capital or labour market imperfections, but in any case it is the long-run macroeconomic effects that are the focus of this analysis.

(ii) factors having little impact on how Corporation Tax affects the real economy, but which do affect the dynamic tax recovery rate, such as changes in personal allowances and the VAT standard rate. These effects are captured fully in the baseline.

4.19. For simplicity the model simulation assumes that the schedule of Corporation Tax rate reductions shown in the table below was announced in the same year as the rate cuts started to take effect (2011-12). In practice the initial 2010 announcement of a phased reduction to 24 per cent by 2014 was followed by subsequent announcements in 2011, 2012 and 2013 detailing additional rate reductions. The model proxies this by adjusting the cost of capital (see Chart 4.4 at the end of this chapter). This assumption should have little impact on the long-run equilibrium effects.

Table 4.2. Summary of rate cuts

Year	Main rate (%)	Small profits rate (%)
2010-11	28	21
2011-12	26	20
2012-13	24	20
2013-14	23	20
2014-15	21	20
2015-16 onwards	20	20

Core CGE results (excluding Foreign Direct Investment)

4.20. Results are summarised below in Table 4.3 and Chart 4.1. When the cumulative Corporation Tax rate reductions are included in the CGE simulations, GDP is estimated to be 0.64 per cent higher than the baseline position after 20 years. This represents £9.6 billion in 2012-13 terms, with £405 going to each household.

4.21.   The CGE model suggests an average fiscal multiplier of 0.62, which is broadly in line with the empirical evidence.[38] In a review of fiscal multipliers, an IMF study found a range of multipliers between 0.2 and 0.7 after two years.[39] The CGE model suggests a multiplier of 0.4 after two years, increasing to 0.82 after 20 years.

4.22.   The GDP effect is the result of an expansion in investment by 2.5 per cent and consumption by 0.6 per cent. The modelled investment increase implies an average cost of capital elasticity of -0.48. Rather than being a model assumption, this is an output of the model. It is close to the elasticities drawn from the literature (see Table 3.1).

Table 4.3: Main CGE model results

Steady state results (20 years)	
	Without FDI
Change in GDP	0.64%
In 2012-13 prices	£9.6bn
Share per household	£406
Change in investment	2.51%
In 2012-13 prices	£3.6bn
Change in consumption	0.62%
In 2012-13 prices	£6bn
Recovery rate	46%
Fiscal multiplier	0.62
Elasticity of investment with respect to Corporation Tax	-0.48

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[38] Fiscal multiplier is the ratio of a change in GDP with the change in the fiscal deficit.

[39] IMF Staff Position Note – Fiscal Multipliers http://www.imf.org/external/pubs/ft/spn/2009/spn0911.pdf

