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Towards a European R&D Incentive? An assessment of R&D Provisions under a Common Corporate Tax Base

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Abstract

EU businesses underinvest in R&D which is a driver of economic growth and productivity. While the world is becoming more R&D-intensive, the relative weight of the EU is decreasing, mainly due to the rapid rise of China. Taxation has been increasingly used to stimulate investment in R&D. A recent proposal for a Common Consolidated Corporate Tax Base (CCCTB) across the European Union (EU) includes an R&D incentive. This paper presents the rationale for the inclusion of R&D provisions, quantifies the subsidy implied by alternative options using the user's cost approach and approximates aggregate impacts by means of simple extrapolations from elasticities found in literature. We find that the CCCTB without an R&D incentive would significantly deteriorate incentives to invest in R&D. We present alternative options and argue that the level of support should be ambitious to address the pressing need in the EU to invest more, stay globally competitive and reach the EU's target of investing 3% of its GDP in R&D. Importantly, to take full advantage of the opportunities offered by this tax reform, EU member states will have to coherently mobilise a range of policies and engage in complementary non-tax interventions in their national innovation systems. We conclude with a broad consideration of what these may be for the varied and variably developed business innovation capabilities found across the EU.

1 Introduction

To correct the tendency of the market to underinvest in R&D, most European Union (EU) member states treat R&D expenditures favourably. Tax support for R&D has been increasing in recent years, particularly in the aftermath of the Great Recession. At the same time in response to the sizeable challenges posed by base erosion and profit shifting, the European Commission has put forward a proposal for an EU Common Consolidated Corporate Tax Base (CCCTB) (European Commission, 2016). The CCCTB proposes a single set of tax rules for businesses, including on R&D treatment. Back in 2011, a previous European Commission proposal for the CCCTB provided that all R&D expenses should be made immediately deductible. In addition to the immediate deductibility of R&D expenses¹, the 2016 reform proposal foresees an allowance. The reform only foresees provisions for input-side R&D tax incentives. Output-side incentives, such as intellectual property ("IP") boxes, are not foreseen.

The proposed reform presents a unique opportunity to massively increase support for business innovation, while simultaneously strengthening public finances and the common market. The reform would introduce a level-playing field within the EU, bringing substantial compliance cost savings and removing distortions that impede the functioning of the common market. Insofar as it favours innovation investment and reduces the cost of capital, it would make the EU as a whole a more attractive destination for mobile capital. Finally, harmonisation would strengthen the Single Market by enhancing predictability and thereby reducing uncertainty.

This paper attempts to anticipate some of the likely impacts and attempts to identify the salient features of an improved reform proposal including R&D, considering EU policy objectives, limitations and literature insights on the shape of effective tax instruments for R&D.

We begin by examining the rationale and objectives of an innovation-minded corporate tax base reform. Market failure is an important stated objective. However R&D tax incentives can be motivated by reasons other than the correction of market failure. The reform should also take due account of EU policy objectives in the area of research and innovation, including the need to support the strategic objective of increasing the share of R&D expenditure relative to GDP and to promote innovation in as wide a cross-section of companies as possible.

We review the literature on the impact of changes in the tax treatment of R&D, focusing in particular on quantitative estimates in terms of business R&D expenditures. We document the kinds of challenges involved in this type of exercise and present what the preponderance of current literature suggests may be likely outcomes out of a wider set of possible outcomes. Literature is categorical in stating that R&D tax incentives are successful in raising business R&D expenditure. It is less clear by how much. The overwhelming majority of literature rejects the outcome of full crowding out, but equally rejects the outcome of additionality. Carefully done meta-analyses and reviews that consider endogeneity and publication bias suggest that partial crowding out of business R&D (i.e. input additionality smaller than 1) is the most likely outcome. However, the evaluation literature shows a great deal of heterogeneity, with variance in the estimates of elasticities also close to 1. National experiences can differ considerably ranging from substantial additionality to crowding out due to the design of the instrument and the characteristics of national innovation systems.

We measure the generosity in the treatment of R&D before and after the currently proposed reform, using the B-Index. The B-Index, a summary indicator of the implicit R&D tax subsidy, permits

¹ With the exception of R&D buildings, which however account for a rather minor part of total R&D spending. According to Eurostat the unweighted EU average of R&D costs for land and buildings is less than 3% of total business expenditure on R&D (source: Eurostat database, variable *rd_e_gerdcost*, total intramural R&D expenditure (GERD) by sectors of performance and type of costs).

straightforward comparisons across countries with complex allowance regimes. We complement existing estimates provided by the OECD for its member states with our own estimates for the remaining EU members (Bulgaria, Croatia, Cyprus, Estonia, Latvia, Lithuania, Malta, Romania) and include an updated estimate for Poland. The comparison suggests that the treatment of R&D envisaged in the 2011 reform proposal would result in a reduction of the implicit tax subsidy across the EU28.

We assess, in a schematic fashion, the possible impact of the current proposal for R&D on business R&D expenditure, and compare it with various alternative reforms. To do so, we first convert B-index estimates into estimates of the user cost using plausible assumptions. We then multiply the pre- and post-reform differences in user costs by the elasticity of business R&D with respect to changes in the user cost of R&D. As elasticity estimates provided in literature vary considerably, we choose a plausible range of literature-backed elasticities (from 1.2 to 0.5) to calculate impacts.

We present several alternative allowances that would serve to either maintain present levels of support, reduce them, or result in substantial increases of business R&D expenditure. We also cost each allowance in terms of foregone CIT revenue.

Finally we discuss complementary national innovation policy interventions that seem necessary in order to maximise the effectiveness of the allowance, in view of the varied and variably developed business innovation capabilities found across the EU. We conclude with suggestions for further research, arguing that a fuller assessment would need to take into account general equilibrium effects and firm heterogeneity.

2 The R&D Provisions of the C(C)CTB: Rationale, Characteristics And Outstanding Issues

In 2011, the European Commission proposed a single set of rules for calculating the tax base of businesses operating in the EU - the Common Consolidated Corporate Tax Base (CCCTB). In June 2015, the Commission presented an Action Plan to re-launch the CCCTB based on two key changes: making it mandatory for large multinationals and splitting it into two phases (European Commission, 2015).

According to the 2015 Action Plan the CCCTB offers a holistic solution to the current problems with corporate taxation in the EU. It would improve the business environment in the Single Market, by making it simpler and cheaper for companies to operate cross border. At the same time, it could serve as a powerful tool against corporate tax avoidance by removing the current mismatches between national systems and fixing common anti-avoidance provisions. The Action Plan announced that within the re-launch of the CCCTB, a consideration will be given to the tax treatment of R&D expenses, notably whether the 2011 proposal should be made more generous for R&D. The European Commission presented a proposal for a re-launched CCCTB in October 2016. It includes two new allowances: an R&D allowance and an allowance for growth and investment to address the bias towards debt financing. Companies will be given a super-deduction for their R&D costs which will be more generous for start-up companies (European Commission, 2016).

There are good reasons why the reform should include provisions about R&D. First, the reform offers a timely opportunity to improve the investment environment. In the aftermath of the financial crisis, economic growth and business investment remain subdued. By many accounts, the EU underinvests in R&D. Comparisons of business R&D intensity and productivity growth between the EU and the US or Japan have, for a long time, been unfavourable to the EU (see e.g. European Commission, 2013). Additionally, the EU Industrial R&D Investment Scoreboard reports that EU business R&D investments have taken a hit following the crisis and unlike the US, have not yet recovered to their pre-crisis levels (JRC-IPTS, 2015). Second, there are strong indications that

intangible outputs of R&D are used as an important tax planning channel to either obtain competitive advantages that undermine the common market or to avoid corporate taxation. Both are important and a strong case can be made for tackling them together.

