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Effective tax rates for R&D intangibles

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Abstract

Tax incentives such as intellectual property regimes provide for reduced taxation of the income derived from research, development, and innovation related activities. By doing so, they lower the overall tax burden from investing in certain qualified intangible assets. This paper proposes a methodology to build indicators comparing the effect of income-based tax incentives for R&D and innovation on firms' incentives to make R&D intangible investments. It provides insights into how such incentives affect firms' decisions on whether, where and how much to invest in R&D intangibles. These indicators are used to illustrate the extent to which these tax incentives may create potential distortions to firms' investment, protection and commercialisation decisions. The model is further developed to account for the design changes to such tax incentives introduced by the OECD/G20 Base Erosion and Profit Shifting minimum standard.

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Executive summary

The use of regimes granting preferential taxation to the incomes from certain R&D intangibles has increased in recent years. In 2022, 21 out of 38 OECD countries and 16 out of 27 EU countries offered income-based tax incentives for R&D and innovation (IBTIs), mostly through intellectual property (IP) regimes. IBTIs reduce firms' effective taxation and can potentially impact firms' decisions on whether, how much and where to invest in R&D as well as decisions on where to locate the intangible assets arising from R&D investments.

Measuring the impact of IBTIs on firms' taxation requires accounting for differences in countries' baseline corporate income tax (CIT) systems and the design of the IBTIs themselves. The gap between the preferential rate and the full rate, the definition of the tax base, the types of assets and income that qualify for relief and the requirements to develop the assets to qualify for relief vary across countries.

This paper presents indicators that synthesise key design features of IBTIs. The paper builds forward-looking effective tax rates (ETRs) for R&D intangible asset investments. Forward-looking ETRs consider the impact of the certain tax provisions on a hypothetical investment and are useful to compare the effect of certain tax provisions on firms' tax liabilities across countries. Indicators of effective average tax rates (EATRs), the cost of capital and B-Index for R&D intangibles accounting for IBTIs are computed for 36 IBTIs available in 26 countries. This includes all OECD countries, EU countries and selected economies with income-based tax support in 2021.

The model presented in this paper seeks to capture key characteristics of R&D intangible investments. It distinguishes between an acquisition phase, during which the firm can perform its own R&D, outsource R&D to other parties, or acquire pre-existing intangibles; and a commercialisation phase, during which the firm decides how to exploit the R&D intangible (either through own use, licensing, or selling the asset). The way in which the firm acquires, commercialises and protects the intangible asset triggers differences in the eligibility for preferential tax treatment. In line with the R&D literature, the model acknowledges that an R&D investment takes time to start generating profits when successful and that the R&D investment and associated profits loses value over time due to obsolescence or competitive pressures. The calibration assumes that the investor requires a 30% pre-tax rate of return, a gestation lag of two years and a 15% geometric rate of decay for the R&D investment. These calibration parameters, although sourced from the literature, may vary widely across different intangible assets and industries, but are instrumental in establishing a common base to compare the impact of IBTIs on firms' tax liabilities

The main insights are as follows:

- **IBTIs significantly reduce the taxation on qualifying and successful R&D investments.** Considering the case of an intangible asset which is the result of a firms' own R&D, taxes due fall substantially in the 21 OECD countries with IBTIs. The average EATR is 6.4% among OECD countries, compared to 19.8% in the absence of IBTIs.
- **The impact of IBTIs on the cost of capital and B-Index is more limited.** The cost of capital for internally generated R&D intangibles falls to 3.5% among OECD countries with income-based support, from a baseline of 4.2% if ordinary taxation would be applied. The B-Index likewise falls to 97% from a baseline of 100%. This effect of IBTIs is much lower than for expenditure-based R&D tax incentives which provide a direct reduction in the initial cost of the investment rather than a reduction of income taxes.
- **The level of implicit tax subsidies offered through IBTIs depend on their design.** Implicit tax subsidies from IBTIs increase with the difference between the statutory tax rate (STR) and the

tax rate under the IBTI. They decrease with certain design features affecting the calculation of qualifying profits. Capitalising or recapturing past expenses when calculating qualifying profits decreases implicit tax subsidies by 27% (5 pp) on average for OECD countries with such provisions in place compared to the case where such requirements would not be in place. Similarly, the deduction of ongoing expenses at the same rate at which income is taxed (also known as the ‘net approach’) decreases implicit tax subsidies by 27.4% (4.5 pp) compared to the case where such requirements would not be in place.

- **The Base Erosion and Profit Shifting (BEPS) Action 5 minimum standard has discouraged the use of certain acquisition strategies that could facilitate the transfer of intangibles to benefit from IBTIs.** Acquiring pre-existing intangibles or outsourcing R&D to related parties and subsequently benefitting from preferential tax treatment is no longer possible under the BEPS Action 5 minimum standard except to the extent of further development of the associated intangible asset by the taxpayer. These development conditions limit the transfer of intangibles from one jurisdiction to another to access tax benefits. The impact is substantial. Firms outsourcing R&D costs to related parties face an average EATR of 14% among OECD countries, seven percentage points higher than if these firms had outsourced R&D to unrelated parties or done the R&D themselves.
- **Under BEPS Action 5, the EATR that firms face on their intangible investments depends on how the intangible is acquired.** The BEPS Action 5 ‘nexus ratio’ introduces a proportional link between the qualifying R&D expenditures that led to the intangible asset and the income that can benefit from tax relief. The larger the contribution of the taxpayer (through own R&D or outsourcing to unrelated parties) to the development of the asset, the larger the share of qualifying income that can benefit from relief.
- **IBTIs may affect firms’ decisions on the acquisition, commercialisation and protection of intangible assets, through their effect on eligibility.** The greater the difference in the tax treatment between qualifying and non-qualifying intangible assets, the greater the incentive for firms to alter their decision-making to benefit from tax relief under an IBTI. Under the IBTIs examined in this paper, there are greater incentives for firms to do their own R&D or to outsource to unrelated parties, and greater incentives for firms to protect intangibles formally (e.g. through a patent), since formal protection is required in most cases.