Chart 4.1. Contribution to change in GDP from consumption and investment
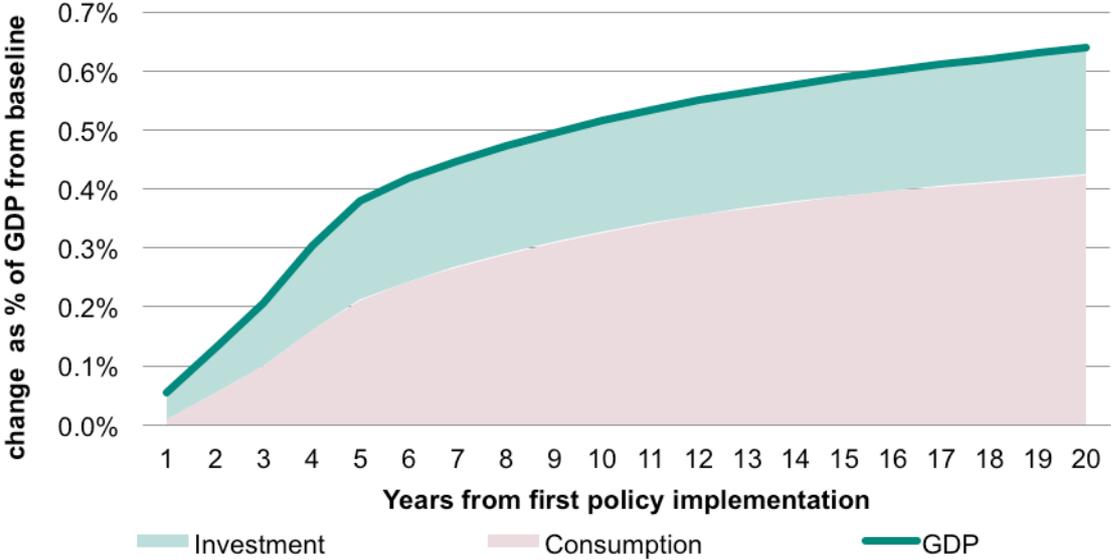
4.23.   The expansion in GDP largely follows the Corporation Tax reduction schedule, low in the initial years and high after the full reduction is implemented. The reduction in Corporation Tax reduces firms' cost of capital, enabling the 2.5 per cent increase in investment in order to achieve the new desired level of capital stock. This higher level of capital accumulation has a positive effect on GDP (channel 1 in Chart 3.1). With cheaper capital, firms substitute from labour to capital at the margin. However, to produce more output with higher capital stock, firms need more labour. The output effect outweighs the substitution effect causing an increase in the demand for labour and therefore higher wages and employment.

4.24.   With higher post-tax returns to both capital and labour, households' income rises (channel 2), enabling additional consumption. This consumption effect is amplified as prices fall due to lower costs of production (channel 3). Aggregate consumption in the economy expands by 0.62 per cent.

4.25.   More of the incidence of the Corporation Tax reduction is borne by owners of capital. Comparing the wage increase in relation to rate of return on capital increase, the incidence of the tax decrease falls more on capital, which bears 55 per cent of the reduction, while labour bears 40 per cent.

4.26.   With a marginal overall price decrease, consumers bear 5 per cent of the reduction. It should be noted that price changes vary across sectors with goods produced by capital intensive sectors exhibiting larger reductions than the non-capital intensive sectors, as argued by Harberger (2006). Empirical evidence on price incidence is very limited with most papers distinguishing between workers and capital only.

4.27.   The CGE model assumes that capital is internationally immobile (closed capital markets), so it is likely to understate labour's share of the burden reduction as the UK has open capital markets. This means that labour is likely to benefit relatively more from the tax reductions than the model suggests. It also suggests that recovery rates could be higher, because labour income is subject to a higher average tax rate than capital income.

CGE tax recovery effects

4.28.   The increase in GDP leads to an expansion in most tax bases, causing an increase in tax revenue that makes up about 45 per cent of the static loss in Corporation Tax revenue. This recovery is at the lower end of the range found in the literature review (see Table 3.3). However those studies cover different tax reductions and are based on different tax structures, both of which will influence recovery rates. Also, the CGE modelling does not include increased revenue from reduced profit shifting away from the UK, unlike Varney (2007). Profit shifting occurs when multinational or global companies direct their profits through locations with lower tax rates.

4.29.   Chart 4.2 shows how different taxes contribute overall to tax recovery. Around ten per cent of the overall cost of the rate reductions is recovered in Corporation Tax receipts. This reflects firms and investment expanding and generating more profit, which in turn is taxed, adding to overall Corporation Tax receipts.