As taxation is commonly used to support business R&D there is an obvious opportunity to both favour investment and direct it toward knowledge-intensive activities, in keeping with EU's objective of 3% of GDP devoted to R&D by 2020 as set out in the flagship *Europe 2020 Strategy* (European Commission, 2010). With just over 2% of GDP devoted to R&D in 2014, meeting the target remains a formidable challenge. R&D is an important part of the investments necessary for productivity-enhancing and market-augmenting innovations, but not the only one. Firms in services sectors, for instance, innovate in ways that involve little, if any, R&D. A growing body of evidence suggests that ancillary activities and investments in design, information technology, marketing and business processes (or models) can be just as important for innovation (Bell, 2009; Garcia, 2011; Ciriaci and Hervas, 2012). The Europe 2020 strategy too argues that it is important to consider the broader range of expenditures relevant for innovation (European Commission, 2010, p. 10). The commitment in the strategy not just to R&D but to innovation in broad terms is reflected in the proposal to develop an indicator that reflects both R&D and innovation intensity. For this and many other reasons (discussed in section 4.2) a CCCTB R&D allowance, however generous, can never become a substitute for an articulated national innovation policy. National innovation policy interventions complementary to the CCCTB would be needed to favour innovation investment in as broad a cross section of firms and sectors as possible.

The lack of a common framework for R&D taxation may be also undermining the common market. In recent years, many EU member states have introduced special regimes (so-called IP boxes) for income from R&D (and sometimes other intangible assets). Recent analysis suggests that they do not meet their stated objective of increasing business R&D and point to evidence suggestive of their use as profit shifting vehicles (Alstadsæter et al., 2015). The removal of the possibility of IP boxes as part of the CCCTB reform would contribute to a level playing field for companies across the EU.

3 Tax Incentives and Business R&D: Insights from Evaluation Literature

R&D tax incentives have been in place in many countries for over three decades. There is an extensive literature attempting to evaluate their impact. This literature concentrates on the immediate impact they have on business R&D expenditure. In this section we first present a brief overview of the chief methods used by this literature to arrive at estimates of elasticity of business R&D with respect to R&D tax incentives. We do so in order to better understand the capabilities and limitations of evaluation studies and the kind of coarseness that is embedded in their estimates. Then, we relate these studies and their results to a classification of policy-relevant outcomes defined in terms of input additionality.

A typical econometric study of the impact of tax incentives examines firm-level variation in R&D expenditure to ascertain statistically the influence of policy changes controlling for other factors. While existing studies vary widely in terms of specific methods and level of sophistication, they involve the estimation of variants of the following function:

$$R_{i,t} = \alpha + \beta_1 X_{i,t} + \beta_2 Z_{i,t} + u \quad (1)$$

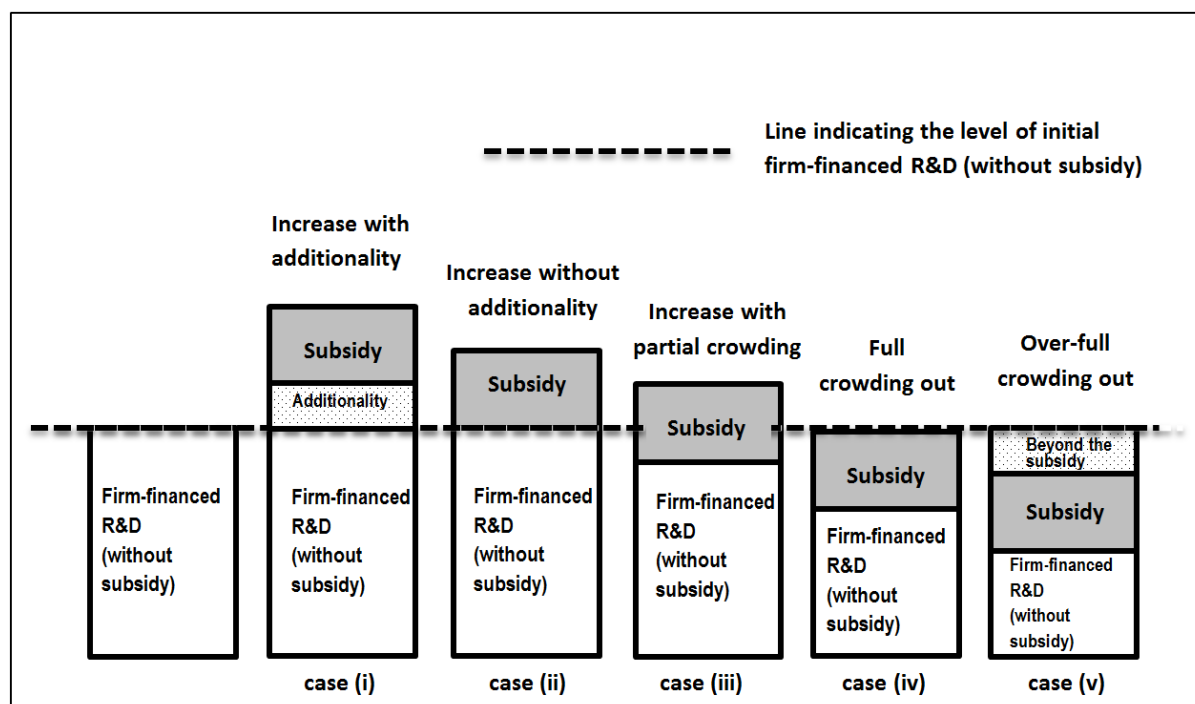
For every company i at time t , R&D expenditure R is a function of a vector X of variables that are plausible determinants of R&D (typically including some measure of past R&D such as R&D stocks, controls for firm size and sometimes sectors, etc.). Z is some measure of the generosity of the tax incentive. In the so-called direct approach, Z is the (monetary value) level of the tax incentive. In the so-called structural approach (called as such because it positions the influence of policy within a

structured 'model', arguably corresponding to the flow of causality) Z is the user cost of R&D. The user cost of R&D can be thought of as a price index of the "actual costs" faced by companies. The user cost is a function of, among other things, the wage cost, capital costs for R&D and of features of the tax system such as the Corporate Income Tax (CIT) rate and the presence of tax incentives for R&D.

Using the structural approach, reductions in the user cost (which corresponds to increases in generosity in the direct approach) result in increases in R&D expenditure. The coefficient β_2 corresponds to the strength of this relationship. If all variables are expressed in logarithmic form, as is usually the case, then β_2 is an elasticity and can be interpreted as the degree of responsiveness of R&D expenditure with respect to changes in the user cost of capital. By fitting specification (1) to firm-level panel data researchers obtain an empirically estimated value for this elasticity and the direction of the relationship.

Of key interest for policy evaluation is ascertaining "input *additionality*", defined as the firm's R&D expenditure that can be attributed to the policy intervention relative to the size of the tax credit itself (CPB, 2014). It is useful to distinguish conceptually among five discrete possible outcomes of policy, ranging from *increase with additionality* to *over-full crowding out* as presented in Figure 3.1 and further explained below.

Figure 3.1 - Possible outcomes of fiscal policy intervention on business R&D expenditure *additionality*



Source: Panel a of Fig. 2 in Dimos and Pugh (2016), p. 799

In studies using the direct approach, input *additionality* is simply equivalent to the estimated coefficient β_2 . In studies using the structural approach an intermediate calculation step is required to identify the part of the elasticity that corresponds to changes in the taxation of R&D.