1. Introduction

Tax incentives that offer preferential tax treatment to the income from R&D and innovation activities have surged in the last two decades.[1] While in the year 2000 only five OECD countries offered income-based tax incentives for R&D and innovation (IBTIs), this number has increased to 29 in 2022 (Appelt et al., 2023[1]). IBTIs allow income arising from certain intangible assets to be taxed at preferential tax rates. Across countries, the design of IBTIs varies significantly, which may translate into differences in the level of support they offer to firms (González Cabral et al., 2023[2]). Measuring such differences is key to understanding their impact on firms' investment decisions to develop and locate intangible assets. This requires setting up a framework that accounts for certain specific features of intangible investments and their tax treatment.

Investments in intangible assets differ in several ways from tangible investments. First, although intangible assets do not have physical existence, they also 'depreciate' in the sense that their contribution to a firm's profits can decline over time due to forces such as competition or obsolescence (Hall, 2007[3]). This may occur because an intellectual property (IP) right expires, allowing other firms to imitate the innovation, or because the innovation has simply been superseded. Second, it takes time for R&D activities to lead to the development of an intangible asset. Internally generated intangible assets that are the result of R&D, therefore, require a certain gestation lag before they become productive capital (Pakes and Schankerman, 1979[4]; Pakes and Griliches, 1980[5]). Third, an investment in R&D may not lead to the existence of a productive intangible asset as R&D investments are risky and uncertain (Arrow, 1962[6]).

The tax treatment of intangible investments varies with firms' decisions on the acquisition, protection and commercialisation of the R&D intangible. This stems from the fact that IBTIs differ in the types of assets and income they provide relief to and on the conditions they impose on the development of the asset (González Cabral et al., 2023[2]). The way in which firms acquire the intangible, by doing R&D internally, by outsourcing R&D or by acquiring pre-existing R&D intangible determines eligibility for preferential tax relief. Most notably regimes compliant with Action 5 of the Base Erosion and Profit Shifting (BEPS) project do not allow acquired pre-existing R&D intangibles or intangibles that are the result of R&D outsourced to related parties to qualify for relief. The standard tax treatment of costs associated with internally developed R&D intangibles, which are often expensed, is also different from the tax treatment of costs associated with pre-existing intangibles acquired from other firms, which are typically capitalised akin to tangible assets. Decisions on whether and how to protect the intangible interact with differences in the types of assets qualifying for relief in the different countries. Most regimes only allow formally protected assets such as patents or copyrighted software to qualify, implying that if the firm pursues informal protection mechanisms, income would be subject to standard taxation. Differences in the commercialisation of the intangible asset, licensing, own use or sale, may affect eligibility for preferential tax treatment.

This paper develops a modelling framework to analyse the effect of IBTIs on firms' effective tax rates on an intangible investment that results from R&D. The model uses the forward-looking effective tax rate (ETR) framework of Devereux and Griffith (2003[7]), as extended by Klemm (2008[8]) to

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[1] This paper is part of a series produced under the KNOWINTAX project, co-funded by the European Commission to measure income-based tax support for R&D and innovation. It is accompanied by a paper describing key design features of IBTIs (González Cabral et al., 2023[2]) and their uptake and cost to governments (Appelt et al., 2023[1]).

consider the case of a permanent investment.[2] The model considers the existence of a gestation lag between the time when R&D is conducted, and the time when it becomes productive capital and hence generating profits. The presence of a gestation lag means that the R&D phase can be distinguished from the commercialisation phase, where preferential income taxation may apply. Making this distinction has several advantages. It provides for a better mapping of the lifecycle of R&D investments, it highlights the targeting of IBTIs to the commercialisation phase of an investment, and it facilitates the modelling of certain design features of IBTIs such as differences in the treatment of past and ongoing IP expenses. This specification also allows for the integration of expenditure-based R&D tax incentives (González Cabral, Appelt and Hanappi, 2021[9]). The economic depreciation of R&D and the gestation lag are calibrated empirically to match average decay of R&D and length of the gestation lag, respectively (Li and Hall, 2020[10]).

The model develops ETRs for different types of approaches through which a firm can come to own an intangible asset (acquired, outsourced or internally generated). The model is used to produce indicators of the effective average tax rate (EATR), the cost of capital and B-Index for internally generated, outsourced and acquired R&D intangibles.[3] Results are presented for 26 (out of 48) countries that offered IBTIs in 2021, including all OECD countries, EU countries and some partner economies.[4] The model assumes that the R&D and commercialisation of the R&D intangible occur in the same country, abstracting from cross-border issues at this stage. Four key design features of IBTIs are captured: the preferential tax rate, the treatment of ongoing IP expenses, the treatment of past IP expenses and the presence of development conditions through the nexus ratio introduced by Action 5 of the BEPS Project.[5] The model abstracts from expenditure-based tax incentives and the impact of financing decisions.

This work relates to previous literature examining the impact of IBTIs using forward-looking indicators. Evers. Miller and Spengel (2015[11]) measured the effect of IP regimes in EATRs, EMTRs and cost of capital in 2014 for 12 European countries.[6] Müller, Spengel and Steinbrenner (2022[12]) extend the modelling framework to capture the impact of the BEPS Action 5 nexus approach and present estimates for 16 European countries for 2021. Both models are based on the one-period perturbation

[2] This formulation offers more flexibility to best capture situations where the tax treatment to income or expenditure varies over the lifetime of the project. The permanent investment case relaxes the assumption of a one-period perturbation of the capital stock, i.e., the asset is not sold after one period but kept until it is fully depreciated. As discussed by Celani et al. **Invalid source specified.** and Klemm (2008[8]), the two time structures yield equivalent results if personal income taxation is excluded and excess depreciation remains untaxed at the sale of the asset.