Chart 4.2. Revenue recovered as a proportion of static Corporation Tax cut
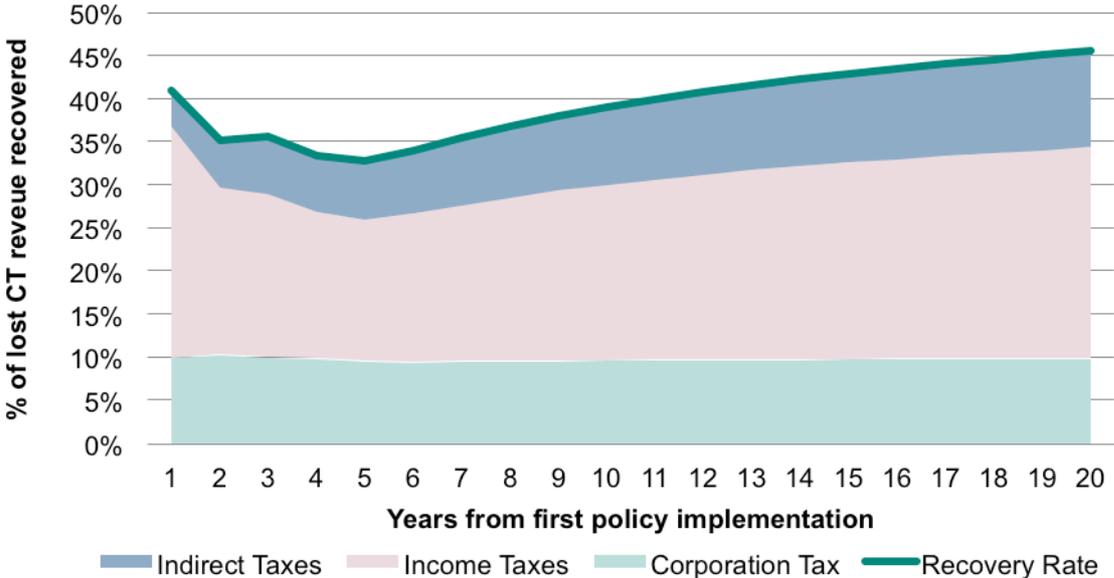
4.30. Taxes on personal income (income tax, employer and employee NICs) rise as the economy expands, such that additional revenues recover 25 per cent of the annual static cost by year 20. This recovery rate falls in the early years as firms substitute capital for labour, but increases thereafter due to the output effect referred to in paragraph 4.23 – with a higher capital stock firms require more labour.

4.31. Indirect tax revenues also increase. Increased output and employment lead to increased disposable income, which in turn raises consumption levels and hence VAT and excise duty receipts. In addition, as firms expand they demand more intermediate inputs such as fuel, some of which are indirectly taxed. Also demand for investment goods increases, meaning higher indirect tax receipts. For example an increase in demand for buildings from expanding companies leads to an increase in stamp duty receipts. The recovery attributed to indirect taxes by year 20 is 11 per cent of the static cost.

Adjustment for FDI

4.32. In order to include an estimate of the impact of the Corporation Tax reductions on FDI, an off-model adjustment was carried out. In the CGE model, the investment semi-elasticity with respect to the average Corporation Tax rate is around -0.68 in the long run. The model treats all investment as domestically sourced.

4.33. The empirical evidence suggests that FDI has a higher semi-elasticity than domestic investment. Therefore, to make the off-model adjustment for FDI, a semi-elasticity with respect to the average Corporation Tax rate of -4.2 is applied. This elasticity is in line with estimates used in previous academic literature.[40] FDI is around 15 per cent of total UK investment and total investment is approximately 8.6 per cent of GDP.[41]

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[40] Ederveen, Sjef and de Mooij, Ruud A , *"How does Foreign Direct Investment respond to taxes? A meta analysis."* October 2005. Table 4.3. We use the macro average tax rate, so implicitly assuming that MNEs can get exemption treatment in their home country.

[41] Source: Office for National Statistics.