The five outcomes have very different policy implications. They are considered separately below.

(i) **Increase with additionality:** whereby R&D increases by a quantity greater than the amount of the tax incentive, implying that the incentive leveraged additional private resources. This is the intended outcome of R&D tax incentives when the policy rationale used to justify them has to do with

correcting underinvestment due to spillovers. The assumption is that additional R&D likely results in commensurate innovation and that the welfare gains due to additional innovation are greater than the amount of foregone tax.

(ii) **Increase without additionality**: whereby *R&D increases by a quantity equal to the amount of the tax incentive*, implying that the incentive did not leverage additional private resources. While this is not the preferred outcome of innovation-minded tax incentives, is still desirable insofar as it implies an increase in overall business-performed R&D (with likely commensurate effects on innovation) and therefore helps correct underinvestment.

(iii) **Increase with partial crowding out**: whereby *R&D increases, by a quantity smaller than the amount of the tax incentive*, implying that the tax incentive partially displaced private-financed R&D. While this is some way from the standard rationales for these instruments, and is therefore far from preferred, it at least implies an increase in business R&D investment. But obviously its desirability depends on the extent of crowding out.

(iv) **Full crowding out**: whereby *R&D remains unchanged following the tax incentive*, implying that the tax incentive fully displaced private-financed R&D. While this can of course not be justified by a market failure rationale, it is sometimes argued that this outcome (or variants of outcome iii) can still be desirable when it serves to discourage the offshoring of R&D, particularly in countries that have experienced a decline in their cost-competitiveness. From an EU perspective however, such a justification would be against the principles of the common market. From a purely national perspective too, it may be insufficient justification for sustaining R&D tax incentives, as there may be better ways of achieving no change in the overall amount of business R&D, including of course the option of doing nothing.

(v) **Over-full crowding out**: whereby *R&D declines following the tax incentive*, implying that private-financed business R&D reduced by a quantity greater than the amount of the tax incentive. Selective support for ailing national industry may result in such an outcome, if the ailing firms in question subsequently fail to improve their prospects. From a public policy perspective this is almost always undesirable.

The algebraic sign (positive or negative) and the magnitude of estimated input elasticities can establish a correspondence to some of the possible outcomes [(i) to (v)]. The first three outcomes are consistent with an algebraic sign that is negative for the user cost (structural approach) and positive for the monetary value of the incentive (direct approach). Outcome (iv) can be discerned when input elasticity is 0 and outcome (v) when the sign is positive for the user cost (structural approach) and negative for the monetary value of the incentive (direct approach). These are summarised in Table 3.1 below. If the bang-for-the-buck can be estimated too (i.e. the monetary increase in business R&D for a one unit's, e.g. euro, foregone tax), then all five conceivable outcomes can be distinguished.

Table 3.1 – Input elasticities and policy intervention outcomes (direct approach)

Intervention Outcome	Corresponds to Input Elasticity	Corresponds to Bang-for-the-buck	to Market failure rationale
(i) Increase with additionality	>1	>1	Positive externality
(ii) Increase without additionality	>1	1	Positive externality
(iii) Increase with partial crowding out	>1	between 1 and >0	Positive externality
(iv) Full crowding out	0	0	None
(v) Over-full crowding out	<0	<0	None

Table 3.2 below summarises elasticities reported in meta-analyses or reviews of evaluation studies. As commonly observed by reviews of this literature (e.g. Zúñiga-Vicente et al., 2014), literature estimates vary widely: the means of reported user cost elasticities and input cost elasticities range between 0.75 and 1 and have cross-study standard deviations in the region of 0.5-0.8. The preponderance of a large volume of empirical literature, old and new (and even a number of recent reviews of studies that critically appraise the influence of numerous methodological problems) find that R&D tax incentives increase business R&D investment and therefore confidently reject outcomes (iv) and (v) (Full Crowding Out and Over-full Crowding Out). Older reviews of evaluation literature suggested user cost elasticities close to -1 (Hall and Van Reenen, 2000). However a recent review of the literature concluded that studies that were more rigorously done (controlling for endogeneity and selection bias) generally point towards elasticities smaller than one (CPB, 2014, p. 32).

Table 3.2 – Summary of elasticities reported in meta-analyses and reviews of the empirical literature

Elasticity of business R&D	Spatial/Temporal Context	Methodological notes	Source
0.91 [0.81]*	1982(min)-2008(max), CAx2, OECDx2, IT, ESx2, UKx2, JP, NLx2, FRx3, IT, USx2.	Structural approach, Long-run estimates	CPB (2014, p.30)
0.97 [0.72]*	1963(min)-2010(max)	Direct approach	CPB (2014, p.33)
0.75 [0.48]*	1975(min)-2005(max) USx7, CAx4, FRx4, NO, NLx2, ITx2, ES, DEX2, JPx2	Structural approach	Koehler et al. (2012, pp. 14-15)
~1 **	Studies across various advanced economies spanning the period from the 1960s to the late 1990s	Direct approach	Hall and Van Reenen (2000)
~1 **	1979(min)-1997(max) G7x2, AU, ESx2, IL, IE, FI, NL, NO, SE, CH	Structural approach	Becker (2015)
~1 **	Several evaluations of the U.S. R&E Tax Credit (1981-2009)	Various	Leyden and Link (2015, pp.137-138)

Notes: * Mean of reported elasticities, standard deviation in brackets. ** Summary assessment / expert commentary by authors of corresponding literature review

3.1 Does the impact of tax incentives vary across firms?

The impact of R&D tax incentives could vary depending on firm's size, age and technology profile.

First of all, there is no uniform conclusion on whether small businesses react more strongly in response to R&D tax incentives (CPB, 2014).² The further complication is that both effects can be

² In many countries it seems so (e.g. Lokshin and Mohnen, 2012, for The Netherlands; Baghana and Mohnen, 2009 for Canada; Bloom et al., 2002 for OECD countries), while the research done on Spanish, Belgian and French R&D tax incentives found large companies more responsive (Corchuelo and Martínez-Ros, 2009; Lhuillery et al., 2013 and Dumont, 2013).

identified at various points of deploying tax incentives in the given country.³ This variation can be due to the design of tax incentives (e.g. whether a refundable tax credit is provided) and to country specific features such as industry dynamics and institutional factors. Notwithstanding the size of the effect, the ultimate aim of the policy instrument is to correct for the market failure and induce the knowledge spillovers. Bloom et al. (2013) conclude that knowledge spillovers of large firms exceed those of small firms, mostly because small firms operate in technological niches. On the other hand, policy rationale seems to change towards targeting the age of companies, as input elasticities have been usually found to be greater for startups (Cornet and Vroomen, 2005, cited in CPB, 2014, p.33).

Small firms are likely to be more reactive to R&D tax credits since they face financial constraints (Baghana and Mohnen, 2009; Kasahara et al 2011; Kobayashi, 2014; Agrawal, 2014). Literature on the financing of innovative activity is clear in stating that firms make little use of debt finance for R&D activities, preferring to use either internally generated cash flow or equity capital (Hall, 2002, Brown et al., 2012).⁴ Young firms' R&D expenditures have been found to be sensitive to changes in both internal and external financing conditions (see for instance Brown et al., 2009), especially when considering venture capital markets investing equity capital in start-up companies. More mature firms have been found insensitive to the same variables. Firms can face constraints in accessing external financing because of information asymmetries and uncertainty. While this kind of constraint was confirmed by studies exploiting patent data for young and smaller firms (see for example Czarnitzki et al., 2014), again larger firms are not only found less subject to financing constraints in the first place, but they also do not seem to benefit from a patent quality signal. This suggests that information constraints are much less binding for established companies.