[3] Estimates of the effective marginal tax rate (EMTR) can be easily derived from estimates of the cost of capital as they are a transformation of the latter. Tax-exclusive EMTRs would be advisable given that the cost of capital can turn negative in the presence of tax incentives (Annex B).

[4] The 48 countries that were surveyed in this study for the use of income-based tax support includes all OECD countries and EU countries and Argentina, Brazil, People's Republic of China (China hereafter), South Africa and Thailand. Results do not account for the United States as the regime applies to foreign-derived income and the model is currently domestic.

[5] The nexus ratio is a provision of the Action 5 of the BEPS project makes qualifying income for IP regimes proportional to the share of expenditures the taxpayer had incurred itself or outsourced to unrelated parties in the total expenditures incurred to create it (OECD, 2015[33]).

[6] Pfeiffer and Spengel (2017[15]) also build on the work of Evers et al. (2015[11]) and extend it to the cross-border case to analyse the effectiveness of expenditure-based and income-based tax incentives in increasing R&D and discuss the potential use of, in particular of income-based tax incentives, for tax planning purposes. The analysis pre-dates BEPS Action 5.

model of Devereux and Griffith (2003[7]).[7] Lester and Warda (2018[13]) integrate IBTIs into measures of the user cost of capital for 11 OECD countries for the year 2014, accounting for a gestation lag. This paper is close to Evers et al. (2015[11]) and Müller et al. (2022[12]) in that it creates indicators that speak to both the extensive and intensive margin. However, it provides more up-to-date estimates and has a larger country coverage of 26 countries, including all OECD countries and EU countries with income-based tax support, and also including IBTIs other than IP regimes.

The model presented in this paper contributes to prior literature by generalising and extending previous models to capture differences in the design of IBTIs over time. The model presented in this paper extends previous models in three accounts. First, the model generalises the specification in Evers et al. (2014[14]) and Müller, Spengel and Steinbrenner (2022[12]) by considering that the gestation lag may be positive and can affect the value of income-based tax benefits, as in Lester and Warda (2018[13]). Second, it considers that firms may invest across both the R&D phase and commercialisation phase (still investing one unit in net present value (NPV) terms), not solely at the onset as in previous models. This feature is key to model differences in the treatment of ongoing and past expenses associated across IBTIs.[8] [9] Third, it considers a permanent investment case formulation that is apt to capture situations where the taxation of income varies over time to be captured. This is key as some IBTIs take the form of temporary reduced rates or tax holidays.

This paper is structured as follows. Section 2 provides a summary overview of the key design features of IBTIs. Section 3 presents the model. Section 4 presents the empirical calibration used to produce the results in Section 5. Section 6 concludes.

[7] Both papers consider a gestation lag of zero and assume all investment occurs at the beginning of the period, abstracting from differences between ongoing expenses (expenses that are contemporaneous to the realisation of income) or expenses incurred in the past.

[8] This is particularly relevant since regimes considering a 'net' approach, as introduced by BEPS Action 5, require deduction of *ongoing* expenses from IP income, but not necessarily those expenses associated with the IP but which incurred in the past. The treatment of past expenses varies from no requirement to account for them in calculating profits to requirements to recapture or capitalise them (González Cabral et al., 2023[2]). The model captures differences between regimes with and without recapturing provisions of past expenses that simultaneously follow a net approach with respect to ongoing expenses. Given the time structure of the investment, previous models were not able to analyse the impact of recapturing when a net approach is in place.

[9] For instance, in Evers et al. (2015[11]) or Müller et al. (2022[12]) firms invest at the beginning of the period. Consider a regime that follows a net approach, the investment (in current expenditure for ease of exposition) can immediately be deducted at the preferential tax rate. Consider a second regime that also follows a net approach but that requires the recapturing of past expenses. In this case, the initial deduction at the statutory tax rate is immediately recaptured at the preferential tax rate, which in turn means that the effect the model is able to capture is the same. This stems from the fact that the structure of the model does not distinguish between ongoing and past expenses.

2. A summary of design features

The design of IBTIs varies across countries across a series of dimensions that determine their scope and the extent of tax benefits they offer to firms. First, IBTIs differ in the types of taxpayers, assets and income qualifying for relief, which creates differences in the breadth of these regimes. Second, although IBTIs provide a preferential tax rate to the income related to R&D and innovation activities, they differ in the definition of the tax base also affect extent of tax benefits offered.[10] This section provides a summary of the design features of IBTIs based González Cabral et al. (2023[2]).

IBTIs apply a preferential tax rate to qualifying income from R&D and innovation, typically the income from formally protected intangible assets. Most countries provide tax relief in the form of an exemption that makes the preferential tax rate a function of the statutory tax rate (STR), while some do so through a reduced tax rate. On average, among OECD countries, the preferential tax rate represents a 65% reduction of the tax rate that would otherwise apply in 2021, reducing this rate down to 7.35%. In most countries, qualifying income covers all forms of IP commercialisation (licensing, sale or use for own production) and extends preferential tax treatment to the income arising from the protection of the IP (income from IP infringement).[11] In some cases, preferential tax treatment may extend to non-IP income which is the case for 'dual category' regimes[12] representing 17% of the regimes covered among OECD countries. In most countries, qualifying assets are required to benefit from formal protection with patents, copyrighted software and plant variety rights being the most common type of assets. In six out of 22 OECD countries exceptions are made to formal protection for certain small taxpayers that allow them to access preferential tax treatment for a wider set of IP assets.

