The future of corporate taxes

A macroeconomic assessment for Luxembourg

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Executive summary

Over the last 30 years, Luxembourg has developed into a high-performing economy, and this remains true in the most recent period: the country's GDP grew by 5.6% in 2014[1], putting Luxembourg way ahead of the 0.9% GDP growth rate achieved by the euro area[2], and its debt-to-GDP ratio is one of the lowest in the euro area at 21.6% of GDP[3] in 2015.

But the recent context is about fierce fiscal competition and a push for increased transparency coming from the OECD's Action Plan on Base Erosion and Profit Shifting (BEPS) initiative, which might force Luxembourg, as well as other countries, to reduce exemptions and tax credits, to name but a few incentives. Therefore, a lack of reform of the statutory tax rate could diminish Luxembourg's attractiveness.

To shed light on the cost and opportunities of reforming corporate taxation, this report will assess the macroeconomic impact of corporate tax changes, especially on GDP, employment, and tax revenues in Luxembourg.

Previous economic studies show that:

- The corporate tax rate has an impact on distinct dimensions of investment: it affects foreign direct investment, especially smaller economies, as they will face more difficulties in attracting foreign direct investment (FDI) aimed at supplying their small markets if they maintain high tax rates. Corporate tax rates also impact domestic investment, and a firm's decision to locate in a certain country, with the financial sector being the most sensitive to changes in the corporate tax rate.

- Corporate tax rate cuts lead to increased wages, which in turn increase consumption and savings; this contributes to higher levels of GDP and therefore employment.
- Overall, previous studies show that reducing the corporate tax rate by 10 percentage points increases the annual growth rate by between 0.6% and 1.8% in the long term.
- Corporate tax rate partly pays for itself through higher growth, with an estimated recovery rate of around 60% 20 years after the implementation of the policy change.

We have also used a model, first developed for Ireland, and adapted it for Luxembourg to measure the impact of the implicit corporate tax rate[4] on exports, output and employment in the private sector. The rationale for working with the implicit tax rate is that due to several tax exemptions and tax credits, the real tax burden on companies differs from the statutory tax rate announced by the Government. With such a model, we arrived at an estimate of the final impact of a change in the implicit corporate tax on GDP[5], but also assessed the impact on tax revenues. This model estimates the effect of the implicit tax rate, which is a measure of the effective average tax burden on companies. It is expressed as aggregate tax revenues as a percentage of the potential tax base. In contrast, the statutory tax rate is the nominal rate announced by the Government.

The main limitations of the model are as follows:

- This model does not take into account the multiplier effects of a change in the corporate tax rate, especially the

effect on the public sector.
- It cannot capture the non-linear effect of corporate taxes on the economic variables, nor can we take into account the effect on the wider labour market, e.g. changes in wages.
- We only estimate the long-term impact of the corporate tax reform.
- We assume that corporate tax changes will affect all firms equally and this model is mostly useful for limited changes around the benchmark.
- We do not take into account tax rate differentials across jurisdictions, and assume there will be no change in the corporate tax rate of these jurisdictions.
- We do not have at our disposal a micro data set, preventing us from simulating the sensitivity of investment to corporate tax rate increases across different sectors and types of businesses in Luxembourg.

The above limitations relate to the positive effects of an implicit corporate tax rate reduction, and a negative effect otherwise. The effects measured in the study are, therefore, prudent rather than aggressive.

Because we cannot capture all of the ripple effects a change in the implicit corporate tax rate will have, our measurement will likely underestimate the impact on GDP and employment.

This also applies to tax revenues. Because the estimated increase in tax revenues due to an increase in the implicit corporate tax rate can be interpreted as a maximum, the actual impact would likely be lower. On the other side, we are overestimating the loss in the tax revenues associated with a decrease in the implicit corporate tax rate as we cannot capture all of the effects on the economy in light of fiscal competition across jurisdictions.

1. STATEC (2015), Luxembourg in figures.
2. Eurostat (2014), GDP growth rate.
3. European Commission (2015), European Economic Forecast Winter 2016.
4. The implicit tax rate provides a measure of the effective average tax burden on companies. It is expressed as aggregate tax revenues as a percentage of the potential tax base. In contrast, the statutory tax rate is the nominal rate announced by the Government.
5. More details on the model are provided in Appendix.

From this macroeconomic model for Luxembourg, each percentage-point increase in the implicit corporate tax rate will decrease exports of services by 2.32%, decrease private-sector value added by 1.23%, and decrease GDP by 0.89%.

We also simulated three scenarios of changes in implicit tax rates: a decrease by 3 percentage points, an increase by 2 percentage points and finally an increase by 5 percentage points. To get results that are more easily interpretable, we have decided to express the changes in the implicit tax rate into corresponding changes in the statutory tax rate. We specified several identities to derive the sensitivity between the statutory and implicit tax rates[6], which allow us to convert the changes in the implicit tax rate obtained from our model, into changes in statutory tax rate.

Expressed in terms of changes in the statutory tax rate, our model predicts that in the long term:

The relationship between the tax rate and tax revenues is non-linear. Indeed, a rise in the tax rate raises tax revenues but has a negative impact on the tax base. Therefore, at a specific threshold, the reduction in the tax base overcompensates for the increase in the tax rate.

Whatever the limitations, we hope this report can help to enhance and contribute to the debate on taxation and on the means to achieve sustainable growth, as corporate tax rate is considered one of the most growth-damaging taxes. Ivan Van de Cloot and Marc De Vos[7] mentioned a ranking of taxes according to their impact on economic activity. Corporate tax is the most damaging to the economy, followed by personal taxes and consumption taxes; property tax was considered to be the least damaging to the economy.

Reforming the corporate tax system is finally a substantial opportunity to diversify the Luxembourg economy as it could attract financial and non-financial corporations through tax incentives.

Therefore, finding the right balance between tax revenues and GDP growth should take into account the long-term objectives for the Luxembourg economy.

Finally as mentioned before, the study is not able to capture the behaviour of competing countries. Currently, the three competing financial places (UK, Ireland and Switzerland) have now announced tax rates which are half of the Luxembourg tax rate. Absent reform, this rate differential is too high to sustain the Luxembourg financial place and the broader economy. Clearly, those places might have other hidden taxes (such as real estate taxes) but as the market is now focussed on the headline corporate tax rate, it is the latter that counts whereas there should scope to increase some other taxes and the corporate tax base.

A cut by 8.25 percentage points will

- Increase the GDP by 2.68% (EUR + 1.81 billion)
- Increase the level of employment by 0.86 % (+3,836 employees)
- Decrease tax revenues by EUR 576 million

An increase by 5.50 percentage points will

- Decrease the GDP by 1.79% (EUR -1.21 billion)
- Decrease the level of employment by 0.58% (-2,558 employees)
- Increase tax revenues by EUR 325 million

An increase by 13.75 percentage points will

- Decrease the GDP by 4.47% (EUR -3.02 billion)
- Decrease the level of employment by 1.44% (-6,394 employees)
- Increase tax revenues by EUR 725 million

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6. See section 5.4 for a detailed presentation of the methodology.
7. Itinera Institute Analyse, Paving new ways, Équité fiscale, 2014/10.

Introduction

Luxembourg: a high-performing economy

Over the last 30 years, Luxembourg has developed into a high-performing economy. Its strategic location in Europe, its experienced and multilingual workforce and a highly developed infrastructure make it a location of choice for multinational corporations:

- Luxembourg is Europe's largest cross-border investment fund centre with more than EUR 3.5 trillion in net assets and 27.3% of total European AuM[8].
- The worldwide headquarters of SES Astra is in Luxembourg.
- The European headquarters of PayPal, Skype, and Amazon are in Luxembourg.

As a result of this success, the Luxembourg economy is performing relatively better than the rest of the euro area:

- The country's GDP grew by 4.8% in 2015[9], putting Luxembourg way ahead of the 1.7% GDP growth rate achieved by the euro area[10].
- Luxembourg has recorded lower levels of unemployment (6.6% in April 2016)[11] than the rest of the euro area (10.2% in January 2016)[12]. The debt-to-GDP ratio is one of the lowest in the euro area at 21.6% of GDP[13].

The specific landscape of the Luxembourg economy also shapes the structure of the government's tax revenues. In fact, the main contributors to tax revenues are the financial sector and international corporations: 71.7% of corporate tax revenues (CIT) were generated by companies operating in the financial sector[14] in 2014, with banks and Soparfis[15] contributing the most to tax revenues.

Fierce competition push for reforms

In the context of increasing fiscal competition, putting in place the right measures to attract foreign investment and multinational corporations should remain a priority, and some countries have already taken action:

- The UK has decided to cut its corporate tax rate from 20% since 2015 to 19% in 2017 and progressively to 15%.
- In Switzerland, the corporate tax rate is at 13% in the canton of Geneva.
- Ireland clearly remains the most attractive country in Europe with a 12.5% corporate tax rate since 2003.

All three countries also have a strong financial sector and a highly developed infrastructure and therefore agglomeration effects are likely to be sizeable, especially as those countries are three of Luxembourg's fiercest competitors. Agglomeration effects refer to companies from various industries locating in clusters and therefore benefitting from spillover effects[16], meaning that a change in one industry has immediate impacts on multiple industries. Taking the example of connectivity infrastructure such as airports for instance, Luxembourg clearly does not benefit from the same scale externalities as London and therefore agglomeration effects are likely to be somewhat lower.

In particular, current UK policies are worrying for Luxembourg. The UK – and especially the City of London – benefits from great agglomeration effects involving a highly developed financial market and infrastructure, and yet UK policy members have embarked on an aggressive reduction of corporate tax rates.

8. PwC (2016), Luxembourg, an overview.
9. STATEC (2015), Luxembourg in figures.
10. Eurostat (2015), GDP growth rate.
11. STATEC (2016), Employment, unemployment and unemployment rate.
12. Eurostat (2016), Unemployment rate.
13. European Commission (2015), European Economic Forecast Winter 2016.
14. CES (2015), Analyse des données fiscales au Luxembourg.
15. A "Société de Participations Financières" (Soparfi) is a standard, fully taxable Luxembourg company which can take the legal form of any type of joint stock company (SA, SARL, SCA, COOP SA). A Soparfi is neither a specific type of company nor a special tax regime. It is rather used to refer to resident companies that hold and manage the shareholdings of subsidiaries (PwC Luxembourg).
16. Glaeser E. (2010), Agglomeration Economics.

At 29.22%, Luxembourg's corporate tax rate is higher than some other European countries. However, the implicit tax rate is lower due to several exemptions and tax credits, which are commonly used by most countries in order to remain competitive in a context of high international firm mobility as well as decreasing barriers to global capital flows[17].

Clearly, there is also pressure for greater transparency and simplification. Published in 2013, the OECD's Action Plan on Base Erosion and Profit Shifting aims to modernise the current international tax framework to provide for more robust anti-tax avoidance laws and render the international tax system more transparent. BEPS will ultimately result in fewer exemptions and fewer deductions and – if there is no change in policy – a higher implicit tax rate for companies.

This is why the government needs to take action on corporate taxation. In this respect, a recent note[18] from the IMF has highlighted the need to reform tax regimes for corporations. If this does not happen in Luxembourg, the country will become significantly less attractive.

Figure 1: Comparison of selected corporate tax rates, 2015

Luxembourg	29.22%
The Netherlands	25%
Switzerland (Zürich canton)	21.15%
United Kingdom	20%
Ireland	12.50%
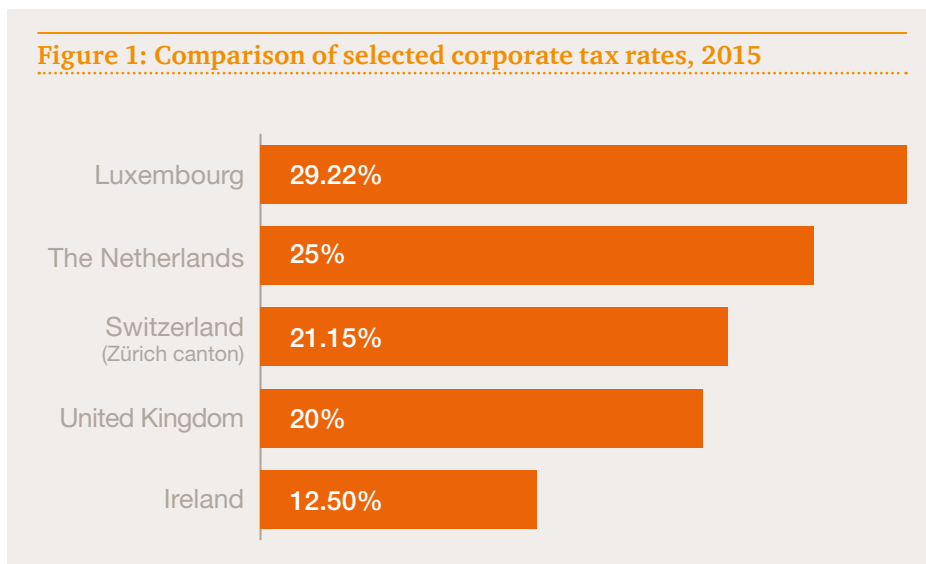
Objective and structure of the report

This report aims to assess the link between the corporate tax rate and economic activity in Luxembourg in order to better understand and quantify the potential impact of corporate tax reforms on key macroeconomic variables. The term "economic activity" in this report encompasses distinct dimensions of the dynamism of the real economy: total investment, employment and GDP. We also assess the cost of reforming the corporate tax rate by estimating the change in tax revenues.