Recent studies also looked at adjustment costs which can impact on the effectiveness of tax incentives. Agrawal et al. (2014) highlight the potential importance of fixed adjustment costs in small firms' responses to R&D tax incentives. Long-run estimates by Rao (2016) imply that adjustment costs do matter, in particular for larger firms, and their importance varies across firms.

Doing (more) R&D can be conditional on the presence of complementary non-R&D innovation activities (in design, engineering, marketing and IT functions) and capabilities within firms (see also section 4.2). Incremental schemes⁵ are found to have a greater impact on SMEs and for firms in services and other low R&D-intensity sectors and may therefore better suited to technology catch-up (Castellacci and Lie, 2015).

Taken together, the considerations made above suggest that from an innovation perspective, it may be desirable for tax policy instruments to differentiate across types of firms, and to be dynamically adjustable.

3.2 Do R&D tax incentives translate into more innovation and social gains?

The impact of R&D tax incentives cannot be judged only in terms of R&D investment. R&D investment leads to new knowledge and innovations that spill over to other companies and sectors

³ The cases are Italy (Caiumi, 2010; Cerulli and Poti, 2012) and Japan (Kasahara et al 2011; Kobayashi, 2014; Koga, 2003).

⁴ At least two rationales support this view. First, lenders prefer firms with physical assets to be employed as collateral; R&D-intensive firms produce intangible capital which is often embedded in human capital, is firm specific, and is not traded on any liquid market. Second, innovation is highly unpredictable and prone to agency problems between lenders and borrowers, thus the former will ask for a large risk premium and raise the cost of financing (Hall and Lerner, 2010).

⁵ Contrary to volume based schemes that provide tax relief for the entire amount of R&D expenditure, incremental schemes provide tax relief for only additional R&D expenditure when compared against a historical value (e.g. average of the last three years).

and benefit wider society. In view of difficulties in the evaluation of even the immediate impacts of R&D tax incentives, it is not surprising that relatively few studies attempt to evaluate their effects further down the causality chain, on innovation, productivity or economic output. Overall, the studies that attempt to do so, find a positive impact on innovation (for a review see CPB, 2014). More recently Dechezleprêtre et al. (2016) looked at impacts of tax incentives on innovation following a policy change in the UK tax credit. The authors show that the R&D generated by the tax policy increases patenting and creates positive spillovers on the innovations made by other, technologically related companies. Boler et al. (2015) explore the introduction of an R&D tax credit in Norway and find that the policy change increased R&D investments and imports and the two effects led to higher revenues. Very few studies have undertaken cost-benefit analysis of the R&D tax incentives, but evaluations in Canada, Netherlands and Norway point towards positive welfare gains.

One of the unintended impacts can be the increase in the wages of researchers (Lokshin and Mohnen, 2013 and Dumont, 2013). As the supply of researchers is relatively inelastic, increases in the generosity of R&D tax credits can be partly absorbed by higher researcher wages. Supply will be more elastic in countries with high international mobility of researchers, in particular private sector inventors and 'star' inventors who are sensitive to tax differentials (Akcigit et al., 2015, and Moretti and Wilson, 2015). Other unintended impacts include changes in researchers employment (Goolsbee, 1998, Rogers, 2010, Guceri, 2016). Another concern in the literature is that companies will try to maximise their tax reductions from R&D tax incentives, for example by relabeling some of their non-R&D expenses as R&D. However, this concern has not been confirmed empirically. Guceri and Liu (2015) find a positive and significant impact of UK tax incentives on R&D spending with no evidence of systematic change in qualifying expenditure. Similar evidence of little abuse has been found by Agrawal et al (2014), Rao (2016) and Dechezleprêtre et al. (2016).

3.3 Which instrument should be used to incentivise private R&D?

There has been a long standing debate on whether direct subsidies or tax incentives are more effective. Evidence on this issue is scarce and inconclusive. Dimos and Pugh (2016) perform an extensive meta-analysis of evaluations of direct subsidies, and in common with meta-analyses of R&D tax incentives they find that subsidies do not crowd out private investment but that additionality is very small. In her review of the impact evaluation literature, Becker (2015) reports that there is growing evidence that public subsidies are effective in increasing R&D in small businesses. IMF (2016) suggests that both instruments lead to a growth of total factor productivity, however the effects are different by sector and type of firm.

Most governments apply a mix of tax incentives and direct subsidies to foster private R&D investment. This lends support to the view that the design of the instrument is at least as important as which instrument is used and that complementarities should be exploited (CPB, 2014; IMF, 2016). CPB (2014) benchmarked more than 80 tax incentives in 31 countries based on 20 principles of best practice in their design. An example of good practices include that R&D tax incentives should focus on R&D expenses (input) rather than on outputs of the R&D process (i.e. IP income). They should also better target young companies by for example including a carry-over facility and/or cash refund option.

The traditional rationale for R&D tax incentives assumes that the tax incentives will be picked up uniformly across the business sector. However literature on the development of firm-level innovation capabilities suggests that the initiation and upscaling of R&D activities hinges on complementary innovation activities and capabilities in management, engineering, design, marketing and information technology, some of which cannot be developed at short notice (Bell and Pavitt, 1995; Bell, 2009). In other words, the effectiveness of R&D tax credits in the companies

where it can have the greatest impact may hinge on the presence of complementary national innovation policies which support the development of other business innovation capabilities.

4 Calculations of Impact of Current Proposal on R&D

In order to evaluate the prospective impact that the CC(C)TB reform proposal may have on the incentives to engage in R&D investments, in the present section we employ B-indexes and link them to estimates of how R&D investments react to changes in the cost of capital.

4.1 B-indexes before the reform

The intuition behind B-indexes is that, in the absence of any subsidy or tax incentive for R&D investments, R&D costs would be treated for the purposes of taxation like any other cost incurred by a corporate firms, i.e. they reduce net profits by an amount equal to the cost less the saving in taxes due to such costs being tax deductible. In symbols, if t represents the (marginal) corporate tax rate, then one euro of expenses has a net-of-tax cost for the firm equal to $(1-t)$, assuming such expenses can be fully depreciated in the first year they are incurred. As net profits are obtained by multiplying gross profits by $(1-t)$, a marginal investment (for which gross profit equal costs) is such that the following equality holds:

$$Profit * (1-t_{profits}) = Cost * (1-t_{costs}) \quad (2)$$

Or, equivalently:

$$1 = Cost * (1-t_{costs}) / Profit * (1-t_{profits}) \quad (3)$$

A B-index represents possible deviations of this ratio from 1, assuming a target *Profit* of 1. If the B-index is larger than 1, it means that for a marginal investment producing net-of-tax profit equal to 1, a net-of-tax expenditure greater than 1 is needed to reach the break-even point. By the same reasoning, a B-index lower than 1 implies that the marginal investment is more attractive in comparison to the no-incentives scenario. Therefore: in presence of incentives to R&D we have a B-index lower than 1; in absence of any incentive the B-index is exactly equal to 1; and with deterrents to investment the B-index is larger than 1.

A B-index can deviate from value 1 for multiple reasons:

- Costs related to capital goods may not be fully deductible in the first year and have to be amortized over two or more years. A common form of R&D incentive is indeed to allow for accelerated amortization for selected capital goods.
- Special allowances may increase the benefit obtained as tax-reductions, most usually by allowing for a given percentage of qualified expenditure items as tax credit or deduction from the taxable base.