4.34.   The results after the off-model adjustment are summarised in Table 4.4 below.[42]

Table 4.4. Results of adjustment for FDI

Steady state results (20 years)	
	With FDI
Change in GDP	0.81%
In 2012-13 prices	£12.2bn
Share per household	£515
Change in investment	4.52%
In 2012-13 prices	£6.2bn
Change in consumption	0.62%
In 2012-13 prices	£6bn
Recovery rate	58%
Composite Corporation Tax elasticity	-1.22

4.35.   Applying the semi-elasticity of -4.2 to the FDI element of investment increases GDP by 0.81 per cent against baseline, and 0.15 per cent higher than excluding FDI. 0.81 per cent is equivalent to £12.2 billion in today's prices, and the share of this going to labour is on average £515 per household. FDI adds two per cent to the increase in investment. The overall increase of 4.5 per cent against the baseline equates to £6.2 billion additional investment in today's prices.

4.36.   Including FDI increases the recovery rate of the static cost reduction, from 45 per cent to about 60 per cent. This is within the range from the literature suggested in paragraph 3.19.

Sensitivity analysis

4.37.   This section describes the results of some sensitivity analysis around the central model estimates, that is, excluding FDI effects.

4.38.   The first sensitivity relates to the value-added elasticity between capital and labour. Firms produce goods and services using inputs of labour, capital and intermediate goods. Firms may decide to employ capital and labour in different proportions. This relationship is governed by the elasticity of substitution between capital and labour. Chart 4.3 below shows the sensitivity of the central scenario (elasticity of -0.8) to a lower bound (elasticity of -0.4) and an upper bound (elasticity of -1.2). A higher elasticity makes it easier for firms to substitute capital for labour. This results in a greater increase in GDP following the Corporation Tax cuts.

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[42] Please note that this is an off model adjustment rather than a full CGE model run. It assumes that the additional investment translates to a direct increase in GDP. It also assumes that the recovery from additional investment is proportional to the recovery in the CGE modelling results.

4.39.   Changing this elasticity has an inverse effect on the recovery rate, which is 43 per cent in the higher elasticity scenario and 48 per cent in the low elasticity scenario. With it easier for firms to substitute away from labour and use relatively cheaper capital, there is a bigger relative increase in the Corporation Tax base. However, since wages are more highly taxed than profits, the fall in Income Tax and National Insurance Contributions outweighs the increase in other tax revenues.

Chart 4.3. Sensitivity of change in GDP to elasticity between labour and capital
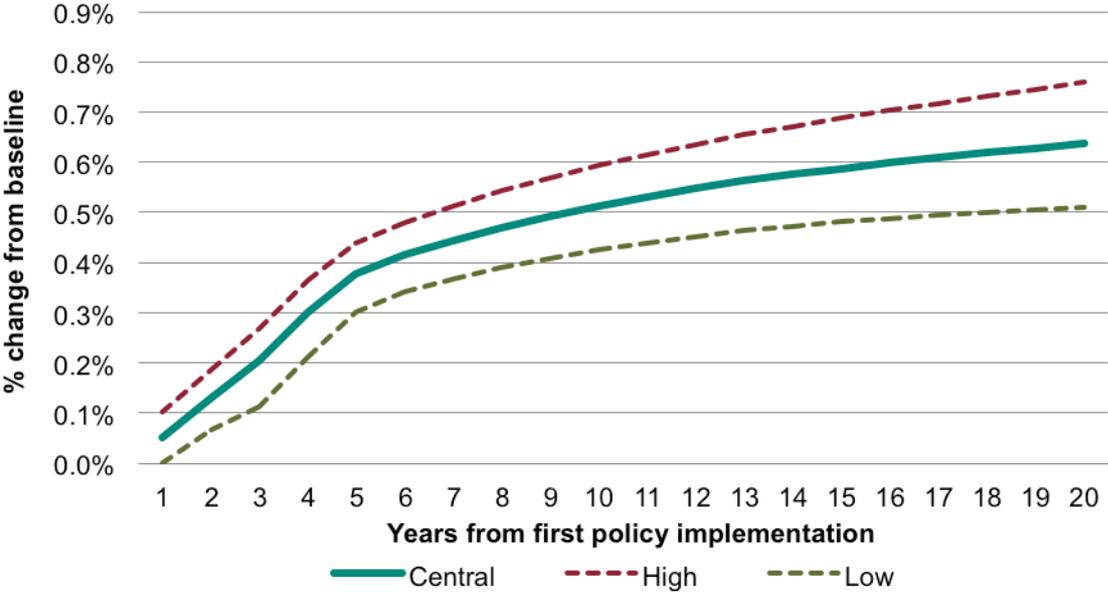
4.40.   The second sensitivity modelled relates to the cost of capital adjustment parameter. We assume that firms face a cost when adjusting their capital stock which depends on the level of investment undertaken. This captures phenomena such as the cost of training employees to use new technology. Higher capital adjustment costs cause firms' optimal level of investment to be lower, which leads to a smaller increase in GDP following the Corporation Tax reductions (see Chart 4.4 below). The revenue recovered from all taxes is also lower in the high cost scenario as firms' produce less with the same mix of inputs. However the recovery rates (not shown) do not vary much, ranging from 45 per cent in the high scenario to 46 per cent in the low scenario.