To this end, we have structured the analysis and the report as follows:

• First, we have reviewed the existing literature on the link between the corporate tax rate and economic activity as corporate tax rates has been found to negatively affect FDI inflows, investment location decisions, wages, firms' innovative activities and GDP.

• Next, we have estimated the historical impact of the tax rate on Luxembourg's economy. We have estimated an implicit tax rate and applied a model developed for Ireland to estimate the link between corporate tax and economic activity through its effect on exports, employment and GDP.

• Finally, based on our main results, we have simulated the effect of an increase/decrease in the implicit corporate tax rate on GDP, employment and corporate tax revenues.

17. Morisset J. (2003), Tax Incentives, The World Bank Group.
18. IMF (2016) "Luxembourg: Concluding Statement of the 2016 Article IV Consultation Mission."

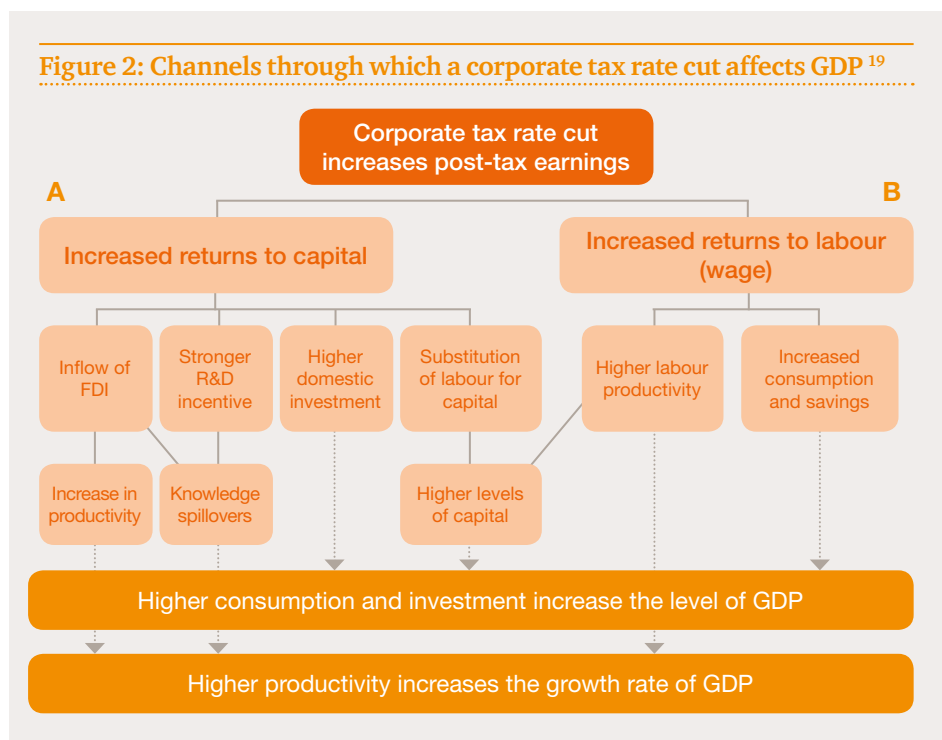# Findings on the economic effects of changes in the corporate tax rate

The main channels through which a corporate tax rate reduction affects the distinct dimensions of economic activity are illustrated in Figure 2.

First, a corporate tax cut affects firms' post-tax earnings. This results in a higher rate of returns to investors (effect A in the figure above). A corporate tax cut also means that capital becomes relatively cheaper than labour which might lead to substitution effects (use of more capital and less labour for the same output). But cheaper capital also stimulates output as it decreases the cost of producing, pushing upward the demand for both capital and labour. Assuming that the output effect (increase in the use of both capital and labour following a reduction in the cost of capital) dominates the substitution away from the relatively more expensive labour in this case, a corporate tax rate cut also leads to increased returns to labour (effect B in the figure beside).

Also, increased returns to capital not only give a stronger incentive for capital accumulation and R&D spending, hence innovation, but also create an attractive investment climate for FDI. On the other hand, increased returns to labour lead to higher labour productivity as well as increased consumption and savings. Higher productivity levels in general, combined with higher levels of capital and increased consumption, contribute to higher levels of GDP.

In this section, we will present the main empirical results to show the extent to which there is evidence on the impact of a reduction/increase in the corporate tax rate on the economy.

Figure 2: Channels through which a corporate tax rate cut affects GDP [19]

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                    Corporate tax rate cut
                    increases post-tax earnings

A                                                                    B

Increased returns to capital          Increased returns to labour (wage)

Inflow    Stronger   Higher      Substitution    Higher        Increased
of FDI    R&D        domestic    of labour       labour        consumption
          incentive  investment  for capital     productivity  and savings

Increase in    Knowledge              Higher levels
productivity   spillovers             of capital

Higher consumption and investment increase the level of GDP

Higher productivity increases the growth rate of GDP
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19. HM Revenue & Customs (2013), Analysis of the dynamic effects of Corporation Tax reductions & Department of Finance (2014), Literature Review of the economic effects of corporation tax, Economic and Social Research Institute, Dublin.

High investment sensitivity

The role of the corporate tax rate in influencing capital and foreign direct investment is well established as illustrated in Table 1.

Foreign direct investment

Research by the OECD[20] and academic papers[21] suggest that a 1% decrease in the corporate tax rate results in an increase of foreign direct investment by 2.9% to 3.7%. To illustrate, this means that decreasing the corporate tax rate from 10.1% to 10% leads to an increase in FDI by around 3%, i.e., an increase from EUR 0.97 million to EUR 1 million.

The extent to which corporate taxes impact capital formation through FDI also depends on the size of the economy, with smaller economies, such as Luxembourg, finding it more difficult to attract FDI aimed at supplying their small markets if they maintain high tax rates[22]. Additionally, smaller economies tend to generate smaller agglomeration effects because their basis to build infrastructure is thinner than for large economies. Luxembourg for instance still lacks intercontinental flight connections at this point, its residential real estate market is thinner than that of bigger economies, and its research centres are limited.

Table 1: FDI elasticity to corporate tax rate

Study	Years/countries	A 1% decrease in the corporate tax rate (e.g. from 10.1% to 10%) leads to an increase in FDI by
OECD (2005)	Average from 31 empirical studies	3.7%
De Mooij and Everdeen (2001)	Average from 25 empirical studies	3.3%
Bénassy-Quéré et al. (2004)	Bilateral FDI across OECD countries	3%
Pain and Young (1996)	FDI from Germany and the UK between 1977 and 1992	2.9%

Domestic investment

A corporate tax rate not only affects the amount of FDI, but also affects domestic capital investment.

- Lower corporate taxes propel investment by increasing the return on their investments.
- Evidence[23] suggests that raising the effective corporate tax rate by 10 percentage points reduces the investment-to-GDP ratio by 2.2 percentage points[24].
- Analysis of Scotland[25] shows that a corporate tax rate cut from 23% to 20% is likely to increase overall investment by 1.9% 20 years after the implementation of the policy change.
- A similar study[26] applied to the case of the UK corporate tax reform estimates that investments are likely to increase by 4.5% 20 years after implementation of the corporate tax rate cut from 28% in 2010 to 20% in 2015.

20. De Mooij and Everdeen (2005), Explaining the variation in empirical estimates of tax elasticities of foreign direct investment, Tinbergen Institute.
21. De Mooij and Everdeen (2001), Taxation and foreign direct investment: A synthesis of empirical research, Pain and Young (1996), Tax competition and the pattern of European foreign direct investment.
22. OECD (2008), Tax and economic growth.
23. Djankov et al. (2008), The effect of corporate taxes on investment and entrepreneurship. (A contradiction has been found between the elasticities in the results part and the ones mentioned in the abstract).
24. To illustrate, this means that increasing the effective corporate tax rate from 10% to 20% reduces the investment rate from 5% to 2.8%.
25. Scottish Government (2011), The impact of a reduction in corporation tax on the Scottish economy.
26. HM Revenue & Customs (2013), Analysis of the dynamic effects of Corporation Tax reductions.

Investment location decision

Corporate tax rates not only impact the amount of investment (domestic or foreign) but also affect firms' actual investment location choices. The Economic and Social Research Institute (ESRI) in Ireland estimated the effect of corporate taxes on the probability of a firm choosing to locate in a given jurisdiction[27].

- There is a strong negative effect of corporate tax on the location decisions of firms, with the impact of tax declining in importance at higher rates.
- The effective average tax rate (EATR) has a "marginal impact" of 1.2% on the location choice of FDI, meaning that if firms had an 75% chance of locating in a given jurisdiction, decreasing the corporate tax rate from 10.5% to 10% (corresponding to a 5% decrease) increases the likelihood of choosing this destination to nearly 80%.
- There are differences across sectors: actually, the financial sector is the most sensitive to changes in the corporate tax rate with a 1% decrease in the EATR increasing the probability of choosing a destination by 2.6%. Financial sector companies may be more sensitive to changes in the corporate tax rate due to their footloose nature, while service companies need to be close to their customers, which makes them less sensitive to taxes. Table 2 presents the results across sectors.

Table 2: Investment locational decision elasticity to corporate tax rate measures found in Ireland

Study	A 1% decrease in the corporate tax rate (from 10.1% to 10%) increases the likelihood of choosing a destination on average by
All sectors – average	1.2%
Manufacturing	0.9%
Services	0.7%
Financial sector	2.6%

As an illustration, if the corporate tax rate were to go from 11% to 10%, this corresponds to a 10% variation. According to the findings above, this would result in a 12% increase in the probability of choosing a jurisdiction on average, but a 26% increase in the probability of choosing that jurisdiction for a company in the financial sector.

27. Department of Finance (2014), Economic impact assessment of Ireland's corporation tax policy, Economic and Social Research Institute, Dublin. The authors use firm-level data on 3,238 newly established multinational subsidiaries across 26 European countries from 2005 to 2012.

More and better-paid workers

The existing literature highlights that a corporate tax rate cut leads to increased wages which increase consumption and savings, which contribute to higher levels of GDP, therefore employment.

The impact of corporate tax rates on wages and employment is the following:

- Applied to the case of the Irish tax reform[28], lowering the corporate tax rate from 40% to 12.5% has resulted in an increase in wage rates by 4.2%[29] and employment by 0.8% in total by 2005.

- Evidence from Germany[30] suggests a one-euro increase in the corporate tax bill decreases the wage bill by 56 cents. This means that workers bear a considerable share of the tax burden. In addition, a 1% increase in the corporate tax rate has been found to reduce employment by 1.2%[31].
- Another result[32], based on 20 high-income countries, finds that a 10% reduction in the corporate tax rate increases mean gross wages by 7%.
- A recent work[33], considering the incidence of corporate tax in an open economy setting (such as in the case of Luxembourg), indicates that employees bear the greater share of the corporate tax burden because companies have a higher ability to reinvest their mobile capital outside a given economy.

In total, the incidence of the corporate tax rate depends on the bargaining power of employees and employers. Put simply, if employers have difficulty in retaining their employees, when the corporate tax rate increases, employers will not be able to transfer the tax to their employees, otherwise they would resign. Conversely, when the unemployment rate is high, employers can easily pass on the cost of the tax to their employees through lower real wages. Also, for multinational corporations, providers of capital may require constant return, therefore a corporate tax rate increase will be passed on to employees. In Luxembourg, where unemployment is low and many companies are partnerships, an increase in the corporate tax rate is less likely to be passed on to employees whereas a decrease is likely to be passed on to employees.

28. FitzGerald J. et al. (2010), The macro-economic impact of changing the rate of corporation tax, Economic modelling.
29. The authors not only assume that the output effect outlined in section 3 dominates but also consider that the tax on labour was increased to offset the loss of revenue from a reduction in the corporate tax rate. Because a major part of the tax incidence falls on employers in Ireland, employers end up paying higher wages. Thus the increased wage rate in this simulation does not reflect increased returns to labour.
30. Fuest C. et al. (2015), Do higher corporate taxes reduce wages?, IZA.
31. Siegloch S. (2013), Employment effects of local corporate taxes. The author analyses the specific setting of German local business taxes, therefore the findings are not directly comparable to corporate tax rates set at the federal level.
32. Felix A. (2007), Passing the burden: Corporate tax incidence in open economies. The author uses cross-country data from 20 high-income countries between 1979 and 2002.
33. Devereux et al. (2012), The direct incidence of corporate income tax on wages.

Substantial recovery rates

Stronger economic growth after a tax cut generates tax revenues that partially offset the revenue lost directly from lower corporate taxes.

- Once the additional investment projects resulting from the corporate tax rate reduction have been completed, this will boost profits and lead to additional corporate tax revenues.
- Higher consumption generates extra value added tax and excise duty revenues.
- Higher wages and employment increase income tax leading again to higher tax revenues.

Evidence suggests that a reduction in the corporate tax rate partly pays for itself through higher growth, with an estimated recovery rate of 58% in the case of the UK[34] as a whole and 60% in Northern Ireland[35] 20 years after the implementation of the policy change.