An appealing property of the B-index as an indicator is that it is able to capture both general characteristics of the corporate tax system (like how different classes of capital goods are depreciated) and those specific to R&D investments, in an internationally comparable way. Its main limitation lies in the fact that it is focused on the R&D investment side of the corporate income tax system only. Thus, it does not capture possible effects due to different fiscal mechanisms such as, for example, R&D employment credits, IP boxes or VAT exemptions, nor the effects of policies designed to elicit innovation not related to corporate R&D.

We employ B-indexes as published in OECD (2015) with the addition of our own calculations for eight EU member states that are not covered by the OECD. The OECD assumes a common structure of R&D investments for all countries, where 60% of the costs are for labour, 30% for other current expenses, 5% for machinery and equipment, and 5% for buildings. Expenditures for capital goods are

depreciated using a straight-line or declining balance depreciation method, as applicable, and corrected for the existence of accelerated depreciation schemes for R&D. B-indexes are calculated for representative firms for which caps or ceilings that limit the amount of eligible tax incentives are not applicable, and that generate enough profits to fully claim any tax reduction directly stemming from the R&D investment. The twenty-three OECD B-indexes were last updated (at the time of writing) in October 2015, while the eight additional B-indexes here included are based on policies as observed in May 2016.

The general form of the indexes we calculated is:

$$B\text{-Index} = [1 - t (R\&D_{current} + R\&D_{NPV}) - C R\&D_{eligible}] / (1-t) \quad (4)$$

where:

- $R\&D_{current}$ is the share of R&D expenditures that is for current costs,
- $R\&D_{NPV}$ is the net present value of the share of R&D expenditures for capital investments,
- C represents "non taxable" tax allowances expressed as a percentage of current R&D expenditures, or alternatively "non taxable" tax credits (Warda 2001),
- $R\&D_{eligible}$ includes expenditure items that can be used to compute the allowance or tax credit.

In case full depreciation of capital investments is allowed in the first year and if no tax allowance is present, then $R\&D_{current} + R\&D_{NPV} = 1$ and $C = 0$ and therefore the B-index is equal to 1. If amortization is imposed then $R\&D_{NPV}$ decreases and the B-index rises above 1; and as tax allowances or credits are introduced (any value $C > 0$), the B-index is reduced accordingly.

For the eight countries that were not covered by the OECD (2015) (i.e. Bulgaria, Croatia, Cyprus, Estonia, Latvia, Lithuania, Malta, Romania) we followed the OECD methodology as follows: In order to represent the combined effect of the general corporate tax and of R&D provisions, we combined data from several sources. We used ZEW (2014) calculations for the effective average corporate tax rate and for net present values of assets classified according to the Devereux-Griffith methodology. Data for the R&D provisions come from TAXUD (2014), Deloitte (2015) and OECD (2015). We chose R&D provisions so that they would represent the overall incentives faced by the most typical firm, that is, the incentives accessible by a wide enough population of potential applicants (this choice would rule out, for instance, R&D incentives that are only allowed for very specific industries or only for start-up enterprises).

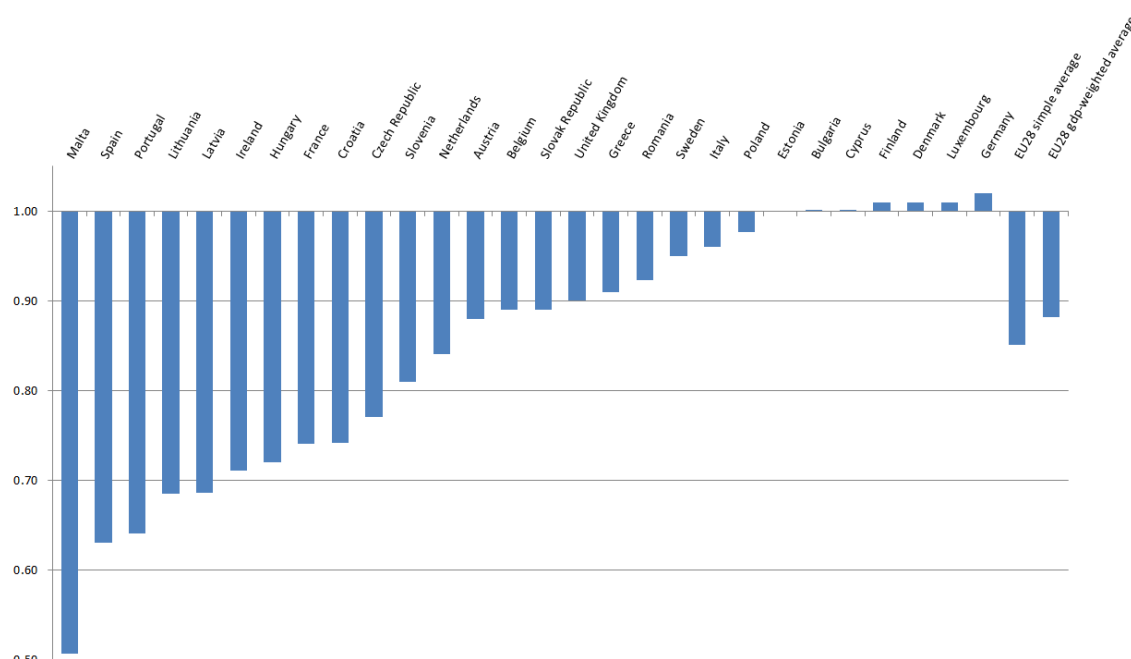
For Croatia, as the law provides three different allowance rates (150%, 125%, 100%) based on the classification of the R&D investment (as fundamental, applied or development research, respectively) we computed a weighted average of the three rates with weights obtained from Eurostat (database variable *rd_e_gerdact*) as shares of basic, applied and development over total research spending in the country. These calculations obtained a rate of 117% which is what was used to compute the Croatian B-index. For Malta, as there is a tax credit with three different rates (25%, 50%, 75%) we used the value of 37.5%, that is, the average between the rates for the two most common categories. In order to obtain a picture as close as possible to the current state of the incentives to business R&D we also modelled a recently introduced reform in Poland, which drove the B-index to 0.98 (down from the OECD value of 1.00).

This formulation is sufficient for representing policies in the eight countries under scrutiny, as they either do not have any special allowance for R&D (this is the case for Bulgaria and Estonia), or the allowance is in the form of a "non-taxable" allowance (by "non-taxable" we mean that the amount of deductible R&D costs is not reduced by the allowance, this is the case in Croatia, Cyprus, Latvia, Lithuania, Romania) or in the form of "non-taxable" tax credit (as is the case of Malta). In order to calculate the net present value of R&D capital investments we employ ZEW (2014) data for 2014 which summarize the rules enacted in each country for amortizations and depreciations, separately

for machinery and buildings. We assume, as the OECD does, that machinery and equipment account for 5% each of total R&D expenditures, however we also include costs for intangible assets and assume that half of the expenditures for machinery and equipment is in the form of externally acquired intangibles. This allows to better calculate the net present value and also to include special provisions, like for Cyprus where allowance are based on R&D spending for intangible assets.

We thus obtain a representation of all 28 EU member countries updated at their latest R&D policy. Figure 4.1 shows the value of the B-indexes for the full 28 EU sample, plus the simple average and the GDP-weighted average. Countries with larger GDP tend to have less generous provisions for R&D spending, and this is reflected in the difference between simple and weighted averages of the B-indexes. This is notably true for Germany which has no tax incentives for R&D and produces the largest B-Index (equal to 1.02) among the 28 EU members. On the opposite extreme we have Malta (B-index equal to 0.51) which is a small economy with very generous R&D incentives covering an ample array of eligible expenditures. In-between we have Estonia where an uncommon tax system is in place which cannot be assimilated to a corporate income tax, and for which we obtain a B-index equal to one, meaning that no incentive or deterrent to R&D investment is present.