Chart 4.4. Sensitivity of change in GDP to the adjustment cost of capital
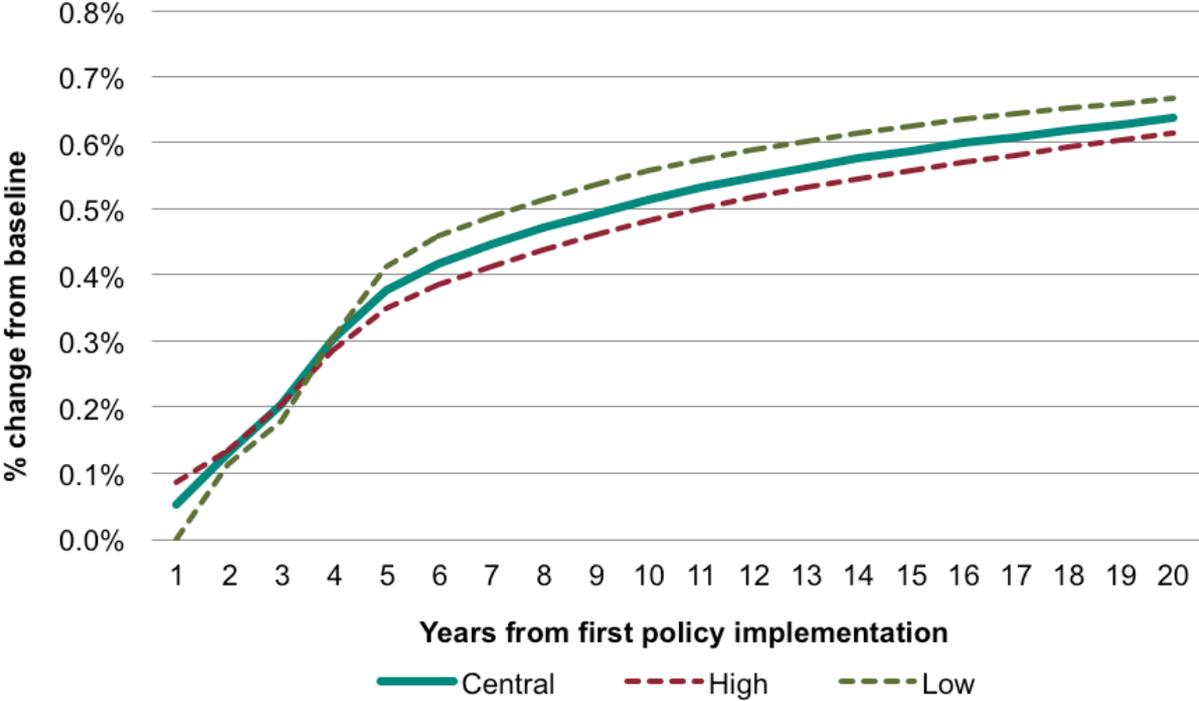
4.41. These examples show some sensitivity around the central modelling scenario. However, the variations in GDP are not particularly large, nor are the variations in the recovery rate. The upper sensitivities produce results that are still lower than those suggested by the off-model adjustment to include FDI.