Table 3: Impact of a corporate tax rate cut on tax revenues

Study	Country/year	Recovery rate of a corporate tax reform
HM Revenue & Customs (2013)	UK, 20 years after the policy change	58% of a reduction in corporate tax rate pays for itself through higher growth
Varney (2007)	Northern Ireland, 20 years after the policy change	60% of a reduction in corporate tax rate pays for itself through higher growth

34. HM Revenue & Customs (2013), Analysis of the dynamic effects of Corporation Tax reductions.
35. Sir David Varney (2007), Review of Tax Policy in Northern Ireland.

Economy booster

The effect of corporate tax on GDP has been documented empirically[36]. Given what happened in Ireland, Scotland, the UK as a whole and the US, we can establish that reducing the corporate tax rate by 10 percentage points increases the annual growth rate by anywhere between 0.6% and 1.8%.

The results from these countries are as follows:

- In the case of Ireland[37], reducing the corporate tax rate from 40% in 1994 to 12.5% by 2003 increased the level of GNP by 3.7% in 2005 over what it would otherwise have been.
- Evidence from the UK shows that reducing the corporate tax rate from 28% in 2010 to 20% by 2015-2016 increases the level of GDP by 0.8% 20 years after implementation of the policy change.
- The model applied to the case of the Scottish tax reform finds that cutting the corporate tax rate from 23% to 20% increases the level of GDP by 1.4% by year 20.

Simulation based on the US tax system[38] compares the overall economic results of three simulated corporate tax rates (25% OECD average, 20% UK corporate tax rate and 15% Canadian federal tax rate):

- If the US were to adopt the Canadian rate (15%), it would produce the biggest boost to long-term GDP, lifting the level by 4.3%.
- If US lawmakers were to take a more modest approach and adopt the 20% UK rate, the policy would still boost the level of GDP by 3.3%.

Table 4: Link between economic growth and corporate tax rates

Study	Country/year	Recovery rate of a corporate tax reform
FitzGerald J. (2010)	Ireland between 1970 and 2005	A corporate tax reduction from 40% to 12.5% increased GNP by 3.7% over the benchmark
HM Revenue & Customs (2013)	UK, 20 years after policy change	A corporate tax reduction from 28% to 20% increases GDP by 0.8% by year 20 over the baseline
Scottish Government (2011)	Scotland, 20 years after policy change	A corporate tax reduction from 23% to 20% increases GDP by 1.4% by year 20 over the baseline
Scott A. Hodge (2015)	US	1) A corporate tax reduction from 35% to 25% increases GDP by 2.3% 2) A corporate tax reduction from 35% to 20% increases GDP by 3.3% 3) A corporate tax reduction from 35% to 15% increases GDP by 4.3%

The tax mix also has an impact on economic growth. A decrease in the corporate tax rate has the largest positive effect on GDP per capita among all other taxes considered (e.g. personal income, consumption and property tax)[39].

Tax complexity matters too: research conducted by the Central Bank of Ireland[40] estimates the impact of the tax system's complexity on FDI: a 10% reduction in tax complexity is approximately comparable to a one-percentage-point reduction in the effective corporate tax rate.

Applied to the case of Luxembourg, if nothing changes in the statutory tax rate, companies will face higher implicit tax rates due to the implementation of the BEPS requirements impacting transfer pricing activities or interest deduction practices for instance[41].

It must be mentioned though that the Luxembourg tax system is not complex in itself. When ranked based on the time to comply with all tax obligations, the country ranks second in the EU&EFTA region with only 55 hours to comply compared to the EU&EFTA average of 173 hours[42].

36. Arnold J. (2008), Do tax structures affect aggregate economic growth? Empirical evidence from a panel of OECD countries. The author uses 70 OECD countries over the period 1980 to 1997.
37. FitzGerald J. et al. (2010), The macro-economic impact of changing the rate of corporation tax, Economic modelling.
38. Scott A. Hodge (2015), The economic effects of adopting the corporate tax rates of the OECD, the UK and Canada.
39. Arnold J. (2008), Do tax structures affect aggregate economic growth? Empirical evidence from a panel of OECD countries. The author uses 21 OECD countries over the period 1971-2004.
40. Lawless M. (2009), Tax complexity and inward investment, Research technical paper, Central Bank of Ireland.
41. Flash News PwC (2015), OECD Action Plan for BEPS – the package is final.
42. PwC and World Bank Group (2016), Paying Taxes.

Innovation, productivity and technological change impacting economic growth

Corporate tax hinders innovative activity by reducing the return available to firms from introducing innovations to their product lines and production processes or through reduced investment in new capital assets which embody technological progress. Reducing corporate tax rates thus affects productivity by incentivising R&D and high-tech foreign investment.

The overall macroeconomic impact of higher levels of productivity is an increased GDP growth rate as firms are able to produce a higher value of output for the same level of input from one period to the next.

Research conducted by the OECD[43] presents different channels through which corporate tax impacts total factor productivity (TFP)[44]:

- Corporate taxes distort relative factor prices resulting in a reallocation of resources towards possibly less productive sectors, which may lower TFP.
- Complex corporate tax causes high tax compliance costs for firms and high administrative burdens for governments, which absorb resources that could be used for productive activities, causing productivity and efficiency losses.

- To the extent that corporate taxes reduce FDI and the presence of foreign multinational enterprises, they can hinder technology transfers and knowledge spillovers to domestic firms.
- Corporate taxes distort corporate financing decisions, favouring debt over equity because of the deductibility of interest from taxable profits. This affects TFP by distorting the allocation of investment between industries, favouring those that find it easy to raise debt finance and disadvantaging those that have to rely more on equity, such as knowledge-based industries that invest heavily in intangible property.

Results based on US-state-level corporate taxes[45] suggest that a 1% increase in the corporate tax rate reduces firms' innovative capabilities by decreasing the number of patent grants by 0.6%.

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43. OECD (2008), Tax and economic growth.
44. Total factor productivity is the part of economic growth that is not accounted for by increases in capital and labour. It is typically taken as a measure of innovation or technological progress in an economy.
45. Mukherjee A. et al. (2015), Do taxes hinder innovation?.
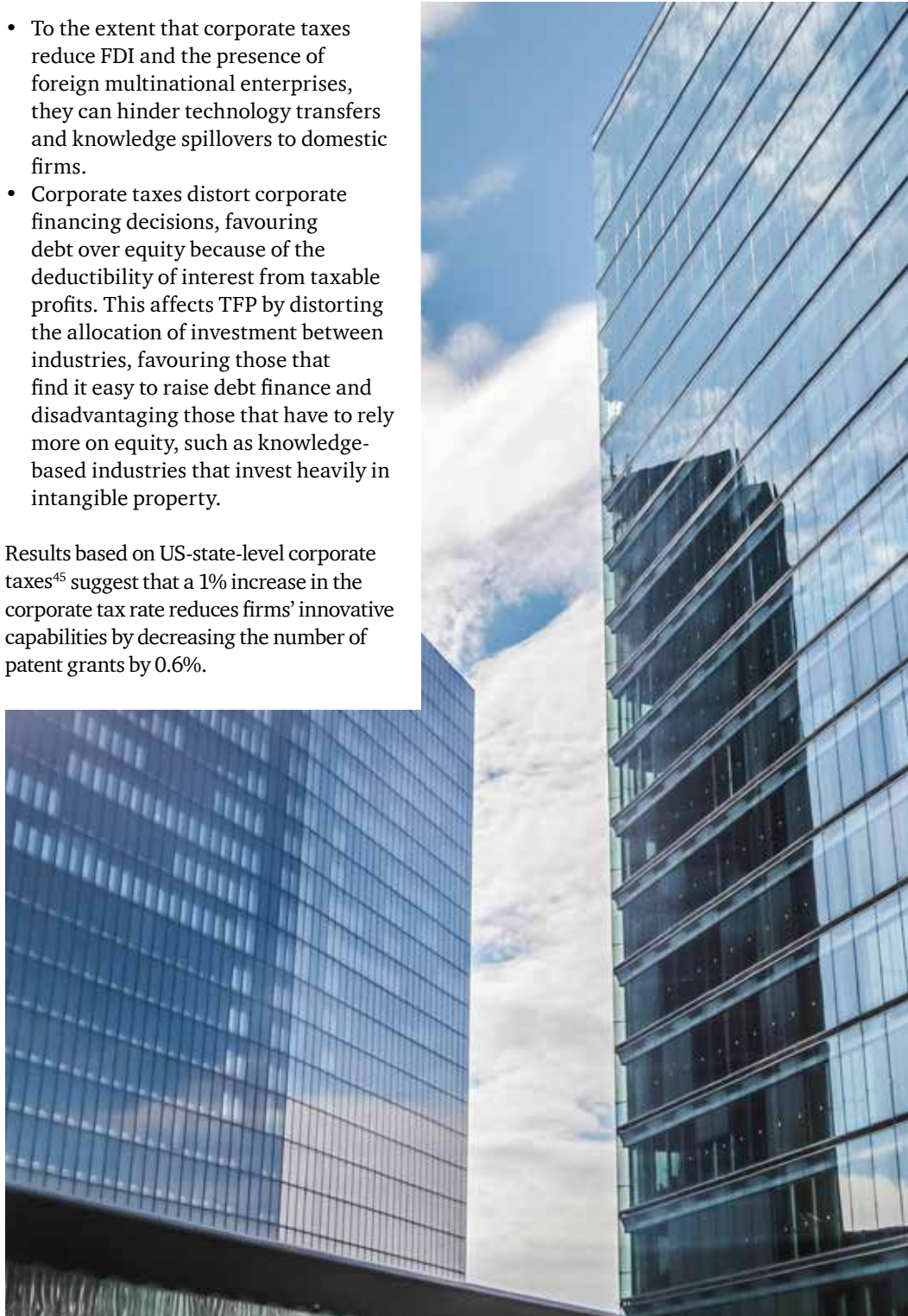
Luxembourg's macroeconomic model

Understanding the Luxembourg corporate tax system involves making a distinction between the nominal tax rate (defined by the Luxembourg tax law) and the implicit tax rate after e.g. tax exemptions, tax rebates or tax deductions have been applied. These adjustments vary depending on the company's individual circumstances. Indeed, unlike what happens in many countries where these adjustments affect the actual amount of taxes paid by companies, it is important to go beyond the statutory tax rate to better understand corporate tax.
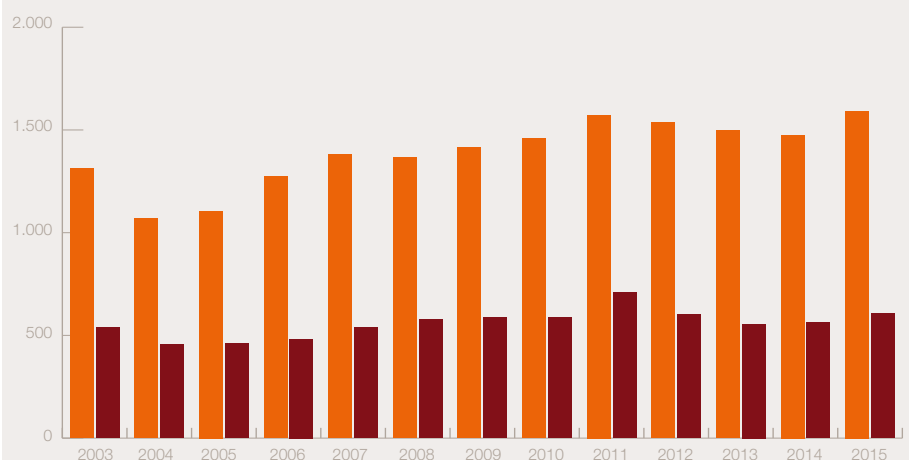
Corporate tax system overview

Basically, the Luxembourg corporate tax includes two branches:

- The corporate income tax (CIT), which has a current rate that amounts to 21%, increased by a 7% solidarity surtax.
- The municipal business tax (MBT), which is determined by each city (for instance: 6.75% for Luxembourg City).

Currently, the combined corporate tax rate in Luxembourg amounts to 29.22%. The majority of corporate tax revenues originate from CIT, with municipal business tax accounting for a lower fraction of total tax revenues.

- Corporate tax revenues from CIT averaged EUR 1,392 million between 2003 and 2015, with 71.7% originating from the financial sector in 2014[46].
- Municipal business tax averaged EUR 559 million between 2003 and 2015[47].
- Soparfis and banks contributed to 50.6% of CIT revenues in 2014.

Figure 3 Changes to CIT and MBT revenues in Luxembourg between 2003 and 2015

Source: CES fiscalité (2015)

Like all other European countries, Luxembourg's corporate tax system provides tax incentives under certain conditions. A few examples are listed below[48]:

- The so-called "participation exemption regime"[49] offers the possibility for qualifying entities to benefit from a CIT exemption on dividends received from qualifying subsidiaries.
- In the same way, the said regime provides for an exemption from corporate income tax, for capital gains realised on qualifying investments held by qualifying entities.
- Inbound and capital investment incentives, such as investment tax credits, are also available to companies in Luxembourg.
- Luxembourg-resident investment funds are exempt from CIT, municipal business tax and net wealth tax on dividends[50]. They are however subject to a subscription tax.