Figure 4.1 – B-Index estimates for the EU28



4.2 Assessment of the reform on R&D activity

The proposed CC(C)TB reform foresees harmonisation of corporate tax bases across the 28 EU members. Coherently the definition and tax treatment of R&D costs should be harmonized as well. In order to analyse how the reform would affect incentives we build an aggregate EU-wide B-index, based on average values observed in each of the 28 members. We calculate how the average B-index would change subject to different scenarios for the reform, and then compare the current EU-wide B-index with the post-reform EU-wide indexes to assess the change for the EU as a whole.

To analyse how the reform would affect incentives, we transform B-indexes into corresponding user costs for each country following the methodology as in Warda (2001) and Lester and Warda (2014). The user cost of R&D investments is the proper measure to summarize, in a single number and for

each country, the combined effects of the tax system (captured by the B-index) and of the general economic and institutional framework (captured by the real interest rate and economic depreciation rate) on the attractiveness to engage in R&D investments.

B-indexes can be converted into a user cost measure by multiplying them by the sum of real interest rates and economic depreciation rates. We use the economic depreciation rates of capital assumed in CORTAX (see Alvarez-Martinez et al., 2016). We also use real interest rates calculated as the difference between 10-year Treasury bonds less harmonized inflation rates, both calculated as averages over the years 2013-2015 and obtained from Eurostat. The resulting user costs are compared to B-indexes in Table 4.1. For example, one can see that Germany, although not having any tax incentive for R&D, still benefits from a very low cost of capital (0.34); while for example Portugal has a generous tax system for R&D investments, but its overall cost of capital (2.56) is among the largest in the Union.

Table 4.1 – B-indexes and User Costs

Country	B-index	User cost	Country	B-index	User cost
Germany	1.02	0.34	Slovak Republic	0.89	1.51
Finland	1.01	0.30	Austria	0.88	-0.02
Denmark	1.01	0.91	Netherlands	0.84	0.37
Luxembourg	1.01	0.45	Slovenia	0.81	2.56
Cyprus	1.00	6.23	Czech Republic	0.77	0.60
Bulgaria	1.00	3.95	Croatia	0.74	2.55
Estonia	1.00	-	France	0.74	0.77
Poland	0.98	3.29	Hungary	0.72	3.01
Italy	0.96	2.42	Ireland	0.71	1.56
Sweden	0.95	1.11	Latvia	0.69	1.39
Romania	0.92	2.87	Lithuania	0.68	1.72
Greece	0.91	9.13	Portugal	0.64	2.56
United Kingdom	0.90	0.57	Spain	0.63	1.79
Belgium	0.89	0.81	Malta	0.51	0.78
EU28 simple average	0.85	1.98	EU28 GDP-weighted average	0.88	1.17

A large empirical literature estimates the elasticity of R&D activity with respect to the user cost of capital. Informed by the literature review in Section 3, and in view of the variance of the estimates, we choose four distinct values of the elasticity of R&D spending with respect to changes in the user cost of capital. We calculate the percentage change in the user cost that would happen after the proposed reform is introduced in comparison to the pre-reform EU average user cost, and multiply this difference by the chosen elasticity value. In this way, we obtain a gross estimate of the percentage effect of the reform on total R&D spending. The reform under scrutiny is CCTB (without accounting for Consolidation), with an amortization period for buildings of 25 years.⁶ We consider a base case where R&D expenditures do not benefit from any special provision except that they are

⁶ As the length of the amortization period for buildings was the object of debate before publication of the current version of the CCCTB proposal, we also produced calculations assuming different definitions of the tax base: with a longer amortization for buildings and machinery (40 years); with amortization rates equal to the (simple or GDP-weighted) average of the rates currently observed across the 28 members. Differences in comparison to the values reported in Table 4.2 were minimal, thus we omit them here for brevity.

fully depreciated in the first period of acquisition, then on top of it we also introduce a bonus allowance for R&D current expenditures equal to 100% or 200% of expenditures. As an additional set of tests we calculated what rate of allowance one would need to obtain the same EU-wide B-index as before the CCTB reform, which resulted in a rate between 33% and 34%. Results are summarized in Table 4.2.⁷

Table 4.2 – Reform scenarios and their possible impact on R&D investment

<i>Pre-reform:</i>	B-index:				
EU28 GDP-weighted average	0.88	<i>Expected % change in R&D expenditures:</i>			
<i>Post-reform:</i>		<i>Elasticity 1.2</i>	<i>Elasticity 1.0</i>	<i>Elasticity 0.8</i>	<i>Elasticity 0.5</i>
CCTB, full expensing	1.01	-0.27	-0.22	-0.18	-0.11
CCTB, full expensing, 33% bonus allowance	0.88	0.00	0.00	0.00	0.00
CCTB, full expensing, 100% bonus allowance	0.69	0.25	0.21	0.17	0.10
CCTB, full expensing, 200% bonus allowance	0.38	0.78	0.65	0.52	0.32

Some results deserve further discussion. For the value of elasticity that we deem as the most generalisable according to recent literature (0.8), the base scenario reform would cause an 18% reduction in R&D spending. In order to compensate it, an allowance of about 33% coupled with full expensing of R&D expenditures would be needed. An allowance of 100% would considerably strengthen incentives to engage in R&D, and according to our calculations yield an expected increase of about 17%.

However the expected increase would still fall short of the Europe 2020 target of 3% of GDP devoted to R&D. A bolder allowance seems necessary to meet this target. . As the business sector accounts for the majority of R&D in all advanced economies, 2% of GDP seems a reasonable target for business R&D expenditure (in fact the previously mentioned EU Lisbon Strategy explicitly aims for two-thirds of the 3% R&D target to be met by business). In 2014 business R&D intensity for the EU28 stood at 1.3% of GDP. Covering the 0.7% shortfall to the 2% intensity consistent with the Europe 2020 target would require business R&D to increase by about 54%. We consider a scenario with a 200% bonus allowance. Assuming an input elasticity 0.8 this scenario could yield an expected increase in business R&D of about 52% (Table 4.2), which is close to the Europe 2020 target.

The B-index is still an experimental indicator based on quantitative and qualitative information. As a robustness test, we exclude countries for which we calculated the B-indexes ourselves to assess the sensitivity of the business R&D impacts to our own calculations of B-indexes. If we only use the 20 B-indexes provided by the OECD (2015) (so removing the eight new B-indexes we calculated and reverting Poland to its original value of 1.00), the GDP-weighted average B-index for EU 20 drops from 0.88 to 0.86. This means that tax support to R&D is higher (14 cents out of every euro invested). Including our own calculations results in a less generous pre-reform EU system.

It is useful to highlight that the generosity of the allowance depends on the tax rate. The lower the tax rate, the lower the incentive offered by an R&D tax allowance. The optimal generosity is difficult to determine. On the one hand, too generous schemes could lead to a higher share of incumbent firms and a narrower growth distribution in R&D-intense sectors. On the other hand, small incentives are unlikely to have an impact on the behaviour of firms. The impact of the generosity level is likely to be nonlinear and related to the specific design of the policy, target groups and the framework conditions in place (CPB, 2014). The CCTB provides for a common tax base in corporate

⁷ A corporate tax rate equal to EU average of 26% is assumed in the calculations.

taxation, while the tax rate remains the sovereign right of the Member States. Under the CCCTB reform, the common base is apportioned according to a formula. The relevant rate would therefore depend on a weighted average of tax rates after formula apportionment. The reduction in the relevant rate could decrease the generosity of the allowance and the incentive effect, while the increase in the rate could have the opposite effect. We assumed an EU CIT rate of 26% which is a GDP-weighted average of EU CIT rates. Assuming a much lower post-reform average CIT rate of 16%, would mean that R&D investment would still drop by about 17% in case no action is taken (1 percentage point less than in the main scenario). However, to keep the same situation as before the reform, the rate of allowance would need to double. Thus, a reduction of the tax rates after the reform would make the allowances discussed so far less able to foster additional R&D spending.