Access to preferential tax treatment is often tied to development conditions that link qualifying income to the taxpayers' R&D activity. Most regimes require the taxpayer to contribute to the development of the IP asset to access preferential tax treatment. For regimes compliant with the BEPS Action 5 minimum standard these development conditions are implemented through the nexus ratio that makes qualifying income from an asset proportional to the share of the total expenditures incurred to create it that are either incurred by the taxpayer had incurred itself or outsourced to unrelated parties (Box 1). The BEPS Action 5 minimum standard also implies that income from marketing intangibles such as trademarks can no longer qualify for relief.

IBTIs also differ in the computation of the tax base to which preferential tax treatment applies. The BEPS Action 5 minimum standard led to the alignment of certain design features such as the requirement to deduct ongoing expenses and IP losses at the same preferential tax rate at which qualifying income is taxed (this is also known as the 'net approach') (Table A.2). To date, differences in the design of tax incentives remain largely with respect to the treatment of past expenses and the treatment of IP losses. Certain regimes require deductions made in the past to be recaptured upon the commencement of benefits from preferential tax treatment. However, in some cases, a threshold approach establishes that only income above a certain amount can qualify for relief. Certain countries require the capitalisation of R&D for assets to be able to benefit from preferential tax support. Finally,

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[10] Table A.1. and A.2. in Annex A provides a summary of key design features of IBTIs which will be used for modelling.

[11] Qualifying income from IP is typically required to be separated from non-qualifying forms of income. Different IBTIs have different approaches to achieve this goal, e.g., based on transfer pricing conventions, streaming methods, etc.

[12] Dual category regimes are IBTIs that provide preferential tax treatment to IP and non-IP income. The scope of dual category regimes is therefore broader than IP regimes, which solely provide relief to IP income.

different methods to ensure that IP losses are used against IP profits are in place across countries. Lastly, tax benefits may be subject to certain limitations such as ceilings that are often not specific to the income-based tax support measures.

Box 1. Key design changes introduced by BEPS Action 5

Qualifying assets and qualifying income

BEPS Action 5 restricts IP assets that can qualify for tax benefits to (i) patents and other IP assets functionally equivalent to patents if they are legally protected and subject to similar approval and registration processes; (ii) copyrighted software and (iii) IP assets that share similar traits to patents but that do not fall in the previous two categories but that are certified in a transparent process by a competent government agency. Only taxpayers with less than EUR 50 million (or nearest amount in domestic currency) in global group-wide turnover and with no more than EUR 7.5 million in gross revenue from all IP assets on average in the last five years are eligible to apply for relief under this third category. Marketing intangibles such as trademarks and income derived from them can never qualify for relief. Overall income from IP assets should be limited to IP income. Embedded IP income may benefit, if it can be separately calculated using, for instance, transfer pricing conventions. Qualifying income earned in a given year should always be defined net of associated ongoing IP expenses incurred in the same year. The regime should ensure that losses associated with the IP cannot be used against ordinary income.

Qualifying expenditures as a link to substance: The nexus ratio

The nexus ratio sets a proxy for the substantial activities undertaken by the taxpayer. The numerator equals qualifying expenditure (QE) which includes (*a*) expenditure directly incurred by the taxpayer that currently qualifies for relief under expenditure-based R&D tax incentives plus (*b*) the cost of outsourcing to unrelated parties. Interest payments, acquisition costs, building costs and any other costs not directly linked to a specific asset, do not enter the definition of qualifying expenditure. The denominator equals overall expenditures (OE), which is the numerator plus (*c*) acquisition costs and (*d*) costs of outsourcing to related parties. To allow some flexibility in the development mix of the asset, jurisdictions may allow taxpayers to apply a 30% uplift to qualifying expenditures, increasing qualifying expenditure but never to the extent that qualifying expenditure would be greater than the total amount of overall expenditure. The nexus ratio as a function of QE, OE and terms *a*, *b*, *c*, and *d* can be expressed as follows:

$$\boldsymbol{Nexus\ ratio} = \frac{\boldsymbol{Qualifying\ expenditure\ to\ develop\ the\ IP\ (QE)}}{\boldsymbol{Overall\ expenditures\ to\ develop\ the\ IP\ (OE)}} = \frac{\boldsymbol{Min((a+b)*1.3, OE)}}{\boldsymbol{a+b+c+d}}$$

The nexus approach is additive in that both qualifying and overall expenditures represent expenditure incurred over the life of the IP asset. Expenditures for the purpose of the nexus ratio enter the calculation when they are incurred (independent of the accounting or tax treatment). For example, if the firm acquires an IP asset for EUR 75 and further developed it incurring EUR 25 of in-house R&D. The nexus ratio for this asset would be equal to 25*1.3/(75+25)=32.5%. Only 32.5% of IP income can benefit from relief, and the rest is taxed at the full rate. If the firm instead incurs EUR 25 in acquiring the IP and developed EUR 75 in-house, the nexus ratio for this asset would be equal to 97.5%. Hence almost all IP income can benefit from preferential tax treatment. In exceptional circumstances, the nexus ratio can be rebutted if the taxpayer demonstrates that the level of eligible income as calculated by the nexus ratio does not accurately reflect their contribution to R&D activity. To enable this calculation, taxpayers should establish a track and trace system that links expenditure, assets and IP income. As a transitional measure, countries could introduce rules that allowed taxpayers already benefiting from an existing regime to keep such entitlements until no later than 30 June 2021.

Source: Based on (González Cabral et al., 2023[2]).