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46. CES fiscalité (2015).
47. Estimation for 2015 using Government Budget data (2016).
48. PwC (2015), Luxembourg – Corporate tax credits and incentives.
49. Transposition of the "Parent-Subsidiary" EU Directive (PwC Flash News (2015), Luxembourg-new corporate tax measures for 2015 and 2016.).
50. Since investment funds are generally tax exempt in most countries, this is again not specific to Luxembourg.

Estimates of the implicit corporate tax rate

The presence of various exemptions leads to a discrepancy between the statutory corporate tax rate and the implicit and effective corporate tax rate in Luxembourg. Although some studies based on the link between the Irish[51] or the UK[52] corporate tax rate and their respective economic activity have used the statutory tax rate, we consider that using the implicit tax rate is a better indicator in order to assess the link between corporate tax rate and economic activity.

Three main approaches exist in the literature in order to estimate the implicit and effective corporate tax rates, i.e. the real tax burden as a proportion of the tax base[53]:

1. **The Model Company approach** compares estimated tax liabilities in different jurisdictions for a benchmark company endowed with certain characteristics.
    *   The approach examines how the profits of such model companies would be taxed across a range of jurisdictions. It therefore gives an estimate of the effective tax rate rather than the implicit tax rate.
    *   While firms can easily be compared across countries with this method, the model cannot represent the composition of all companies that operate in each country.

2. **The National Aggregates approach** determines the implicit corporate tax rate by looking at the average corporate tax burden of the entire corporate sector in a country and using statistics available from a relevant tax authority or statistical agency.
    *   The idea is to measure the total amount of corporate tax in a given year and to divide it by the total amount of profit earned by companies operating in the country.
    *   The main limitation is that operating surplus might deviate from actual profits.

3. **The Combined Company approach** uses published or reported company accounts and determines an aggregate or average measure of tax paid on company income using the data collected.
    *   This method is useful to determine the effective tax rate of the companies included in the sample.
    *   The main limitation is that it can only give a picture of the global effective tax rate paid by companies operating across several jurisdictions and it is not reflective of the corporate income tax imposed by any particular country.

51. FitzGerald J. et al. (2010), The macro-economic impact of changing the rate of corporation tax, Economic modelling.
52. HM Revenue & Customs (2013), Analysis of the dynamic effects of Corporation Tax reductions.
53. Adapted from Department of Finance (2014), Technical paper on effective rates of corporation tax in Ireland.

To calculate the effective tax rate, we consider a hypothetical company and estimate what its tax burden would be. Given that the sector/state of development of the company may impact its tax burden, the effective tax rate may vary substantially from one company to another. This is why we rather estimated the implicit tax rate, which gives an estimate of the overall tax burden in Luxembourg. In order to estimate the implicit corporate tax rate representative of the Luxembourg corporate tax landscape, we have adopted the following approach:

- Our estimations are based on the national aggregates approach using gross operating surplus and total corporate tax paid by companies operating in Luxembourg for the period 1990 to 2014.
- The gross operating surplus was obtained from the macroeconomic database of the European Commission, AMECO.
- Data on corporate tax revenue came from the Budget of the Luxembourg Government and from the OECD tax database.

We estimated the implicit corporate tax rate by dividing the total corporate tax revenue in a given year by the total amount of gross operating surplus earned by companies operating in Luxembourg:

- The implicit corporate tax rate varies between 13.61% in 1990 and 10.62% in 2014. There is a slightly increasing trend until 2002, followed by a downward trend, which is also highlighted in the CES report[54]. Also, the BCL estimated the implicit tax rate and found similar results[55].

Figure 4: Changes to CIT and MBT revenues in Luxembourg between 2003 and 2015

Source: Budget 2016, OECD, AMECO, PwC calculation.
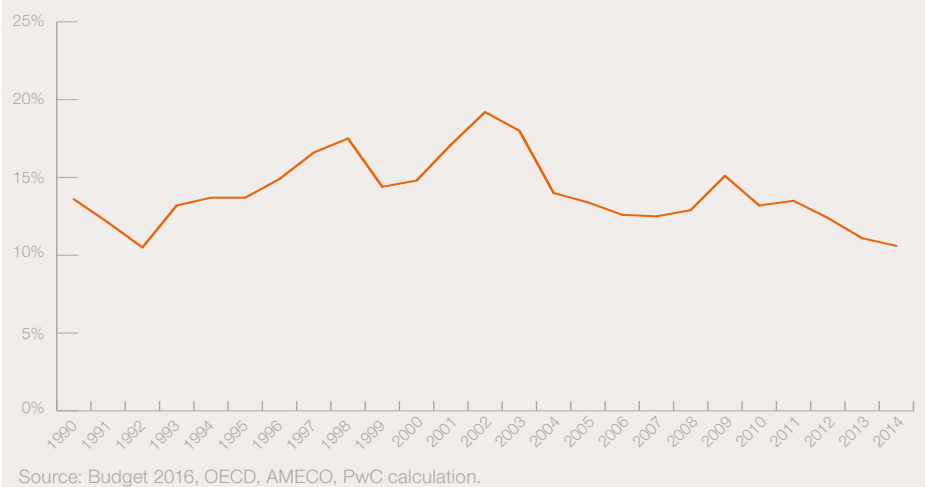
- Since our methodology takes into account all companies operating in Luxembourg, it gives a broad picture of the implicit tax rate without being biased towards one sector.
- The main limitations could be twofold. First, there could be a non-negligible discrepancy between the gross operating surplus and the profits related to the level of capital depreciation. Second, there might be a lag between the tax revenues received by the tax authority and the profits registered by the company such that for a given year, tax revenues might not be yet fully booked.

54. CES Fiscalité (2015), Analyse des données fiscales au Luxembourg.
55. BCL (2016), Avis de la BCL sur les projets de loi concernant le Budget des recettes et des dépenses de l'Etat pour l'exercice 2016 et la programmation financière pluriannuelle pour la période 2015-2019.

Each percentage-point cut in the implicit corporate tax rate boosts GDP by 0.89% and employment by 0.30%

We estimate the effect of implicit corporate tax on the private sector and take into account the distinct channels through which we can arrive at an estimate of the final impact of implicit corporate tax on GDP[56].

The model that we use was developed for Ireland by Thomas Conefrey and John FitzGerald in a paper entitled "The macro-economic impact of changing the rate of corporation tax". The rationale for choosing it is the fact that the Irish economy is comparable to the Luxembourg economy in terms of size, openness and specialisation in financial services. Both countries are the European domiciles of choice for cross-border fund distribution[57] and have the expertise and experience in establishing a wide range of international funds. In addition, they both rank in the top five most open economies in terms of exports of services and goods as a percentage of GDP, with Luxembourg ranking second and Ireland fourth in 2014[58]. But one difference between the two economies is the presence of cross-border workers in Luxembourg, having an immediate impact on employment and hence economic activity in the country. The Irish model also focused on the impact of corporate tax on macroeconomic variables. Finally, it is a sound methodology published in a peer-reviewed journal.

The model assumes that tax policy affects the economy through its impact on exports, employment and value added. It is specified as follows:

1

The first equation expresses exports of services as a function of:

- External demand, which can be approximated by the GDP of other countries. In our case, we use the GDP of the UK, France, Germany and Belgium, which are Luxembourg's main commercial partners. They represent around 50% of total exports of services[59].
- Competitiveness, which is measured through relative wages. Here, we use Luxembourg wages relative to those in Ireland and Switzerland. Those two countries are small, have open economies and a highly developed financial services industry. They are also among Luxembourg's main competitors in financial services and in attracting multinational corporations[60].
- Corporate tax rate. As explained above, we use the implicit tax rate for Luxembourg.

The results of our estimation are as follows:
$$Log(X_s) = -29.94 + 2.89 \, log(GDP_{other}) - 3.06 \, log(W_{LU}/W_{IE,CH}) - 2.32 \, t_{ITR}$$

where X_s are exports of services[61], GDP_{other} is the average GDP of the UK, France, Germany and Belgium, $W_{LU}/W_{IE,CH}$ is the wage rate in Luxembourg relative to the average wage in Ireland and Switzerland and t_{ITR} is the implicit corporate tax rate.

Our results are in line with the findings obtained in the case of Ireland, though the responsiveness of relative wages is higher in Luxembourg:

- Demand from other countries positively affects exports of services: a 1% increase in demand increases exports of services by 2.89%.
- An increase in Luxembourg real wages relative to Irish and Swiss real wages has a negative impact on exports of services: a 1% decrease in competitiveness decreases exports by 3.06%.
- A one-percentage-point increase in the implicit corporate tax rate decreases exports of services by 2.32%[62].

56. More details on the model are provided in Appendix.
57. PwC (2016), Global Fund Distribution poster.
58. World Bank (2014), Development Indicators.
59. STATEC (2014), Annual trade of services and financial services of Luxembourg by partner country.
60. As the UK has a more diversified economy, UK wages do not reflect to a large extent the competitiveness of the financial services industry, therefore we have not included them.
61. It was not possible to distinguish the services exported by the private sector from the ones exported by the public sector for the whole period. However, in the years for which a breakdown was available, we observe that more than 90% of the services exported come from the private sector.
62. The coefficient in the regression is significantly different from zero at the 10% level only. However, it is of plausible magnitude and fully consistent with the results from the Irish study. Therefore, it is considered appropriate for use in the underlying model.

2

The second equation links exports of services to the value added of the sector.

The value added of the private sector is a function of:

- Exports of services, as production in a small country is mainly driven by external demand, and this is particularly true for Luxembourg as it ranks second according to the World Bank[63] in terms of exports of services and goods as a percentage of GDP with 203.3% in 2014.
- The part of domestic demand that generates output for the private sector[64].

The results of our estimation are as follows:

$$\text{Log}(Q_s) = 2.65 + 0.53 \log(X_s) + 0.16 \log(D)$$

where Q_s is the value added of the private sector, X_s the exports of services and D is the domestic demand weighted by input-output coefficients[65].

We find that a 1% increase in exports of services increases the output of the private sector by 0.53%.

Our results are in line with the findings obtained in the case of Ireland, though the responsiveness of relative wages is higher in Luxembourg:

- Consequently, a one-percentage point increase in the corporate tax rate generates a 1.23% decrease in private-sector value added.
- This estimate is somewhat higher than the results for Ireland, but the discrepancy can be explained by the dependency of the overall private sector on its ability to export. As it is an extremely open economy, Luxembourg exports around 85% of its total production (all sectors combined)[66], foreign trade having a significant impact for the private sector[67].

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63. World Bank national accounts data and OECD national accounts data files.
64. To measure this, we have weighted domestic demand by input-output coefficients.
65. See Appendix for further explanation.
66. The official portal of the Grand Duchy of Luxembourg (2015), Foreign trade.
67. The total output of the private sector accounted for 93% of the total output in the country in 2014 (STATEC – Production par branche).

3

The third equation determines employment in the private sector (in terms of the number of people employed), which depends on the wage rate in Luxembourg relative to wages abroad[68] and on the value added of the private sector.

The results of our estimation are as follows:

$$Log(L_s) = -4.53 - 1.80\log(W_{LU}/W_{IE,CH}) + 0.33\log(Q_s)$$

where L_s is employment in the private sector, $w_{LU}/w_{IE,CH}$ is the wage rate in Luxembourg relative to wages in Ireland and Switzerland and Q_s is the value added of the private sector.

We find a strong relationship between the value added of the private sector and employment in the private sector, as a 1% increase in the value added of the private sector increases employment in the corresponding sector by 0.33%. This is consistent data observed for Luxembourg: the employment growth rate is related to GDP growth, with periods of expansion in the economy being followed by increases in employment[69].

Implicitly, this implies that a decrease in the corporate tax rate will generate a substitution effect (as capital becomes cheaper than labour) which is overcompensated for by the output effect (the increased demand in both capital and labour due to increased profitability).

4

Finally, to estimate the overall impact on GDP, we use the following identity: GDP is the sum of the value added in both the private and public sector, plus taxes minus subsidies.

$$GDP = Q_s + Q_p + taxes - subsidies$$

where GDP is the gross domestic product of Luxembourg, Qs is the value added of the private sector and Qp is the value added of the public sector.

Some limitations of our model are as follows:
- We do not have a general equilibrium model, therefore we cannot quantify the multiplier effects of a change in the corporate tax rate, especially on the public sector.
- Nor can we take into account the effect on the wider labour market, e.g. changes in employment after changes in the corporate tax rate.
- The model does not capture the non-linear effect of corporate taxes on the economic variables.
- We do not take into account tax rate differentials across jurisdictions, and assume there will be no change in the corporate tax rate of these jurisdictions.
- We do not have at our disposal a micro data set, preventing us from simulating the sensitivity of investment to implicit corporate tax rate increases across different sectors and types of businesses in Luxembourg.
- We assume the share of the private sector in the GDP remains constant (73% in 2014) to derive the effect of changes in the corporate tax rate on GDP. However, this share has been decreasing slightly, therefore we might overestimate the share of the private sector in the economy, and consequently the impact of taxes on GDP.
- We therefore do not take into account the indirect effects of corporate taxes on the public sector. Consequently, our model assesses the effect of corporate taxes on the private sector only.

Given the results from equations (1) and (2), we can conclude that a one-percentage-point change in the implicit corporate tax rate will lead to a 0.89% change in GDP. For instance, this means that an increase in the implicit tax rate from 10% to 11% will decrease GDP by 0.89% in the long term.