4.3 CIT revenue implications of the reform

A full appreciation of the impact of the reform in terms of foregone CIT revenue due to R&D tax incentives is a challenging exercise. A simple approximation to illustrate the order of magnitude of its likely impact can be obtained by working backwards from the input elasticity of business R&D with respect to changes in the cost of capital: if a one percent increase in the generosity of the tax incentives results, on average, in a 0.8 percent increase in business R&D, it stands to reason that a one percent increase in business R&D results in $(1/0.8=)$ 1.25 percent increase in foregone CIT taxes. To translate these changes in the taxation of R&D into net effects on total CIT revenue required some intermediate calculation steps, including an estimate of the R&D-derived taxable base using literature estimates on the rates of return of overall business investment (set at 8% following Fama and French, 1999 and Poterba, 1998) and estimates on the rates of return of R&D investment (set alternately at 10, 20, 30 and 40%, to reflect the wide variance of the estimates provided in Hall et al., 1999).

Following these simple steps Table 4.3 presents our estimates of the likely changes in CIT revenues under the three main R&D scenarios, *assuming no other behavioural responses to the reform than the changes in R&D spending*. These figures do not account for the likely increase in GDP that more R&D spending would generate in the long run (the reasons for this limitation are detailed in the last paragraph of this section), instead they just estimate the mechanical loss in revenues due to the combination of the allowances and the CCCTB tax base as compared to the pre-reform scenario, that is, keeping GDP at the pre-reform level. In view of the many assumptions upon which these estimates rely, we checked their sensitivity for different elasticities of R&D spending to the cost of capital (as before 1.2, 1, 0.8 and 0.5), different rates of return to R&D investment (10%, 20%, 30% and 40%), and different shares of R&D in total business investment (17% suggested by Eurostat versus 12% obtained by combining Orbis with the JRC Industrial R&D Investment Scoreboard⁸). We report the minimum and maximum bounds obtained by alternative choices in the above assumptions in the last four columns of Table 4.3.

The main estimates of Table 4.3 are broadly in line with an alternative approximation relying on OECD data. The OECD reports indirect support for business R&D as shares of GDP for 19 EU member states, excluding Poland, Romania, Bulgaria, Croatia, Malta, Cyprus, Latvia, Lithuania and Luxembourg. The weighted average of the reported EU member shares was 0.08% of GDP or approximately 11 billion EUR. Assuming a linear relationship between changes in the B-index and foregone CIT revenue for R&D tax incentives, the change in the B-index corresponding to the 100% bonus allowance scenario would imply roughly a 5% decline in total CIT revenues. This corresponds to the effect reported in Table 4.3. The change in the B-index required for the 200% bonus

⁸ We are grateful to our colleagues Mafini Dosso and Antonio Vezzani (European Commission Joint Research Centre) for offering this information as part of their ongoing work.

allowance would imply roughly a 13% decline in total CIT revenues (as compared to 15% in the table 4.3).

Table 4.3 – Reform scenarios and their possible impact on total CIT revenues

	<i>Main estimates</i>		<i>Minimum</i>		<i>Maximum</i>	
	<i>Change as share of CIT</i>	<i>Change as % of GDP</i>	<i>Change as share of CIT</i>	<i>Change as % of GDP</i>	<i>Change as share of CIT</i>	<i>Change as % of GDP</i>
Full expensing	+5%	+0.13%	+2%	+0.05%	+9%	+0.21%
100% bonus allowance	-5%	-0.12%	-2%	-0.05%	-8%	-0.20%
200% bonus allowance	-15%	-0.38%	-6%	-0.14%	-25%	-0.63%

Note: Estimates based on linear calculations from literature-derived elasticities with respect to changes in R&D. In particular these estimates do not consider other behavioural responses to the reform such as, for instance, the impact of changes on R&D on GDP growth and, by extension, CIT revenues. See accompanying text for a discussion of assumptions and limitations.

As stated the figures in Table 4.3 do not take into account the likely increase in revenues that would be caused by a rise in GDP, the latter being the expected outcome of increased R&D spending. The likely impact of the R&D-related part of the CCCTB reform on GDP growth is very difficult to estimate. Extrapolating from literature estimates of the elasticity of output with respect to changes in business R&D (0.13 as estimated by Donselaar and Koopmans, 2016), and considering a hypothetical increase in business R&D by 38%, the IMF (2016) expects a long-term increase on GDP of about 5%. Linearly extrapolating from this, the most generous scenario examined here (a 200% allowance) and assuming 52% increase in business R&D may raise GDP by about 7%. However such estimates should be seen with great caution. The variance observed in quantitative literature on the returns to R&D (e.g. Hall et al., 1999) argues strongly against crude linear extrapolations. In fact the literature on the statistical distribution of highly valuable inventions (e.g. Scherer and Harhoff, 2000; Silverberg and Verspagen, 2007) suggests that they have no mean and no variance and therefore attempts to forecast the aggregate outcome of R&D with precision are not meaningful.

5 Synergies Between European and National Policies

The impact calculations offered in the preceding sections can be seen as projections of what appears likely to happen in the “average” EU country and the average instrument. The wide variance observed in literature estimates of user cost elasticities across countries calls for caution and hints at the importance of national context. It follows that the actual effectiveness of the CCCTB provisions in individual countries cannot be guaranteed in the absence of complementary interventions attuned to national context.

Simply put, national policy can improve the effectiveness of CCCTB provisions by reducing the opportunity cost of innovation relative to other business investment possibilities. This depends to a large extent on conditions prevalent in the context within which the firm operates, notably the presence of a dynamic broader innovation system.

One way to reduce the opportunity cost of innovation is by reducing the profitability of alternative investment possibilities, particularly those deemed socially undesirable. This is why the most lasting impact of public policy on business innovation comes from promoting competitive markets. Increased competition, promoted by anti-trust regulation and by lowering entry barriers makes rent

seeking activities less profitable and is thus a powerful subsidy to innovation. The opportunity cost of business innovation investments may also be affected by other features of national taxation. The distinct components of a tax system do not work in complete isolation and the possible interactions between them should be considered. The design of direct and indirect taxes affects the set of incentives relative to the quantity and quality of investments partaken. Literature has shown how capital gains taxation (Keuschnigg and Nielsen, 2003 and 2004) may affect the venture capital market, how subsidies to small companies and new entrepreneurship (Haufler et al., 2014) can affect the riskiness (thus, the degree of innovativeness) of new investments and how personal taxation could affect risk-taking (d'Andria, 2016b), innovation-related investment (d'Andria, 2016a) and the formation of human capital over time (Nielsen and Sørensen, 1997, Jacobs and Bovenberg, 2010). Given that most of these tax items are outside of the scope of the CCCTB reform and are country-specific, their heterogeneity contributes to widen the gap for the predicted effectiveness of CCCTB R&D provisions.