3. A model of R&D intangible asset investment

This section presents the modelling framework and the different cases considered in the analysis. Section 3.1 provides an overview of the decision margins that firms face along the lifecycle of their R&D intangible investment and provides a matrix of cases to be analysed. Section 3.2 presents the model to compute forward-looking ETRs. The model is based on the example of an internally generated intangible asset that is either licensed out or kept for a firms' own use. To ensure tractability, the model is first laid out without tax considerations, and then the case of standard taxation and preferential taxation are introduced. The modelling of key design features of IBTIs (preferential tax rates, treatment of ongoing and past expenses and development conditions) is discussed in the last step. Section 3.3. and 3.4 extend the modelling to other commercialisation strategies (e.g., sale and transfer of an IP asset) and other acquisition strategies (e.g. acquiring pre-existing IP and outsourcing R&D costs). While the model is expressed in general terms, recursive formulation is contained in Annex B.

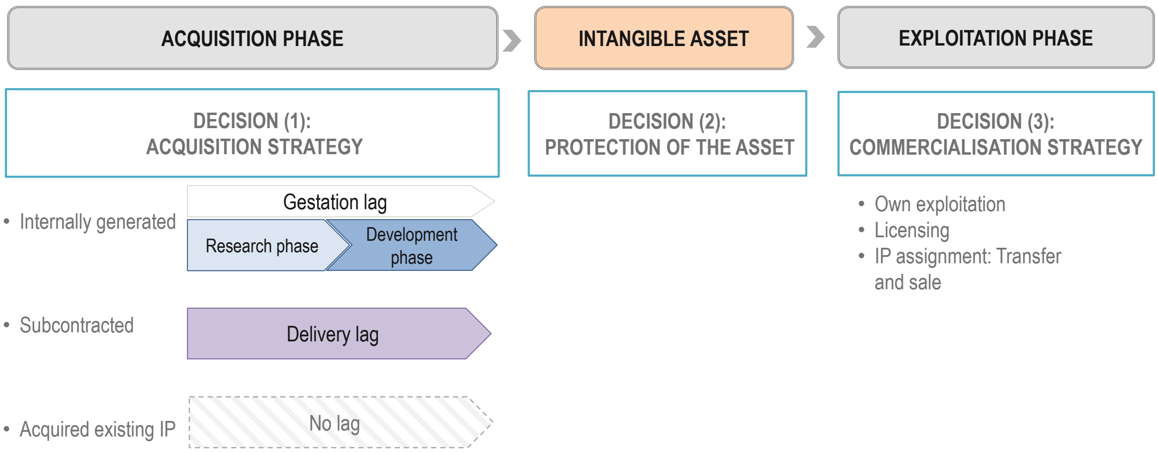
3.1. Investment phases and firms' decisions

Firms face a variety of decisions in building and exploiting their intangible capital that influence the timing structure of the investment and its taxation. Figure 1 illustrates the phases of an investment for modelling purposes, from its acquisition to its exploitation. This representation is highly stylised but provides a useful starting point to highlight the key margins crucial for quantitative comparisons of tax impacts on firms' choices relating to the acquisition and exploitation of intangible assets.[13] During the acquisition phase, firms may internally generate the intangible, subcontract the R&D to a related or unrelated party or acquire an existing asset. In each case, the timing structure is different.

- Firms that **internally generate** the intangible asset undertake the R&D in-house. This implies that there is a research phase in which new knowledge is acquired and created; and a development phase where the firm uses the knowledge acquired in the research phase to produce new products or processes or to improve existing ones. The time lag between when the investment is made and the intangible asset becomes productive capital constitutes the gestation lag (Pakes and Schankerman, 1979[4]; Pakes and Griliches, 1980[5]).
- Firms that **subcontract the R&D to another unrelated or related party** will outsource the R&D to another firm which will deliver the asset when developed. This delivery lag corresponds to the gestation lag from the perspective of the subcontractor which is producing the R&D.
- Firms that simply **acquire an existing asset** will experience no gestation lag, as the asset is ready to be used.

[13] In practice, the innovation process is dynamic and may lead to feedback loops between the different phases. Similarly, firms' decisions are not necessarily sequential or known in advance and firms may choose to combine different strategies in building an intangible asset.

Figure 1. Investment phases and firms' decisions: A focus on the acquisition phase



Note: The figure is illustrative. The length of research and development phases, and gestation and delivery lags may vary.
Source: OECD.

After the firm is in possession of the asset, the firm faces additional decision margins. Once in possession of the asset, a firm will decide on the type of protection it will seek, if at all.[14] While the decision on the level and type of protection of the asset is not modelled explicitly, its impacts are discussed in Section 3. During the exploitation phase, the firm can retain ownership and use of the intangible asset (own exploitation) or sell the rights to use the asset (licensing); or assign the IP (transfer and sale). The combination of different choices along these decisions margins will lead to differences in the standard tax treatment that would apply to the intangible. These decisions also impact the firms' ability to access preferential taxation as will be discussed in Section 5.

The combination of firm's acquisition, protection and commercialisation strategies provides a matrix of cases for analysis. Table 1 captures firms' choices in a systematic manner, providing a matrix of relevant cases for analysis that will inform the modelling in Section 3.2-3.4. Previous literature has mainly focused on patents that are either internally generated (Evers, Miller and Spengel, 2015[11]; Pfeiffer and Spengel, 2017[15]; Evers and Spengel, 2014[16]; Müller, Spengel and Steinbrenner, 2022[12]) or on acquired intangibles such as acquired patents or pre-packaged software (Ernst and Spengel, 2011[17]; Evers and Spengel, 2014[16]; Hanappi, 2018[18]). While acquired and internally generated patents are covered by cases 1 and 2 in Table 1, the proposed modelling approach integrates other features such as asset protection as well as development and commercialisation strategies within the same framework.[15] For ease of exposition, the following section focuses on the derivation of the most complex case – i.e. investments in internally generated intangible

[14] In reality, a certain lag may still apply if there is some adjustments for the asset to become fully functional to the firm. This is not incorporated into the model.