Chapter 5 – Economic trends since 2010 and implications for growth and investment

5.1.   The CGE model considers the long term macroeconomic effects following a policy change. The model does not forecast short term effects, rather it provides indicative results showing where the key impacts are likely to happen and their relative magnitude in the long run. It is too early to test the modelled results against real data. But we can look at economic trends since 2011, when the corporate tax reforms were introduced, and their implications for growth and investment in the near term.

Growth and business investment

5.2.   The first Corporation Tax reductions – from 28 per cent to 26 per cent - were introduced in April 2011. During this period the UK economy was subject to three key shocks: the euro area sovereign debt crisis and related global uncertainty, high commodity price rises, and the on-going effect of the financial crisis. These factors created uncertainty for business, particularly around future demand and access to finance. The uncertainty also affected consumers, reducing consumption. Given such uncertainty, it is reasonable to expect the transmission channels set out in Chapter 3 to be less effective in the short run.

5.3.   Business investment has been subdued. Investment fell by 30 per cent in real terms between the first quarter of 2008 and the third quarter of 2009.[43] Of the 5.7 per cent shortfall in the OBR's June 2010 prediction for GDP growth by 2013 Q2, business investment contributed four percentage points.[44]

5.4.   Analysis by the OBR and Bank of England has attributed subdued investment performance to several key factors, including prolonged uncertainty over demand conditions, lower than expected profits, and constrained credit conditions particularly for smaller firms.[45] As noted in Chapter 4, the CGE model does not capture such factors as its strength is in modelling the long-term economic effects of policies (rather than short-term shocks). As such, it is reasonable for initial data to deviate from the CGE model results.

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[43] ONS Statistical Bulletin - http://www.ons.gov.uk/ons/dcp171778_340698.pdf - Table G1.

[44] OBR Forecast evaluation report October 2013 - http://budgetresponsibility.org.uk/category/publications/

[45] OBR *'Forecast Evaluation Report – October 2013',* Bank of England *'Inflation Report – November 2013'*

5.5.   However, recent evidence suggests barriers to investment are receding. The Deloitte CFO survey reports that credit is easier to obtain and cheaper than at any time since the crisis, and there has also been a sharp fall in reported levels of uncertainty since the fourth quarter of 2012.[46]

5.6.   The labour market has performed relatively strongly. In the third quarter of 2013 employment increased by 378,000 over the year and 381,000 above its pre-recession peak. Latest private sector jobs figures are only available to the second quarter of 2013 but show that private sector employment has increased by over 1.4 million since the first quarter of 2010.[47]

5.7.   The UK economy has gained momentum in 2013 as business and consumer confidence has improved. Real GDP growth in the third quarter of 2013 was 0.8 per cent, with growth across all industrial sectors of the economy. As confidence continues to grow and economic conditions begin to normalise it is reasonable to expect the Corporation Tax reforms to have a strong positive impact on business investment, in line with the CGE model.

5.8.   In addition, there are signs that inward investment – which we would expect a Corporation Tax rate to have a positive impact on, but one not fully captured in the CGE model – has held up reasonably well in the past couple of years, considering the wider economic climate. Having risen by just 1 per cent between 2010 and 2011, inward investment rose by 22 per cent between 2011 and 2012, despite global FDI flows declining by 18 per cent.[48]

Tax revenues

5.9.   As set out in Chapter 4, the CGE Model shows tax recovery after 20 years of 45 - 60 per cent due to the dynamic economic effects of Corporation Tax reductions. This recovery is due to increases in a number of taxes, not just Corporation Tax. However, it is a long term effect, so it is too early to compare with recent receipts data. In the future, a more detailed analysis of tax returns and investment patterns may be possible. However at present the most recent full set of detailed liabilities data available is for the 2011-12 tax year.