Another way to reduce the opportunity cost of innovation is by interventions serving to raise the rate of return to innovation investment. This is considerably more difficult as it involves capability accumulation and associated scale effects within the firm, complementary investments in the wider innovation system (including in higher education, the public research system etc.) and associated network effects. For less developed national innovation systems lacking complementary capabilities either within firms or in the wider business environment, the rate of return is accordingly low and a foray into higher levels of R&D investment can be especially challenging. Non-R&D and R&D innovation are strong complements⁹. To appreciate the strength of these complementarities it is worth recalling that the productivity enhancing and market augmenting effects of innovation rarely rely exclusively on R&D. Even for the most technologically advanced firms, economically useful innovation is a complex combination of non-R&D and R&D innovation. For the majority of companies economic gains from innovation stem from less ambitious forms of technological innovation (e.g. new-to-the-firm or new-to-the-market/-industry) or innovation that is not technological at all (e.g. design, marketing and organisational innovation). National innovation policy therefore should also favour non-R&D innovation investments, particularly of the kind smaller firms operating in less developed innovation systems would require as a springboard to more, more effective and consequently more systematic R&D.

Assuming firms are willing to invest more in R&D, their ability to do so may be constrained by the availability of risk finance, suitably qualified human resources and other system-level inputs to R&D such as high quality public research organisations and related public infrastructure. Indeed, literature on the determinants of R&D investment point to (in addition to prevalent economic conditions and their impact on the availability of internal finance) the importance of external finance (Becker, 2013) and of the presence of a supportive innovation system including the qualities of tertiary education and the extent of collaboration between industry and academia (Wang, 2010). The now extensive literature on national (Nelson, 1993; OECD, 1997), regional (Cooke, 2001) and sectoral (Malerba, 2002) innovation systems suggests that business innovation is not just subject to the single failure of allocating sufficient resources, but also to extensive coordination failures across space (e.g. regions, industrial sectors and their relations) and time (e.g. evolving interventions aimed at progressive capability accumulation, timely responses to the emergence key enabling technologies etc.). National policy has a role to play in all these cases.

Beyond broad generalisations however, different economic structures and their dominant technologies of production mean that the “ideal” innovation system has very different features across countries. The R&D provisions of CCCTB form a substantial basis upon which national

⁹ Firm-level studies show that the impulses for R&D and other new-to-the-world innovation can often be traced to problems first identified in the context of in-house knowledge-intensive production and delivery activities in engineering, design, IT and marketing (Bell and Pavitt, 1995, Bell, 2009, OECD, 2014).

administrations can expand, adjust and complement support to business sector innovation. It is clear however that CCCTB provisions cannot substitute for a comprehensive and nationally (and where applicable sub-nationally) appropriate innovation policy.

6 Conclusions and Future Work

To correct the market failures in the allocation of sufficient resources to R&D, most countries in Europe and beyond apply tax reliefs to stimulate R&D. Tax support has been increasing in recent years, in particular in the aftermath of crisis years. This paper has sought to evaluate whether and how the EU proposal for a Common Consolidated Corporate Tax Base (CCCTB) can be aligned with national tax policy choices in support of R&D.

We reviewed the literature on the impact of changes in the tax treatment of R&D, focusing in particular on quantitative estimates in terms of business R&D expenditures. We documented the kinds of challenges involved in this type of exercise and presented the current literature conclusions of likely outcomes out of a wider set of possible outcomes. Despite a wide variance in empirical estimates, literature is categorical that R&D tax incentives are successful in raising business R&D expenditure.

We measured the generosity in the treatment of R&D before and after the currently proposed reform, using the B-Index. The B-Index, a summary indicator of the implicit R&D tax subsidy, permits straightforward comparisons between complex allowance regimes. We complemented existing estimates provided by the OECD with our own estimates for the remaining non-OECD EU members (Bulgaria, Croatia, Cyprus, Estonia, Latvia, Lithuania, Malta, Romania) and included an updated estimate for Poland. The comparison pre- and post-reform B-indexes suggests that the 2011 proposal would result in a reduction of the implicit tax subsidy across the EU28.

We assessed, in a schematic fashion, the possible impact of the CCCTB proposal for R&D on business R&D expenditure, and compared it with various alternative reforms. To do so, we first converted B-indexes into estimates of the user cost using plausible assumptions. We then multiplied the pre- and post-reform differences in user costs by the elasticity of business R&D with respect to changes in the user cost of R&D. As elasticity estimates provided in literature vary considerably, we chose a plausible range of literature-backed elasticities (from 1.2 to 0.5) to calculate impacts.

These calculations indicate that the 2011 CCCTB proposal without any bonus allowance for R&D, would result in a significant reduction of business R&D. Maintaining the current level of business R&D would require the inclusion of additional allowances. Specifically, to compensate for the replacement of national R&D tax incentives under the CCCTB, an allowance of 33% would be necessary. We present several alternative allowances that would serve to either maintain present levels or result in substantial increases of business R&D expenditure. We also cost each allowance in terms of foregone CIT revenue. We argue that the EU-wide R&D allowance does not replace national innovation policies, but forms a substantial basis upon which national policies can expand in order to effectively stimulate R&D in a highly interconnected and globalised EU. An EU-wide R&D incentive provides certainty and stability necessary for this type of investment. It creates a level playing field for R&D investment, favours European integration of multinational R&D functions, and provides incentives for a single knowledge market in the EU. It should be accompanied by complementary national non-tax innovation policies to increase leverage and ensure synergies.

An important limitation of the present study is that it relies on general elasticities hailing from a varied, noisy and (perhaps as a result) sometimes ambiguous empirical record. The precise elasticities that are likely applicable to the nuances of alternative versions of a possible C(C)CTB reform in an area as large and heterogeneous as the EU would require more detailed analysis, which would demand more resources than we had at our disposal. Another important limitation of the

present study is that it does not capture general equilibrium effects. For instance, it assumes researchers' wages remain constant whereas in practice they tend to go up (as the supply of researchers is inelastic, at least in the short term). For these reasons the estimates provided here must be treated with caution and will have to be confirmed by country-specific analyses.

Some limitations in the use of B-indexes and the user cost approach have been mentioned in previous sections, namely their focus on corporate tax systems and input-based measures. While some extensions of the methodology would allow to partly account for IP box incentives, for different firm size and loss provisions, and for subsidies, the kind of information provided would still be limited.

A first direction to better capture the effects of tax incentives and subsidies for R&D would be to explicitly account for the heterogeneity in firms and R&D activities by means of micro-data analysis and simulation. Such an approach would also better deal with the existence of various eligibility ceilings and caps put on R&D incentives accessibility. In many countries, for instance, such policies are tailored toward SMEs investing in sectors deemed to be "innovative". Accounting for the relative importance of such firms and sectors in the economy would allow to better appreciate the magnitude of the effects one could expect from changes in the policy.

A second direction for future research is to include both general equilibrium effects and mobility of input factors. Policies to support R&D and innovation do not operate in a vacuum, on the contrary a large share of the empirical literature supports the view that the incidence of tax and subsidy policies on wages and employment, FDI and profit shifting activities by multinational enterprises, mobility of highly skilled workers, and on other dimensions can be relevant and further impact the economy in complex ways.

In addition to the above discrete outcomes and complex interrelations in the magnitude of business R&D, tax incentives can have a host of behavioural impacts many of which are unintended and strongly context-specific. Little is known about them, but what is known suggests that modelling in a general equilibrium framework (not least using computable general equilibrium analysis tools such as the CORTAX model) would be profitable.

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List of abbreviations and definitions

CCTB - Common Corporate Tax Base

CCCTB – Common Consolidated Corporate Tax Base

CIT – Corporate Income Tax

EU – European Union

GDP – Gross Domestic Product

IP – Intellectual Property

R&D – Research and Development

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