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68. In order to remain consistent with equation 1, we have kept Ireland and Switzerland to compute relative wages.
69. Based on GDP and total employment growth rates from STATEC (2001-2014).

- A one-percentage point increase in the implicit corporate tax rate decreases the exports of services by 2.32%. This is very similar to the results found in Ireland.

- Because the Luxembourg economy is small and very open, it is highly dependent on exports. Consequently, the overall value added of the private sector depends significantly on exports of services in the sector: a 1% increase in exports of services generates a 0.53% increase in the value added of the private sector, the effect being higher than in Ireland.

- In total, we find that a one-percentage-point increase in the implicit corporate tax rate will decrease the value added of the private sector by 1.23% and decrease GDP by 0.89%. As an example, an increase in the implicit tax rate from 10% to 11% will decrease the value added of the private sector by 1.23%, and GDP by 0.89% in the long term.

- Given the characteristics of our model, these estimations correspond to a lower bound rather than to a maximum effect of a change in the corporate tax rate.
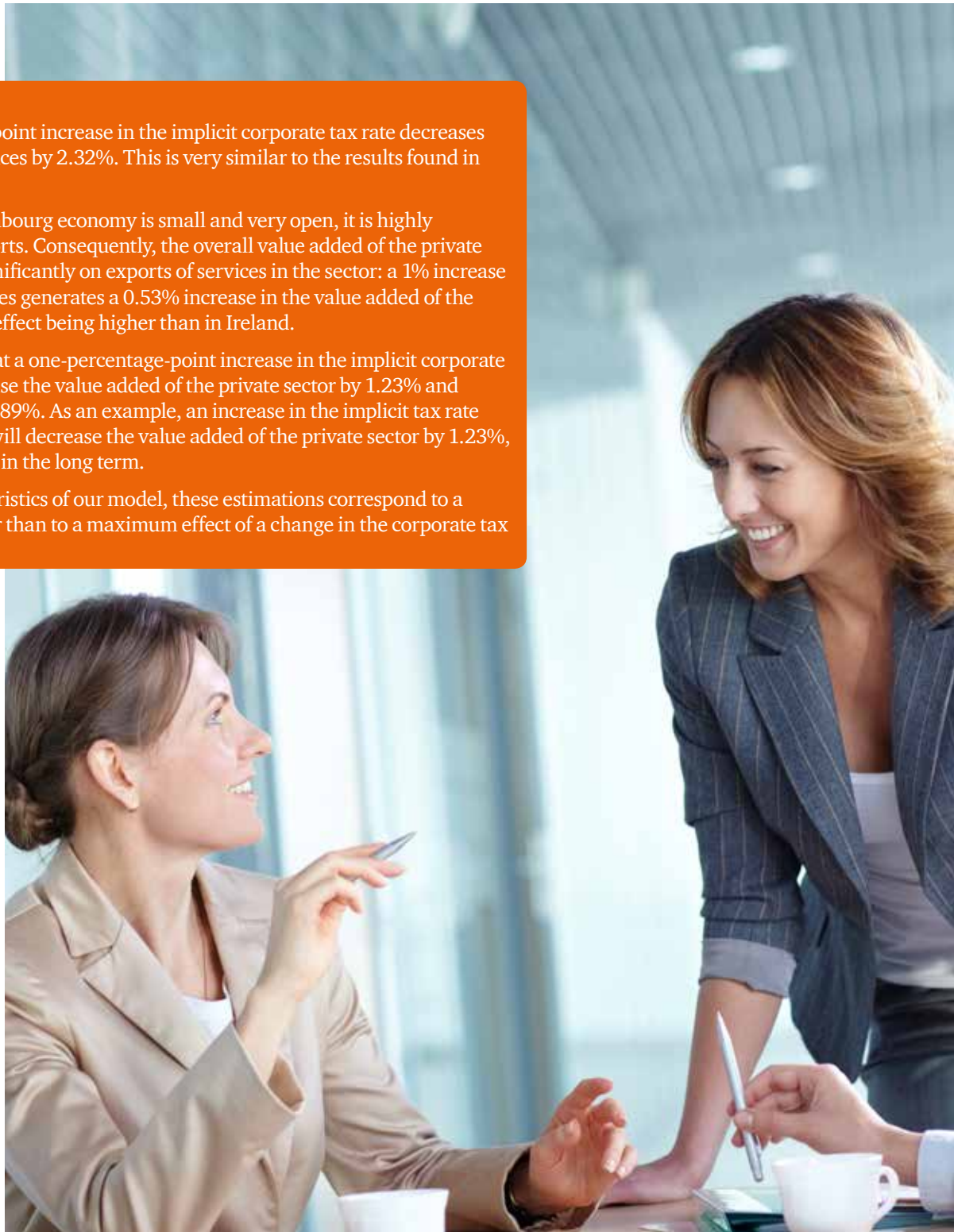
Projections based on potential corporate tax reforms

In this section, we want to measure the impact of changes in the implicit tax rate on the Luxembourg GDP as well as the level of employment in the country and corporate tax revenues. The government has announced an initial package of reforms, but we can expect more will follow, especially in the context of BEPS. Therefore there is no direct link between the changes in the corporate tax rate that we simulate and the announced reforms.
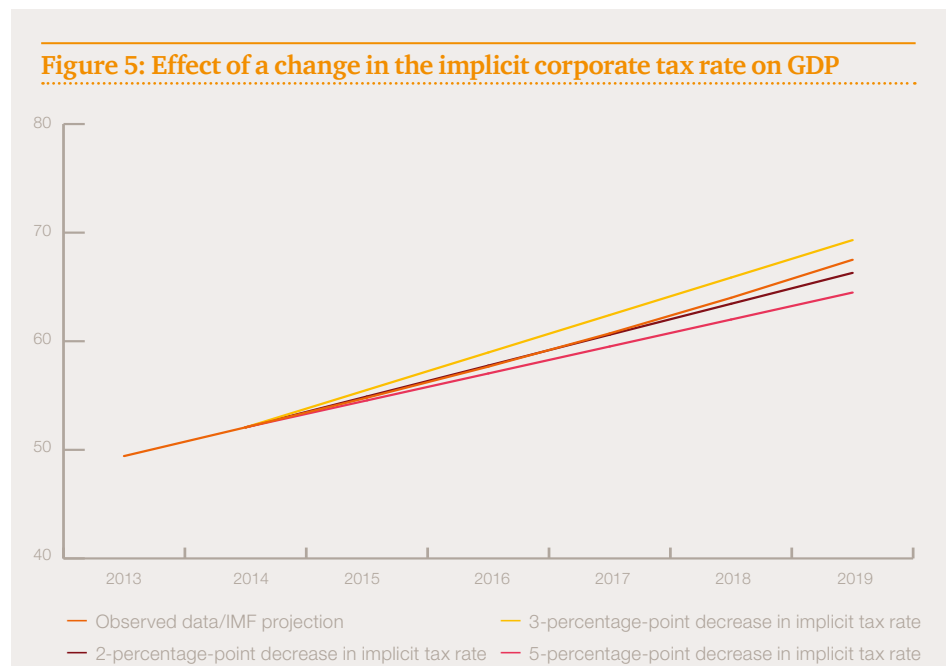
Effect on GDP growth

We have created hypotheses on changes to the implicit tax rate to illustrate the extent to which this may impact economic activity, regardless of what the concrete reforms are. We define the base case scenario as a situation in which the implicit corporate tax rate remains constant, and all other factors also remain constant. Then, we also simulated three scenarios of changes in implicit tax rates: a decrease by 3 percentage points, an increase by 2 percentage points and finally an increase by 5 percentage points.

Effects on the level of GDP using the findings from our estimation model

We have used GDP forecasts provided by the IMF, corresponding to our base case scenario[70].

We have interpreted the elasticity of implicit corporate tax rates to GDP, obtained from our model, as long-term elasticity in order to compute what the resulting GDP would be in each of the scenarios and compare them with the base case scenario.

The findings are illustrated in Figure 5:

Figure 5: Effect of a change in the implicit corporate tax rate on GDP

Legend:
- Observed data/IMF projection
- 3-percentage-point decrease in implicit tax rate
- 2-percentage-point decrease in implicit tax rate
- 5-percentage-point decrease in implicit tax rate

In the case in which the implicit corporate tax rate is cut by 3 percentage points:

- The GDP will increase by 2.68% with respect to what it would be in the base case scenario;
- This corresponds to an additional EUR 1.81 billion by 2020 compared to its forecasted level[71].

70. In the base case scenario, the fact that the UK has decided to cut its corporate tax rate is supposed to have no impact on Luxembourg as long as the forecasts delivered by the IMF do not take this situation into account.
71. All forecasts come from the IMF World Outlook database.

In the case in which the corporate tax rate increases by 2 percentage points:

- The GDP will decrease by 1.79% with respect to what it would be in the base case scenario;
- This corresponds to a loss of EUR 1.21 billion by 2020 compared to its forecasted level[72].

In the case in which the corporate tax rate increases by 5 percentage points:

- The GDP will decrease by 4.47% with respect to what it would be in the base case scenario;
- This corresponds to a loss of EUR 3.026 billion by 2020 compared to its forecasted level[73].

Some limitations of our projections are as follows:

- The estimated elasticities from our model can be interpreted as the long term impact of implicit corporate tax rates on GDP, employment, investment and/or tax revenues, meaning that the estimates correspond to the impact of a corporate tax reform at least 10 years after the implementation of such reform.

- However, because forecasts on GDP, employment, investment and corporate tax revenues are available up to 2020 only, we applied our estimates to these forecasts[74]. Therefore we assume that the full impact of the corporate tax reform will be felt in 2020. In this sense, we may end up anticipating the impact of a corporate tax reform on GDP, employment, investment and corporate tax revenues.
- Finally, as we are not able to model the changes in the wage rate of employees, we assumed that it will remain constant whatever the scenario. However, we could anticipate an increase in wages due to an increase in output for instance. Indeed, an increase in productivity would increase the output which would in turn increase the demand for labour, pushing wages up.
- As mentioned earlier, the model does not take into account all the potential ripple effects of a change in the corporate tax rate, and any change in the corporate tax rate of other jurisdictions.

72. Ibid.
73. Ibid.
74. We could have used some linear extrapolation or other methodology to extend the forecasts up to 2025 but we wanted to avoid making further assumptions.
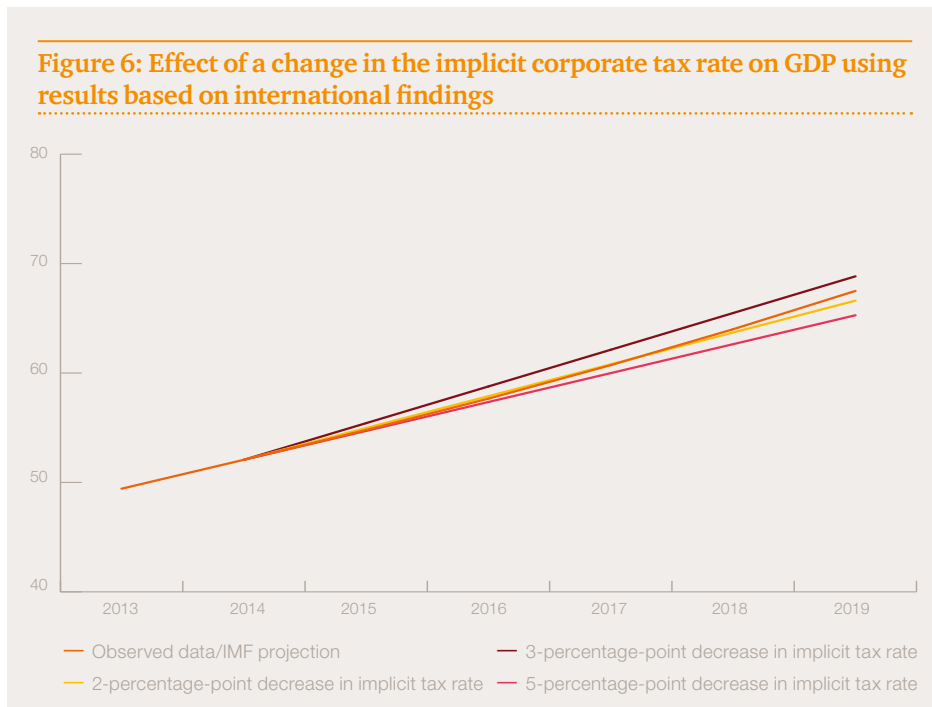
Effects on the level of GDP using international findings

In order to complement the results derived from the model, we have also estimated the long-term impact of our scenarios on GDP in Luxembourg, using findings from other empirical papers.

The elasticity between GDP and corporate tax rate obtained from previous studies is as follows:

- Average GDP-to-corporate-tax-rate elasticity of 0.07[75].

The impact of a change in implicit corporate tax rate on the level of GDP is presented in Figure 6.

Figure 6: Effect of a change in the implicit corporate tax rate on GDP using results based on international findings

Legend:
- Observed data/IMF projection
- 3-percentage-point decrease in implicit tax rate
- 2-percentage-point decrease in implicit tax rate
- 5-percentage-point decrease in implicit tax rate

In the case in which the implicit corporate tax rate is cut by 3 percentage points:

- The GDP will increase by 1.98% with respect to what it would be in the base case scenario;
- This corresponds to an additional EUR 1.33 billion by 2020 compared to its forecasted level[76].