[15] Lester and Warda (2018[13]) assume that the output of R&D is a generic knowledge asset (i.e., in the case of internally generated intangibles). Differences across countries in the types of IP that are eligible for relief is implemented through assumptions regarding the eligible share of income they represent. For example, for countries that only allow income from patents to qualify, the propensity to patent is used as a proxy of the share of income from the knowledge asset that is eligible for relief. Although this approach can be accommodated in the empirical calibration, it is not pursued in this paper. Instead, this paper assumes that income arising from IP qualifies for relief.

assets that are exploited in the firms' own production process or licensed out to another domestic firm (Case 1).[16] The other cases in can be derived based on the same model by applying a different set of input parameters, as discussed below.

Table 1. Matrix of cases for analysis for a given intangible asset

		II. Commercialisation strategy	
		Own use/ License Out	Sale and transfer
I. Development strategy	Internally Generated	Base Case (1)	Case 2
	Acquired	Case 3	Case 4
	Outsourced R&D	Case 5	Case 6

Note: The case of own use and license out are equivalent in the domestic setting (both represent income and taxed domestically) and are collapsed to a single case. A third dimension lacking from this table is the decision to formally protect the asset that would interact with eligibility for preferential tax treatment. Firms may often combine development strategies in acquiring an R&D intangible asset. Mapping all strategies individually aids the development of the modelling framework in Section 3.2 and 3.3. as the tax treatment of the different development strategies varies. Section 5.3 discusses the results for alternative acquisition strategies and Section 5.4 discusses the case where firms may rely on a combination of those.
Source: OECD.

3.2. Internally generated intangible assets (Base Case)

This section will describe the modelling of an EATR on an R&D investment. The EATR provides an indicator of the impact of taxation on firms' choices over discrete investment decisions, e.g. the location of an investment, which is of particular relevance in the case of intangible assets given their greater mobility compared to tangible investments (Grubert, 2003[19]).[17] It refers to the inframarginal investment (one that generates a profit).

The key variable of interest in the development of the EATR is the post-tax profit, R, earned by the firm over the entire lifetime of the intangible asset. Equation 1 provides an expression of the EATR (Devereux and Griffith, 2003[7]; Klemm, 2008[8]). For a profitable investment, the EATR can be calculated as the difference between the pre-tax (R^*) and post-tax profits (R), normalised by the NPV of the income stream (Y^*). The numerator of the EATR captures the effects of taxes paid over the lifetime of the investment in net present value (NPV) terms.[18] [19]

[16] The case of own use and license out are equivalent in the domestic setting (both represent income and taxed domestically) and are collapsed to a single case. The tax treatment is the same from the perspective of the firm that holds IP ownership. The case of licensing will trigger different tax implications for licensee and licensor which are not considered here.

[17] EATRs measure the effect of taxes on profitable investments. They are therefore the indicator of choice, rather than the EMTR, for analyses of IBTIs and investments in intangible assets that will give rise to excess profit when successful. Nonetheless, it is also possible to investigate the impact of IBTIs in the marginal investment, with some considerations (see Annex B).

[18] Annex B provides the expressions of net income, Y^*, and pre-tax economic profits, R^*, that need to be adjusted also for the presence of a gestation lag. Net income includes the net present value of the revenue stream from the investment. This revenue stream decreases over time with the evolution of the capital stock, which itself depreciates over time. Economic profit accounts for any provisions that lower the cost of performing the investment.

$$EATR = \frac{R^* - R}{Y^*} \quad (1)$$

3.2.1. Economic profit in the case without taxation (R^*)

Equation (2) provides a general expression of project-level economic profit, i.e. the NPV of profit earned over the lifetime of the project. In the second term of Equation 2, I_t represents the investment (or disinvestment if the asset is disposed of) the firm makes in time t In the first term, $Q_t$represents the revenue, net of variable costs and gross of amortisation, that the intangible asset generates. Equation 2 captures the fact that revenues from the intangible asset may be obtained with a lag of d periods, i.e. $d \geq 0$ in the first term of Equation 2. These variables are expressed in NPV terms by discounting them using the nominal interest rate, i. [20]

$$R^* = \sum_{s=d+1}^{\infty} \frac{Q_{t+s}}{(1+i)^s} - \sum_{s=0}^{\infty} \frac{I_{t+s}}{(1+i)^s} \quad (2)$$

The expression of economic profit can be adapted to match the particular case of an R&D investment. Figure 2 depicts the time profile of an internally generated investment which is used to underpin the model, and illustrates Equation 2 in more detail. For intangible assets that are the result of firms' R&D efforts, I_t represents the R&D investment of the firm. Assuming that the firm keeps the intangible asset for its own exploitation, the firm invests at time t and does not invest or dispose of the asset in other periods in line with the permanent investment model introduced by Klemm (2008[8]). In this case $dI_t = 1$, $dI_{t+j} = 0 \ \forall j > 0$. Accounting for a gestation lag, the firm's investment in R&D in time t will take d years to materialise into productive capital and generate profits for the firm. Therefore it takes d periods to contribute to the firms' intangible capital stock $dK_{t+d} = 1$ and $dK_{t+j} = 0 \ \forall j \neq d$. The intangible capital stock loses value over time due to obsolescence or competitive forces and is hence modelled as $K_{t+d} = K_{t+d-1}(1-\delta) + I_t$, where δ is the economic amortisation rate associated with the intangible asset. The amortisation of the intangible asset reflects the decline in its contribution to firms' profits over time.[21] The increase in this case in the capital stock happens only after the development period has been completed and the asset is fully functional, such that economic depreciation coincides with the productive life of the intangible