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[46] Deloitte CFO Survey Q3 2013

[47] ONS Labour Market Statistics, November 2013. http://www.ons.gov.uk/ons/rel/lms/labour-market-statistics/november-2013/statistical-bulletin.html

[48] http://unctad.org/en/pages/PublicationWebflyer.aspx?publicationid=588 – See Annex Table 1

Future analysis

5.10.   In time, a more detailed empirical study might be possible using economic and receipts data to compare with the results of the CGE model. Given the limitations around interpreting economic and receipts data, surveys carried out by HMRC and other independent sources can provide a useful insight into the impact the Government's Corporation Tax reductions are having on the negative shock to business confidence and on wider UK competitiveness.

5.11.   For instance the 2012 HMRC Tax Opinions Panel Survey (TOPS) report, found that 72 per cent of largest 800 businesses based in the UK felt the Corporation Tax reduction of 4 per cent between 2010 and April 2012 would have a positive impact on the competitive position of their business.[49] Moreover, 90 per cent of these businesses thought that the Corporation Tax reductions would be effective for maintaining the UK's competitive position.

5.12.   Additionally, in the World Bank's annual *Doing Business* reports, which assess countries' business environments in a range of categories, the UK has gone from 24th to 14th in the world for 'paying taxes' in the past two years, reflecting the reduced burden of Corporation Tax in the UK.[50]

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[49] http://www.hmrc.gov.uk/research/report262.pdf

[50] http://www.doingbusiness.org/reports/global-reports/doing-business-2014

Chapter 6 - Conclusions

6.1.   The Corporation Tax Road Map set out principles for corporate tax reform. It also set out the Government's ambition to make the UK's Corporation Tax regime the most competitive in the G20, to increase the investment and productivity that drive economic growth. Between 2010 and 2015 the main rate of Corporation Tax will have fallen from 28 per cent to 20 per cent, giving the UK the joint lowest rate in the G20.

6.2.   Reducing the rate of one of the more distortive taxes should have greater positive effects on overall economic activity than reducing other taxes. HMRC's CGE model can be used to model these dynamic macroeconomic effects, as well as the resulting effect on tax receipts.

6.3.   The CGE model has been peer-reviewed by leading academics in the relevant field, who said that *'The basic design of the HMRC model for the UK economy meets at large the key requirements for state-of-the-art applied tax policy analysis.'*

6.4.   The model captures the main channels through which a reduction in the Corporation Tax rate affects GDP – these are investment, wages and employment, and prices. The model also captures some, but not all productivity effects. The model does not capture foreign direct investment (FDI) so core modelling results are likely to underestimate the true dynamic macroeconomic effects of the tax rate reduction.

6.5.   Modelling work suggests by year 20 an increase in GDP against baseline of between 0.65 per cent and 0.82 per cent, and that between 45 per cent and 60 per cent of the static cost of the tax reduction is recovered. This range is based on not explicitly modelling FDI and proxying for FDI by applying an off-model adjustment. (Other sensitivity analysis is carried out around the basic modelling results.) The results are broadly in line with the effects suggested in the academic literature.

6.6.   CGE is a long-term macroeconomic effects model, rather than a short-term forecasting model. Thus it is too early to consider its results in light of actual economic performance. The Corporation Tax reductions after 2011 were introduced against a background of very difficult economic conditions, with business and household confidence very low. The labour market has performed well, although business investment has been more subdued. Other economic indicators and business surveys are more positive. So as business confidence grows, business investment is expected to grow strongly, in line with the academic evidence and modelled results presented in this paper.