In the case in which the corporate tax rate increases by 2 percentage points:

- The GDP will decrease by 1.32% with respect to what it would be in the base case scenario;
- This corresponds to a loss of EUR 890 million by 2020 compared to its forecasted level[77].

In the case in which the corporate tax rate increases by 5 percentage points:

- The GDP will decrease by 3.29% with respect to what it would be in the base case scenario;
- This corresponds to a loss of EUR 2.22 billion by 2020 compared to its forecasted level[78].

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75. Elasticities calculated from the findings in the literature review were based on the case of Scotland, the UK as a whole and the US. The interpretation is different from the numbers in our model because these numbers are elasticities, meaning that a 1% change in corporate tax rate leads to a 0.07% change in GDP. In our model, we have semi-elasticities, meaning that a one-percentage-point change in the corporate tax rate leads to a 0.85% change in GDP.
76. All forecasts come from the IMF World Outlook database.
77. Ibid.
78. Ibid.

Summary of projections

The effects estimated from the model developed for Luxembourg are slightly higher than the results coming from international studies. This can be explained by the fact that the Luxembourg economy is relatively more open than those of other countries. Also the Luxembourg economy is more reliant on financial services, which are more volatile and sensitive to the corporate tax rate (as mentioned in section *Findings on the economic effects of changes in the corporate tax rate*, p.8).

Therefore, if we use both estimations to define a range of impact for the three scenarios, we can conclude that:
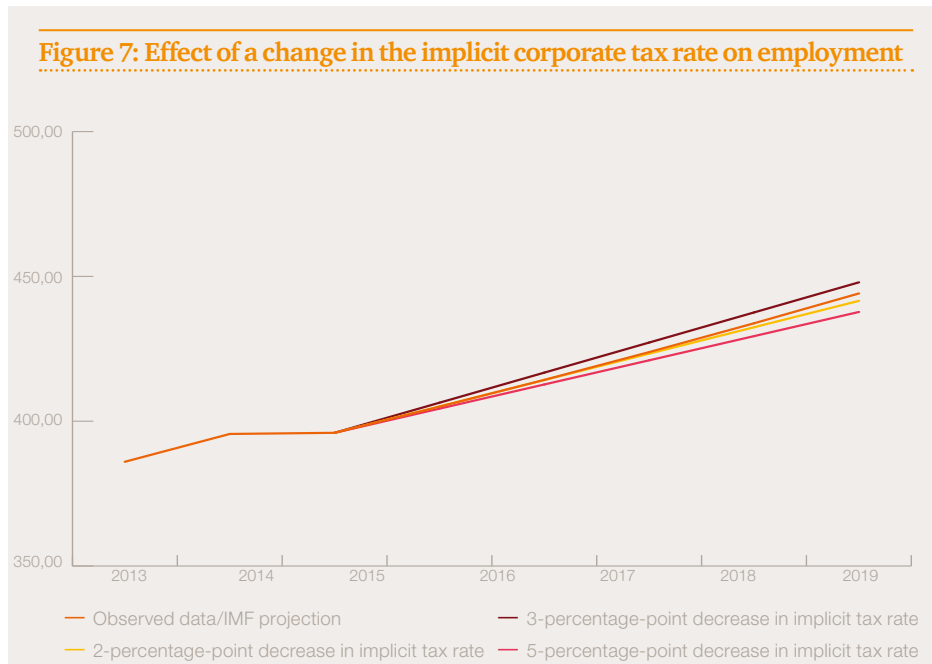
KEY FINDINGS

1. In the case in which the implicit corporate tax rate is cut by 3 percentage points, the GDP will increase between 1.98% and 2.68% with respect to what it would be without any reform.

2. In the case in which the implicit corporate tax rate increases by 2 percentage points, the GDP will decrease between 1.32% and 1.79% with respect to what it would be without any reform.

3. In the case in which the implicit corporate tax rate increases by 5 percentage points, the GDP will decrease between 3.29% and 4.47% with respect to what it would be without any reform.

Effect on employment

We have applied the above-mentioned scenarios to estimate the impact of an implicit corporate tax on the level of employment, using the (long-term) elasticity of employment to implicit corporate tax rate obtained from our estimation model.

We have used the results found in equation (3) to obtain forecasts for employment in the private sector[79]. Regarding the public sector, we assumed it is not affected by such policy changes which we know is not realistic. This way, these estimates correspond to a minimum effect rather than a maximum effect. Forecasts for employment in the public sector were obtained by applying post-crisis growth rates calculated between 2009 and 2014 to existing data from STATEC.

The findings are illustrated in Figure 7 below:

Figure 7: Effect of a change in the implicit corporate tax rate on employment

Legend:
— Observed data/IMF projection
— 3-percentage-point decrease in implicit tax rate
— 2-percentage-point decrease in implicit tax rate
— 5-percentage-point decrease in implicit tax rate

In the case in which the implicit corporate tax rate is cut by 3 percentage points:

- The level of employment will increase by 0.86% with respect to what it would be in the base case scenario;
- This corresponds to an additional 3,836 persons employed by 2020 compared to its forecasted level[80].

In the case in which the implicit corporate tax rate increases by 2 percentage points:

- The level of employment will decrease by 0.58% with respect to what it would be in the base case scenario;
- This corresponds to a loss of 2,557 persons employed by 2020 compared to its forecasted level[81].

In the case in which the implicit corporate tax rate increases by 5 percentage points:

- The level of employment will decrease by 1.44% with respect to what it would be in the base case scenario;
- This corresponds to a loss of 6,394 persons employed by 2020 compared to its forecasted level[82].

There are not relevant elasticities from the international literature to compare our estimations with our findings.

In order to put these estimates into perspective, the number of employees in the Insurance sector is around 6000, in the domiciliation sector it is around 2600[83]. Therefore, our simulations show that a significant share of the labour market could be hit by an increase of the corporate tax rate.

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79. See Appendix for further explanation.
80. All forecasts come from CEDEFOP.
81. Ibid.
82. Ibid.
83. Le secteur de la domiciliation au Luxembourg, Automne 2013, Limsa

Effect on corporate tax revenues

We have used corporate tax revenue forecasts provided in the Government Budget[84], corresponding to our base case scenario.

5

Given that in the base case scenario, the implicit tax rate does not change and corporate tax revenues are given in the Government Budget, we can determine the gross operating surplus for 2020 used as a proxy for profits, through the following equation already used to determine the implicit tax rates:

$\pi(t_{ITR}) = CTR/t_{ITR}$

where π is the gross operating surplus, t_{ITR} is the implicit corporate tax rate and CTR are corporate tax revenues.

6

Then, the relationship between gross operating surplus, value added, employment in the private sector and nominal annual average wage rates is as follows[85]:

$\pi(t_{ITR}) = 1/\alpha * Q_s(t_{ITR}) - w'_{LU} * 1/\beta * L_s(t_{ITR})$

where $\pi(t_{ITR})$ is the gross operating surplus across all sectors, Q_s is the Gross Value Added (GVA) of the private sector, w'_{LU} is the average annual wage per employee across all sectors in Luxembourg, L_s is the number of employees in the private sector in Luxembourg, (α) is the share of the GVA of the private sector on the total GVA and (β) is the share of employment in the private sector on the total employment in Luxembourg.

Assuming that wage rates are constant and using our estimations for the value added and employment in the private sector in each scenario[86], we can derive the corporate tax revenues.

The following table provides our projections for corporate tax revenues in 2020 depending on our 3 scenarios:

Table 5: Impacts of a change in the implicit corporate tax rate on corporate tax revenues

Scenarios	Corporate tax revenues in 2020 (EUR m)	Corporate tax revenues in 2020 (% of GDP)	Corporate tax revenues in 2020 (% of direct tax revenues)
Base case scenario	2,512	3.72%	27.91%
3-percentage-point decrease in the effective corporate tax rate	1,936	2.79%	22.98%
2-percentage-point increase in the effective corporate tax rate	2,837	4.28%	30.42%
5-percentage-point increase in the effective corporate tax rate	3,237	5.02%	33.28%

In the case in which the implicit corporate tax rate decreases by 3 percentage points:

- The corporate tax revenues decrease by EUR 576 million with respect to what they would be in the base case scenario.
- This corresponds to corporate tax revenues accounting for 2.79% of GDP, which represents a decrease of 0.93 percentage points compared to their forecasted level in the base case scenario (3.72%).

This loss of corporate tax revenues would need to be compensated for by increasing tax rates in other areas in order to be budget-neutral. But it would be key to select taxes which are less harmful to economic growth.

The OECD Tax and Economic Growth[87] study established a hierarchy of taxation, where corporate tax ranked as the most growth-damaging form of tax, followed by personal income tax. In this sense, increasing less distortive taxes such as recurrent taxes on

84. CIT forecasts are available until 2019. No forecast is available for the MBT, therefore we applied the growth rate of the CIT to obtain data for 2015-2019. CIT and MBT data for 2020 were calculated by applying a linear trend using the growth rate of the last 3 years projected in the Budget.
85. We use the identity proposed in the paper of reference: FitzGerald J. and Conefrey T. (2010), The macro-economic impact of changing the rate of corporation tax. Also, see Appendix for further explanation.
86. See Appendix for further explanation.
87. OECD (2008), Tax and economic growth.

immovable property or consumption could increase total tax revenues while leaving economic growth relatively unharmed.

In the case in which the implicit corporate tax rate increases by 2 percentage points:

- Corporate tax revenues increase by EUR 325 million with respect to what they would be in the base case scenario.
- This corresponds to corporate tax revenues accounting for 4.28% of GDP which represents an increase of 0.56 percentage points compared to its forecasted level in the base case scenario (3.72%).

In the case in which the implicit corporate tax rate increases by 5 percentage points:

- Corporate tax revenues increase by EUR 725 million with respect to what they would be in the base case scenario.
- This corresponds to corporate tax revenues accounting for 5.02% of GDP which represents an increase of 1.30 percentage points compared to their forecasted level in the base case scenario (3.72%).

The additional tax revenue generated by an increase in the effective corporate tax rate would increase the budget surplus at the expense of the economy as illustrated in the previous sections. However, this would allow the government to lower harmful taxes such as personal income tax, the second-most harmful tax for economic growth[88]. This might be of special relevance, as Luxembourg has among the highest labour costs in Europe[89].

It is important to stress the limits of this exercise:

- We assume that the annual wage will remain constant. This assumption is of importance as we have found in the literature that, on average, when the corporate tax rate increases, part of it is actually paid by workers through lower wages.
- The model does not take into account the indirect effect of a change in the implicit corporate tax rate on the public sector.
- We only simulate the effect of changing the implicit tax rate in a neutral manner, meaning affecting all companies in the same way[90], and assume no change in the corporate tax rate of other jurisdictions.
- Estimations do not distinguish between the short-term and long-term impact of reforms. Indeed, a reduction in the implicit corporate tax rate decreases corporate tax revenues in the short run, but this loss is partially offset by higher economic activity.
- Finally, such models will be most useful for limited changes around the benchmark. However, large changes could produce even more uncertain impacts, as the relationship between implicit corporate tax cuts and profits could be much more non-linear. Indeed, it could be at a small increase in tax rate that Luxembourg could hit a threshold where all mobile firms leave for cheaper countries.

The fact remains that this model enables us to point out that a limited cut in the implicit corporate tax rate could increase GDP with a limited impact on tax revenues: the cost of reducing the implicit corporate tax rate by 3 percentage points will be a loss of around EUR 576 million, but will increase GDP by around EUR 1.81 billion.

However, a substantial rise in the implicit tax rate could see a major outflow of activity and a fall in GDP, as well as a significant fall in tax revenues. Even though the model predicts that tax revenues will still increase when the implicit tax rate increases by 5 percentage points, we can predict that past a certain threshold, all mobile companies will leave for more attractive countries.

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88. Ibid.
89. Centre d'observation économique et de Recherche pour l'Expansion de l'économie et le Développement des Entreprises.
90. As we do not have at our disposal a micro data set, we cannot simulate the sensitivity of investment to corporate tax rate increases across different sectors and types of businesses in Luxembourg.

Linking the implicit tax rate to the statutory tax rate

Our estimation model and impact of the corporate tax rate on key macroeconomic variables and the corporate tax revenues, are expressed in terms of changes in the implicit tax rate. To get results that are more easily interpretable, we have decided to convert the changes in the implicit tax rate into corresponding changes in the statutory tax rate.

In order to do so, we specified several identities to find the sensitivity between the statutory and implicit tax rates.

1

First, total corporate tax revenues (CTR) are equal to the product of the statutory tax rate (t_{STR}) and the sum of all taxable items (x_1, x_2, x_4). These x_1, x_2, x_4 correspond to taxable items according to the Luxembourg fiscal law. The missing item x3, in this example, corresponds to an item which is exempt from taxation.

$CTR = t_{STR} * (x_1 + x_2 + x_4)$

For convenience of notation, we define $X = x_1 + x_2 + x_4$ as total taxable profit, which allows us to express the corporate tax revenues in terms of the statutory tax rate and total taxable profits:

$CTR = t_{STR} * X$

2

Our second identity relies on the relationship previously established between the implicit tax rate (t_{ITR}) and corporate tax revenues. We have seen that the implicit tax rate is equal to the ratio between total corporate tax revenues and total profits (proxied in our case by the total amount of gross operating surplus).