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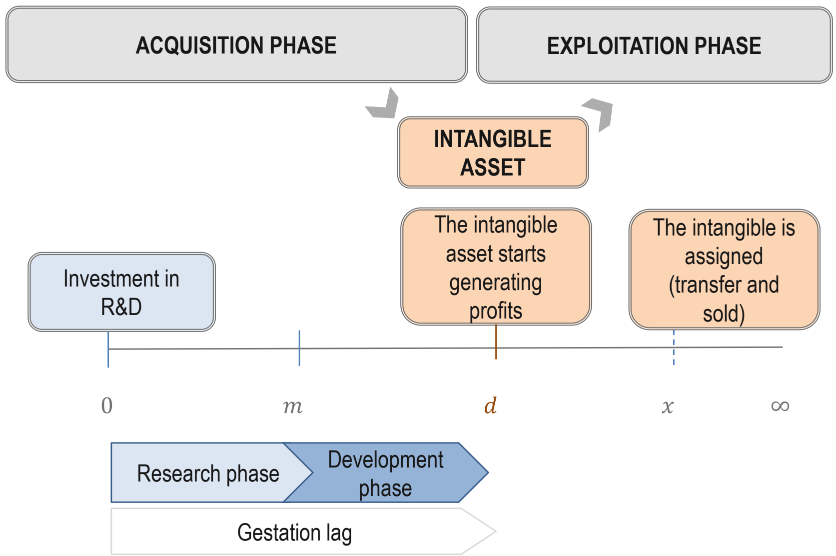
[19] Using post-tax profits, R, indicators that refer to marginal investment decisions, such as the cost of capital, the B-Index and the effective marginal tax rate (EMTR) can likewise be derived and are presented in Annex B for ease of exposition. Although less relevant in this context, the post-tax economic profit R is also key to derive these indicators. Solving for the minimum value of p that would make the investment worth undertaking, i.e. setting $R = 0$ and solving for p, provides an expression of the cost of capital, the tax component of which is typically referred to in the R&D literature as the B-Index **Invalid source specified.**. Using the cost of capital an expression of the EMTR can be derived, which for the purpose of identification in the presence of tax incentives that can drive the cost of capital into a negative territory, the tax-exclusive EMTR is preferred **Invalid source specified.**. See Annex B for detailed for formulation.

[20] Nominal and real interest rates are related through Fisher's rule, whereby $(1+r)(1+\boldsymbol{\pi}) = 1+i$.

[21] This assumption follows neoclassical growth frameworks but it is a common representation used in the literature **Invalid source specified.**. Note that the lag in amortisation is a key difference with Lester and Warda (2018[13]) who assume capital stock increases from the period following the R&D investment.

asset. Starting from period $d+1$, the intangible asset generates output and profits for the firm—term 1 in Equation 2. The net revenue hereafter obtained by the firm in any period $t+d+1$ would be given by $Q_{t+d+1} = (p+\delta)K_{t+d}(1+\pi)^{t+d+1}$. Here, net revenue depends on the past value of the capital stock, p represents the net private return on R&D and π is the inflation rate.[22] Using these definitions, Table B.1 in Annex B provides expressions of the economic profit of the firm in the absence of taxation, R^*, for an internally generated intangible exploited by the firm, omitted here for brevity. [23]

Figure 2. Stylised time structure for internally generated assets



Note: This structure is stylised for the purpose of the modelling. In reality, firms will be taking optimisation decisions at each period and may decide to stop performing R&D or dispose of the R&D even before it starts generating profits.
Source: OECD

3.2.2. *Economic profit under standard tax treatment*

The impact of taxation on firms' profits can be analysed based on the impact of the tax system on the costs of the investment (through deductions affecting the tax base) and on the revenue stream (through income taxation). Extending Equation 1 to the case with

22 p represents the private return as opposed to the social return to R&D. This value is used as the model examines to the firm's incentives to invest, not the broader incentives from a social planner's perspective.

23 The model used in González Cabral et al. (2021[9]) to estimate the impact of expenditure-based tax incentives for an internally generated intangible asset is nested in the model proposed in this section where there is no gestation lag, i.e. the R&D investment at the beginning of the period yields an intangible asset at the end of the period, $d=0$; and the asset is sold after one period. More generally, for any investment, note that in the absence of a gestation lag, $d=0$, the model collapses to the permanent investment case illustrated in Klemm (2008[8]); and assuming that the asset is disposed of after one period would yield the one-period perturbation introduced by Devereux and Griffith (2003[7]) See Celani et al. **Invalid source specified.** for a discussion of the Klemm and Devereux-Griffith models. See footnote 3 for a explanation of the advantages of the permanent investment case for the modelling of IBTIs.

taxation, Equation 3 provides a general expression of the post-tax profits of the firm on an investment in an intangible asset. Annex B provides the recursive formulation of these equations.

$$\boldsymbol{R} = \sum_{s=d+1}^{\infty} \frac{\boldsymbol{Q_{t+s}}}{(\boldsymbol{1+i})^{s}} - \sum_{s=d+1}^{\infty} \frac{\boldsymbol{\tau_{t+s} Q_{t+s}}}{(\boldsymbol{1+i})^{s}} + \boldsymbol{A}^{*} - \sum_{s=0}^{\infty} \frac{\boldsymbol{I_{t+s}}}{(\boldsymbol{1+i})^{s}} - \boldsymbol{F}^{*} \quad \textbf{(3)}$$

Under standard taxation, revenues are taxed at the statutory tax rate as reflected in the second term of Equation 3. The third term in Equation 3 captures the total value of expenditure-based provisions[24] over the lifetime of the project, A^*. The tax implications of the financing structure of the investment are captured in the last term of Equation 3, $F^* = (F^{RE}, F^{NE}, F^{D})$ where the investment can be financed by retained earnings, new equity or debt. However, to simplify exposition, this term is not further developed at this point and will be dropped in subsequent equations.