Annex A. Explanation of the cost of capital and Tobin's *q* approaches

A.1.   The cost of capital and the tax-adjusted-*q* approaches are two methods often used in the academic literature to examine the link between tax parameters and investment. This annex briefly explains the two approaches.

Cost of capital approach

A.2.   In the neoclassical approach developed by Jorgenson in the 1960s there is a structural link between tax parameters and investment via the cost of capital

A.3.   The cost of capital can be calculated as the cost of renting a capital asset for a given period. Using the Hall-Jorgenson (1967) [51] formula the user cost of capital is defined as:

$$c_t = p_t(R_t + \delta_t - E(q_t))$$

Where c is the cost of capital, p price of investment relative to output, R the real cost of finance, δ the depreciation rate, and E(g) the expected rate of inflation of investment relative to output. To account for changes in Corporation Tax and capital allowances the formula above can be adjusted to include tax changes.

$$c_t = T_t * p_t(R_t + \delta_t - E(q_t))$$

Where T is defined as:

$$T_t = \left[\frac{1 - u_t * D_t}{1 - u_t}\right]$$

Where T is the tax adjustment term, u is the Corporation Tax rate and D is the present value of capital allowances. See Wallis (2012) for present value of capital allowances for different assets in the UK.[52] This means the cost of capital falls when either the Corporation Tax rate falls or capital allowances increase. The cost of capital is linked to investment in many models through its impact on the desired level of capital stock.

A.4.   In a number of different models the desired long run level of capital stock depends on the long-run level of output and the cost of capital. The cost of capital and level of capital stock are linked by the user cost elasticity. The user cost elasticity is expected to be negative. This means that a fall in the cost of capital will lead to an increase in the desired level of capital stock. With a Cobb-Douglas production function the user cost elasticity is

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[51] Hall, R. E. and Jorgenson, D. W. (1967). *"Tax Policy and Investment Behaviour". American Economic Review*, Volume 50, No. 3, 391-414

[52] Wallis, GE; (2012) *"Essays in understanding investment"*, Doctoral thesis, University College London

assumed to be equal to -1. But as noted in Table 3.1 in the literature estimates suggest the user cost is around -0.4 for the UK.

A.5.   Higher investment is needed to reach the new level of desired capital stock following a fall in the cost of capital. It is often assumed that firms face adjustment costs, this means that to reach the higher level of capital stock requires above equilibrium investment for a number of years. In addition more investment is needed to replace depreciated capital when the new equilibrium is reached, meaning that the level of investment remains higher than before the change in the cost of capital.

Tax-adjusted Tobin's *q*

A.6.   An alternative method for analysing investment was put forward by James Tobin.[53] Tobin argued investment is likely to depend on q, the ratio of the stock market value of existing capital goods relative to their replacement costs. For example, an increase in the rate of return on capital will mean that purchasing an extra unit of capital will raise market value by more than the unit cost. This higher market value will lead to extra investment until the equilibrium is restored.

A.7.   Tobin's q can be adjusted to take into account tax parameters:

$$Q_t = \left[\frac{q_t - p_t(1 - D_t)}{1 - u_t} \right]$$

where Q is the tax-adjusted q, p is the price of investment relative to output, D the present value of depreciation allowances and u is the Corporation Tax rate.[54] Again when modelling changes in Q economists often assume there are adjustment costs so that higher investment is spread over a number of periods to restore equilibrium.

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[53] Tobin, J. (1969). "*A General Equilibrium Approach to Monetary Theory*". *Journal of Money, Credit and Banking*, Volume 1, No. 1, 15-29.

[54] For further details please see:

Lawrence H. Summers, (1981). "*Taxation and Corporate Investment: A q-Theory Approach*". Brookings Papers on Economic Activity, vol. 12(1), pages 67-140.

And Hayashi, Fumio. (1982). *"Tobin's Marginal q and Average q: A Neoclassical Interpretation."* Econometrica 50(1): 213-24.