$t_{ITR} = CTR/\pi$

Combining the first two identities, we find an expression for the sensitivity between the implicit and statutory tax rates:

$t_{ITR} = t_{STR} * (X/\pi)$

where X/π is the ratio of taxable profit on total profit.

From this identity, it becomes clear that $X = \pi$ corresponds to a situation in which there are no exemptions from taxation and therefore, changes in the implicit tax rate are similar to changes in the statutory tax rate. In a situation with tax exemptions, total taxable profits (X) will be lower than total profits (π) as t_{STR} will not be applied to the full profit earned by companies. Such situations result in a non-perfect correspondence between statutory and implicit tax rates. Finally, the case of $X > \pi$ is not plausible as this would imply that companies are being taxed on more than their total profits.

3

Rearranging the last identity, we derive the sensitivity between the statutory and implicit tax rates:

$t_{STR} = t_{ITR} * (\pi/X)$

Applying this reasoning to our three scenarios, we obtain the following:

Table 6

Changes in the implicit corporate tax rate	Changes in the statutory tax rate
Reduction by 3 percentage points	Reduction by 8.25 percentage points
Increase by 2 percentage points	Increase by 5.50 percentage points
Increase by 5 percentage points	Increase by 13.75 percentage points

Our findings for GDP, employment and corporate tax revenues (with respect to what they would be in the base case scenario) when expressed in terms of changes in the statutory tax rate are summarised below:

In the case in which the statutory tax rate is cut by 8.25 percentage points:

- The GDP will increase by 2.68%;
- The level of employment will increase by 0.86%;
- Corporate tax revenues will decrease by 22.92%

In the case in which the statutory tax rate increases by 5.50 percentage points:

- The GDP will decrease by 1.79%
- The level of employment will decrease by 0.58%
- Corporate tax revenues will increase by 12.95%

In the case in which the statutory tax rate increases by 13.75 percentage points:

- The GDP will decrease by 4.47%
- The level of employment will decrease by 1.44%
- Corporate tax revenues will increase by 28.88%

The main limitations of such sensitivity measure between the implicit tax rate and the statutory tax rate are as follows:

- The identity to determine the link between the statutory tax rate and the implicit tax rate assumes that tax exemptions remain constant. The estimation of the sensitivity between the two corporate tax rates therefore only applies when $X = x_1 + x_2 + x_4$ is held constant. This means we consider the case in which the tax policy does not change, i.e. there is no measures to increase the taxable base.
- We determine the impact of a change in the implicit tax rate on the statutory tax rate by applying the identity: $t_{STR} = t_{ITR} * (\pi/X)$ using 2014 data. This means that we have measured the sensitivity between statutory and implicit tax rates for the latest available data point. Consequently, our model would be weaker in the case of a high volatility of the relationship between statutory and implicit tax rates for the past years.

Conclusions

In this report, we have presented a model to estimate the impact of a change in the implicit corporate tax rates on several macroeconomic variables such as GDP, employment and corporate tax revenues. The model constitutes a first attempt to estimate the relationship between the implicit corporate tax rate and macroeconomic variables in Luxembourg with projections to quantify the long-term impacts by 2020.

No previous study had examined the Luxembourg economy from this angle such that we based our analysis on a model presented in an academic paper related to the Irish economy. The results obtained do not differ drastically from studies conducted in various countries. Nevertheless, we estimated a higher elasticity between macroeconomic variables and the implicit corporate tax rate in Luxembourg. To get results that are more easily interpretable, we have decided to express these changes in the implicit tax rate in corresponding changes in the statutory tax rate. The identities specified in section ***Linking the implicit tax rate to the statutory tax rate*** (p.27) allowed us to derive the sensitivity between the statutory and implicit tax rates and convert our model predictions into changes in statutory tax rate.

The effects measured in the study are prudent rather than aggressive. Because we cannot capture all of the ripple effects a change in the corporate tax rate will have, our measurement will likely underestimate the impact on GDP and employment. This also applies to tax revenues. Because the estimated increase in tax revenues due to an increase in the corporate tax rate can be interpreted as a maximum, the actual impact would likely be lower. On the other side, we

Table 7

| Scenarios | | Impact Assessment | | |
Changes in the implicit corporate tax rate	Changes in the statutory corporate tax rate	% change in GDP	% change in total employment	% change in corporate tax revenues
Reduction by 3 percentage points	Reduction by 8.25 percentage points	+2.68%	+0.86%	-22.92%
Increase by 2 percentage points	Increase by 5.50 percentage points	-1.79%	-0.58%	+12.95%
Increase by 5 percentage points	Increase by 13.75 percentage points	-4.47%	-1.44%	+28.88%

are overestimating the loss in the tax revenues associated with a decrease in the corporate tax rate as we cannot capture all of the effects on the economy in light of fiscal competition across jurisdictions.

While our model captures the impacts of a change in the implicit corporate tax rate on selected macroeconomic variables, it could be further improved by implementing a sectorial analysis and hence looking at the distinct effects on various sectors, recognising that they are not equally sensitive to corporate tax rates.

In order to account for the multiplier effects an implicit corporate tax rate change induces, it could also be interesting to use a general equilibrium model and capture the interdependencies of the economy. This would allow us to estimate the indirect impacts of an implicit corporate tax change and quantify its effect on the whole economy.

It must be stressed that the methodology chosen to calculate the implicit corporate tax rate in this report is only one among many approaches, therefore it is an approximation based on the data available rather than a unique measure of the implicit corporate tax rate.

Finally, it could be interesting to capture the non-linear effects of a change in the implicit corporate tax rates. The results in this report assume the impacts of a corporate tax reform on GDP and employment are linear. Enhancing our findings by taking into account the non-linear responsiveness of our various macroeconomic variables would therefore better highlight the various channels through which such a policy affects the whole economy. However, in this model, the relationship between the implicit tax rate and tax revenues is non-linear. Indeed, a rise in the implicit tax rate raises tax revenues but has a negative impact on the tax base. Therefore, at a specific threshold, the reduction in the tax base overcompensates for the increase in the implicit tax rate.

Whatever the limitations, we hope this report can help to enhance and contribute to the debate on taxation and on the means to achieve sustainable growth. Discussion is indeed necessary: if no corporate tax reform is put in place, the implementation of the BEPS requirements will increase the implicit corporate tax rate, considered one of the most growth-damaging taxes.

Reforming the corporate tax system is finally a substantial opportunity to diversify the Luxembourg economy as it could attract financial and non-financial corporations through tax incentives. Therefore, finding the right balance between tax revenues and GDP growth should take into account the long-term objectives for the Luxembourg economy.

Appendix 1

In the following appendix, we explain our data sources and the methodology chosen to estimate the impact of the implicit corporate tax rate on economic activity in Luxembourg, as well as our strategy for the simulation exercises. We detail our methodology to estimate the effect of a change in the corporate tax rate on corporate tax revenues in Appendix 2.

Table 8 summarises the data we used throughout our estimation model:

Table 8: List of data sources

Variable	Symbol	Coverage	Source
Exports of services	X_s	1990-2014	AMECO
GDP Luxembourg (UK, Belgium, France and Germany)	GDP_{LU} (other)	1990-2014	AMECO
Average annual nominal wages in Luxembourg	w'_{LU}	2000-2014	STATEC
Annual real wages	$w_{LU}, w_{IE,CH}$	1990-2014	OECD
Statutory corporate tax rate	t_{STR}	2000-2014	OECD
Implicit corporate tax rate	t_{ITR}	1990-2014	PwC calculation
1. Tax revenues			Government Budget
2. Gross operating surplus	π		AMECO/ STATEC
Value added of the private (public) sector	$Q_{s(p)}$	1990-2014	PwC calculation based on STATEC and AMECO
Domestic demand weighted by input-output coefficients	D		PwC calculation
1. Domestic demand		2000-2011	AMECO
2. Input-output coefficients			OECD
Employment (in the private sector)	$L_{(s)}$	1990-2014	PwC calculation based on STATEC and AMECO
Corporate tax revenues	CTR	1990-2019	Government Budget

To estimate the effect of a change in the implicit corporate tax rate on economic activity, we have adapted a model applied to the case of Ireland and developed by John D. FitzGerald and Thomas Conefrey[91].

We have slightly adapted it to fit our purpose of estimating GDP, whereas the model for Ireland aimed to assess the impact of corporate tax on GNP. This is why we have not measured profit repatriation.

In the end, we have replicated the first three equations from the Irish model, as well as identities for GDP and corporate tax revenues to come up with an estimate of the impact of implicit corporate tax changes on these two variables.

Other differences between our model and the Irish estimation were due to restricted data availability as well as the different corporate tax landscape in the two countries.

- The Irish study focuses mostly on data between 1970 and 2005, whereas our model covers the years 1990-2014 (unless otherwise stated). This shorter time span is explained by the absence of available data for Luxembourg.
- The statutory corporate tax rate is not significantly different from the implicit corporate tax rate in Ireland; however, due to the many exemptions available, the implicit tax rate differs markedly from the statutory one in Luxembourg, unlike in many other countries.

In what follows we explain our three main equations used to estimate the impact of a corporate tax on economic activity.

91. John D. FitzGerald & Thomas Conefrey (2010), The macro-economic impact of changing the rate of corporation tax.

1

The first equation estimates exports of services.

$$\log(X_s) = \alpha + \beta * \log(GDP_{other}) + \gamma * \log(W_{LU}/W_{IE,CH}) + \delta * t_{ITR}$$

Our results for Luxembourg are summarised in the following equation:

$$\log(X_s) = -29.94 + 2.89 \log(GDP_{other}) - 3.06 \ \log(w_{LU}/W_{IE,CH}) - 2.32 \ t_{ITR}$$
$$ (-14.35) \quad (20.6) \qquad\qquad (-3.29) \qquad\qquad (-4.18)$$

$R^2 = 0.9958$ $\qquad\qquad$ Estimation period: 1990-2014, excluding 2009[92]

Much like Ireland, Luxembourg's economy is extremely open and so the activity of the services sector is essentially orientated towards exports.
- The exports of services depend on the level of activity in neighbouring countries as well as the UK. The reason for this is that Germany, France, Belgium and the UK represent around 50% of total exports of services from Luxembourg[93]. We expect the coefficient on this variable to be positive, meaning an increase in external demand from these countries would increase the exports of services in Luxembourg.
- To measure the cost competitiveness of the Luxembourg economy, Luxembourg annual real wages, relative to Irish and Swiss annual real wages, are included in the equation.
- Finally, the implicit tax rate captures the impact of a change in the corporate tax rate in Luxembourg on exports of services. The implicit corporate tax rate was obtained by dividing the total amount of taxes paid by companies in Luxembourg by the gross operating surplus, used as a proxy for company profits.

2

The second equation estimates the value added of the private sector.

$$\log(Q_s) = \alpha + \beta * \log(X_s) + \gamma * \log(D)$$

Our results for Luxembourg are summarised in the following equation:

$$\log(Q_s) = -2.65 + 0.53 \log(X_s) + 0.16 \ \log(D)$$
$$ (8.20) \quad (23.79) \qquad (3.79)$$

$R^2 = 0.9956$ $\qquad\qquad$ Estimation period: 2000-2011

The value added of the private sector must satisfy external demand (represented by exports) and domestic demand.
- Neither STATEC nor AMECO compile statistics about private-sector exports. Alternatively, we use the export of services as a proxy, since a large share comes from the private sector.
- We use input-output coefficients to compute domestic demand.

---

92. The year 2009 is excluded from our regression because some measures have created a disconnection between tax revenues and the economic activity in that year.
93. STATEC (2014), Annual trade in services and financial services of Luxembourg by partner country.

3

The third equation estimates private-sector employment.

$$\log(L_s) = \alpha + \beta * \log(W_{LU}/W_{IE,CH}) + \gamma * \log(Q_s)$$

Our results for Luxembourg are summarised in the following equation:

$\text{Log}(L_s) = -4.53 + 1.80 \log(w_{LU}/W_{IE,CH}) + 0.33 \log(Q_s)$
$\qquad\quad (-12.63) \quad (-4.45) \qquad\qquad\quad (10.63)$

$R^2 = 0.9870$ $\qquad\qquad$ Estimation period: 1990-2014

Private-sector employment is determined by the differential in annual real wages between Luxembourg and Ireland and Switzerland as well as the value added of the private sector.
- To be consistent with the first equation, we compared Luxembourg wages with the average of Irish and Swiss ones. Therefore we obtained significant coefficients where higher wages in Luxembourg with respect to Ireland and Switzerland led to a decrease in the number of workers employed as the cost per worker is higher. This result is also consistent with the paper from John D. FitzGerald and Thomas Conefrey on Ireland.
- In recent years, we have observed that growth in the Luxembourg economy generated a significant increase in employment. More specifically, our third equation denotes that higher value added of the private sector implies increased demand for employees. In fact, a 1% increase in the value added of the private sector results in a 0.33% increase in the number of people employed by the corresponding sector.

4

Identity:

$$GDP = Q_s + Q_p + taxes - susbsidies$$

This identity relates the GDP to the gross value added of both the private and public sector, adding taxes and subtracting subsidies.

- The GDP is determined by the gross value added of the private sector, which is influenced by changes in the corporate tax rate as estimated in equations 1 and 2, and by the value added of the public sector (adding taxes and subtracting subsidies), which in our model is assumed to be insensitive to changes in corporate tax rates.
- To estimate the long-term effect of changes in the corporate tax rate on GDP, we used IMF forecasts that are made until 2020. Moreover, we found out that the share between private and public sector remained fairly constant between 2000 and 2014, oscillating between 73 percent and 76 percent. Thus, we applied the 2014 share of 73 percent to the GDP to find the part of the GDP coming from the private sector that is influenced by a change in the corporate tax rate. The other 27 percent, which represents the value added of the public sector, is supposed to grow at the rate of the IMF forecast. As such, we can obtain a revised forecast of the GDP, following a change in the corporate tax rate.

Appendix 2

In this appendix, we explain the steps we followed to estimate the effect of a change in the implicit tax rate on corporate tax revenues in the year 2020.

1

First step: collecting data from 2000 to 2014

Corporate tax revenues must satisfy the following identity:

$$CTR = \pi(t_{ITR}) * t_{ITR}$$

where CTR represents the total amount of corporate tax revenues as booked in the state budget, $\pi(t_{ITR})$ is the gross operating surplus across all sectors as a proxy for profits and t_{ITR} is the implicit corporate tax rate.

Corporate tax revenues depend on both profits and implicit tax rates. We expect that a higher implicit corporate tax rate will both increase t_{ITR} and reduce $\pi(t_{ITR})$. So depending on which effect is the strongest, corporate tax revenues could both increase or decrease. In the economic literature, these opposite effects on corporate tax revenues are synthesised as the Laffer curve.

The profit is explained by gross value added when the wage bill is subtracted as in the following equation:

$$\pi(t_{ITR}) = 1/\alpha * Q_s(t_{ITR}) - w'_{LU} * 1/\beta * L_s(t_{ITR})$$

where $\pi(t_{ITR})$ is the gross operating surplus across all sectors as a proxy for profits, Q_s is the Gross Value Added (GVA) of the private sector, w'_{LU} is the average annual wage per employee across all sectors in Luxembourg, L_s is the number of private-sector employees in Luxembourg, α is the share of the GVA of the private sector on the total GVA and β is the share of private-sector employment on total employment in Luxembourg.

We have used private-sector gross value added and employment since our model can capture the effect of a variation in the implicit corporate tax rates on these two variables.

2

Second step: projecting the data to 2020

1. Projections for $\pi(t_{ITR})$

To project profits, we reshuffled the above identity for corporate tax revenues.
$\pi(t_{ITR}) = CTR/t_{ITR}$

The Luxembourg government publishes projections on corporate tax revenues until 2019; we have used the same growth rate as it assumes in its model to find data for 2020. Consequently, we can derive profits in 2020 for our baseline scenario where the implicit tax rate stays the same from 2014 to 2020.

2. Projections for Q_s

For Q_s, we have estimated the data for 2020 based on IMF projections for GDP in Luxembourg. IMF projects an average growth rate of 5.3% from 2015 to 2020. We have applied the same growth rate to the gross value added to find data for 2020.

3. Projections for L_s

For L_s, we have used the following equation derived from our model to be able to project employment:

$\log(L_s) = -4.53 - 1.80\log(w_{LU}/W_{IE,CH}) + 0.33\log(Q_s)$

We took the data that we estimated for Q_s based on IMF projections and supposed that the share between the wages in Luxembourg and Ireland and Switzerland remained constant from 2014 to 2020.

4. Projections for α and β

We supposed that α remained constant between 2014 and 2020. More precisely, the share of private-sector GVA on total GVA (α) was 82% in 2014. This share was applied for the share as at 2020.

To estimate β, we independently projected the number of public-sector employees using the after-crisis compounded growth rate since public-sector employment increases linearly with low variance. We have projected private-sector employment based on the model described above. As a result, the share of private-sector employment on total employment in Luxembourg (β) was estimated at 71% in 2020.

5. Projections for w'_{LU}

w'_{LU} is the variable that closes the identity. We did not estimate it but deduced it based on the other variables. We checked whether w'_{LU} was in line with past growth rates doing linear projections to ensure that the model is well parametrised.

3

Third step: simulating changes in the implicit corporate tax rate on profits in 2020

In the following equation, there are several underlying variables affecting corporate tax revenues.

$CTR = \pi(t_{ITR})*t_{ITR}$

Indeed, within the profit $\pi(t_{ITR})$, both Q_s and L_s are affected by a change in t_{ITR} as depicted in our model. We have used the equations for L_s and Q_s that we estimated for Luxembourg to find the overall effect of a change in the implicit corporate tax rate on the profit.

Interestingly, a change in the implicit corporate tax rate will not lead to a symmetric change in corporate tax revenues. This is due to the fact that the baseline scenario (0%) does not maximise CTR such that we are not at the top of the Laffer curve.

Appendix 3

In this appendix we highlight the difference that must be drawn between the interpretation of semi-elasticity and elasticity.

Semi-elasticity measures the percentage change in a variable with regard to an absolute change in another variable.

- The results from our estimation equations in section 4.3. are expressed in semi-elasticity form, that is we measure the percentage change in exports of services, output of the private sector and GDP following a one-percentage-point change in the corporate tax rate.
- As an illustration, a 3-percentage-point increase in the implicit corporate tax rate from 11% to 14% would lead to a 2.67% decrease in the Luxembourg GDP (elasticity of 0.89 x change of 3 percentage points).
- The simulation exercise in section 5.1 on Luxembourg is based on the semi-elasticity estimates from our model.
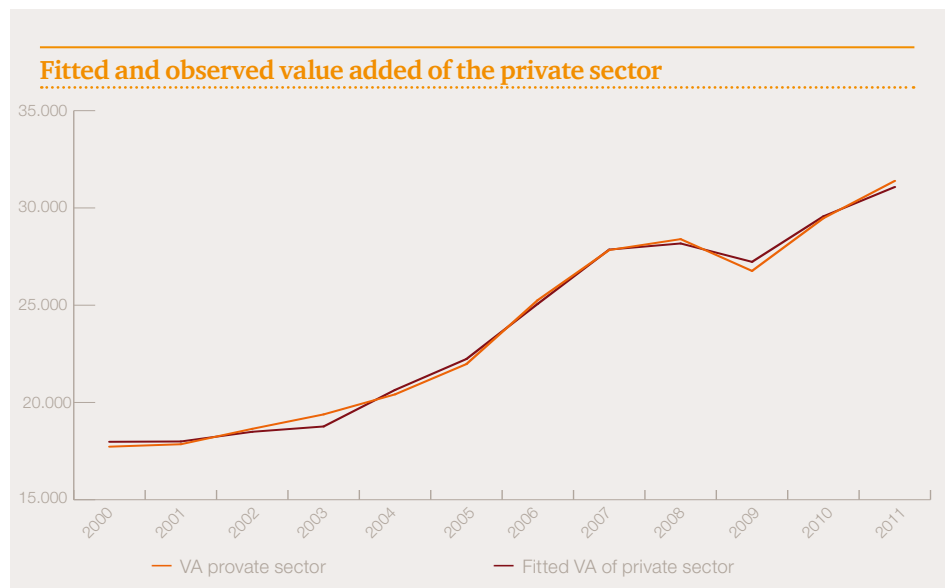
In contrast, elasticity measures the percentage change in one variable with regard to a 1% change in another variable.

- The results mentioned in the literature review in section 3 (except for the impact on economic growth) are expressed in elasticity form; that is we represent the percentage change in investment, investment location decision, employment and firms' innovative capabilities.
- As an illustration, increasing the effective tax rate from 11% to 14%, which corresponds to a 27% increase, would decrease the probability of choosing a country (in that case Ireland since the results come from a model applied to the country) on average by 32.4% (elasticity of 1.2 x change of 27%).
- The simulation exercise in section 5.2. is based on average elasticities found in the literature, therefore the results of the two simulation methods (in sections 5.1. and 5.2) differ from each other.

Appendix 4

The following appendix compares predicted values for exports of services, value added and employment in the private sector using the results of our three estimation equations with the observed data publicly available for these variables.

We can be confident with our estimation results since the two series (fitted and observed) follow the same pattern, meaning our estimated values for exports of services, value added and employment in the private sector describe the observed data well.

Fitted and observed exports of services

— Export of services   — Fitted exprts of services

Fitted and observed value added of the private sector

— VA provate sector   — Fitted VA of private sector

Because our estimation model for private-sector employment explains the observed data well, we have used the fitted values from our third estimation equation to predict the level of private-sector employment in the long term.
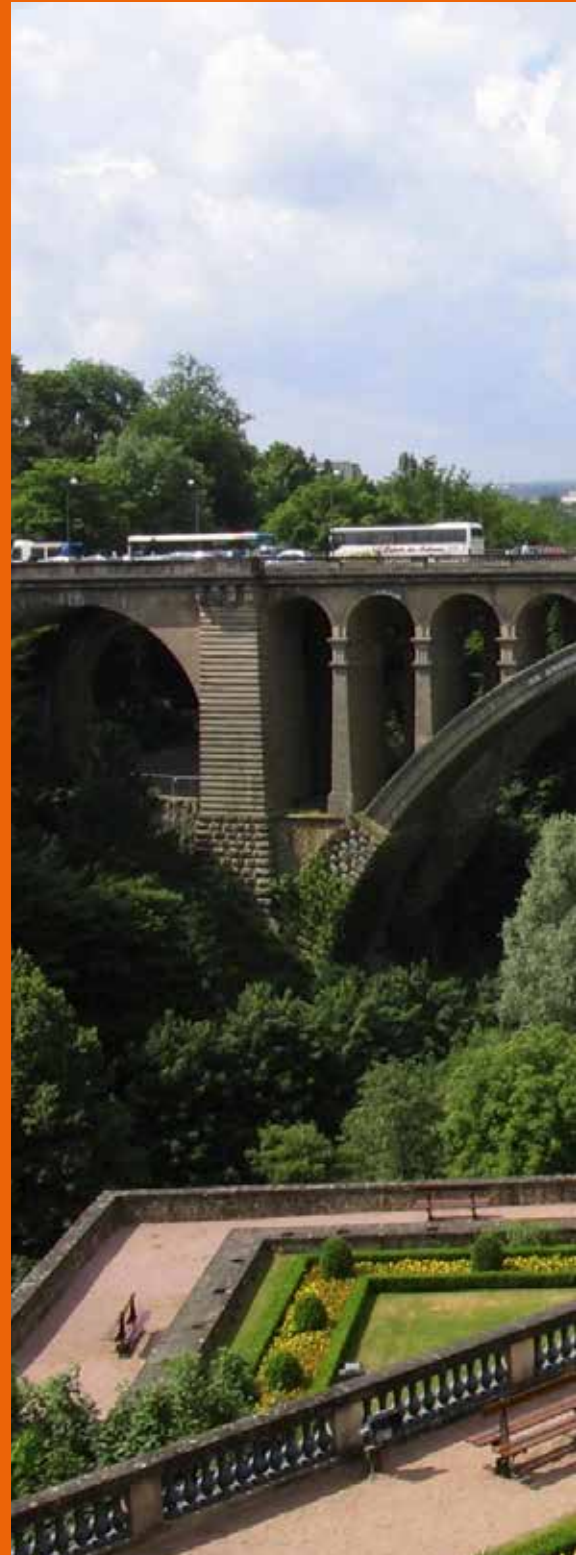
Fitted and observed employment in the private sector

— Employment in the private sector   — Fitted employment in the private sector

Notes
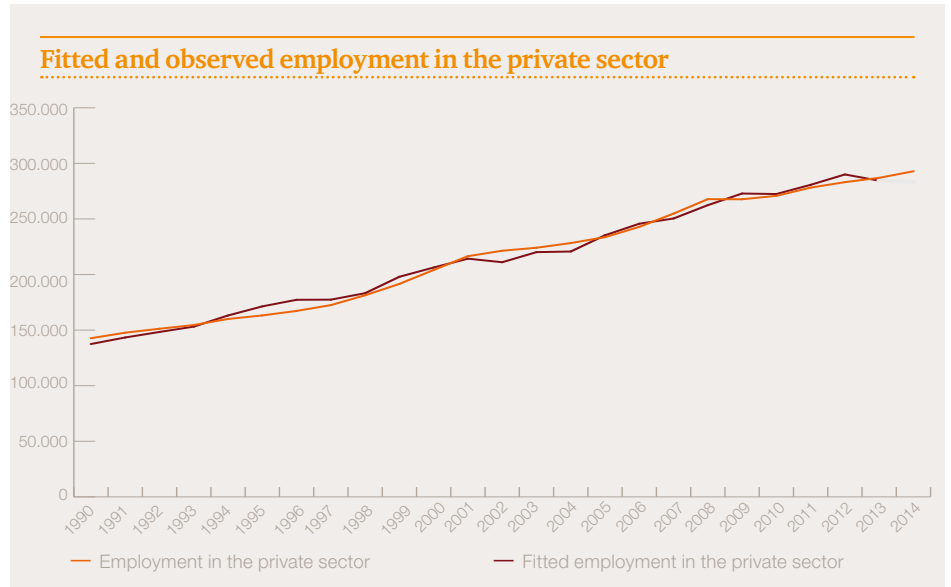
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