The total value of expenditure-based tax provisions, A^*, encompasses both baseline and preferential tax provisions. This includes the value of two key kinds of provisions, $A^* = f(Z_t^B, Z_t^{TL}, \tau_t)$.

- First, those that apply to the tax base, Z_t^B. Such deductions can be standard or preferential and could include, for example, expenditure-based R&D tax incentives). The value of these deductions depends on the applicable tax rate, τ_t.
- Second, it includes tax deductions that apply on the tax liability, e.g., tax credits, Z_t^{TL}.[25]

The timing of tax deductions and income taxation varies with the acquisition strategy. The lags inherent in the development of the intangible asset affect the timing of the tax deductions with respect to the taxation of the revenue stream. In other words, if $d > 0$ in Equation 3.1, firms benefit from tax deductions in the early phase of the project while taxes on revenue accrue only in a later phase provided the investment is successful. For acquired intangibles, tax deductions and income taxation are contemporaneous, $d = 0$. If the asset is not recognised in the balance sheet, and hence R&D expenses are not capitalised into the value of the asset but treated as an expense and deducted when they arise, $A^* = A$ in Equation 3.1. A captures the total value of expenditure-based provisions over the acquisition and commercialisation phase at the statutory rate.

$$\boldsymbol{A} = \sum_{s=0}^{\infty} \frac{\boldsymbol{\tau_{t+s} Z_{t+s}^{B} + Z_{t+s}^{TL}}}{(\boldsymbol{1+i})^{s}} \quad \textbf{(3.1)}$$

[24] The total value of expenditure-based provisions is kept general in this formulation but can be calibrated to captured different tax treatment of current and capital inputs. See for instance Hanappi (2018[18]) for expressions of the total value of expenditure-based provisions of capital inputs and González Cabral et al. (2021[9]) for expressions of capital and current inputs including when preferential tax treatment for R&D inputs is accounted for.

[25] This representation is convenient for the purpose of synthesising the type of tax provisions available. In the case of R&D, expenditure-based R&D tax incentives are quite common among OECD countries see (González Cabral, Appelt and Hanappi, 2021[9]) for the impact of these provisions on firms ETRs and (Hanappi, 2018[18]) on that of standard tax deductions.

In certain cases, firms may be required or may elect to capitalise R&D costs on the balance sheet rather than treat them as an expense. This may refer to all R&D costs or only a fraction, depending on domestic legislation. Modelling the possibility of partial capitalisation of R&D costs requires a distinction in the acquisition phase between the time periods during which R&D expenses will be treated as costs, and when R&D expenses will be capitalised into the value of the asset. Consider that at some point in the acquisition phase m, $m < d$,[26] the firm considers that the R&D investment meets the criteria for the asset to be capitalised into the balance sheet. Period m creates a cut-off. Until period m all costs the firm incurs are treated as an expense, as represented in the first term in Equation 3.2. After period m, all costs are capitalised. To make interpretation easier consider that firms are only required to capitalise development costs. In that case, m is going to be the length of the research phase, and $d - m$, the development phase. At time d where the asset is generated, its initial value, C^{IP}, is equal to the sum of all development costs. These are shown in as Equation 3.2.1. Firms are typically allowed to amortise the value of the intangible asset over its useful life, where φ^{IP} represents the capital allowance rate. If the firm is required to capitalise all costs, $m = 0$ in Equations 3.2. and 3.2.1. The second term in Equation 3.2 represents the total value of expenditure-based provisions available to the firm from the moment the asset is generated. Substituting $A^* = A^c$ as defined in Equation 3.2 into Equation 3 provides an expression for the post-tax economic profit of the firm for an internally generated asset that meets the criteria to be capitalised in the balance sheet.

$$\boldsymbol{A^c = \sum_{s=0}^{m} \frac{\tau_{t+s} Z^B_{t+s} + Z^{TL}_{t+s}}{(1+i)^s} + \sum_{d+1}^{\infty} \frac{\varphi^{IP} \tau_{t+s} C^{IP} + \tau_{t+s} Z^B_{t+s} + Z^{TL}_{t+s}}{(1+i)^s}} \quad \textbf{(3.2)}$$

$$\boldsymbol{C^{IP} = \sum_{s=m}^{d} Z^B_{t+s}} \quad (3.2.1)$$

The capitalisation of R&D costs is less generous than immediate expensing and aligns the treatment of internally generated with that of acquired R&D intangibles. From a tax standpoint, the expensing of R&D costs provides a greater tax advantage for firms. In the case of capitalisation, expenses that would otherwise be deductible early in the process are deferred and obtained in the future in instalments as capital allowances, which are rarely indexed for inflation. This can be seen in Equation 3.2, the tax deduction for the share of firms' expenses (from moment m till d). While from a tax perspective firms may have an incentive to minimise the amount of development costs that is capitalised into the value of the asset, the converse might also be desirable from an earnings management perspective, e.g. capitalisation may provide a sign of trust in the success of R&D investment that could affect investors' expectations about future profits (Mohd, 2005[20]) or may generate more stable levels of tax payments avoiding volatile profit and loss outcomes. It is possible to consider both the case where all R&D costs are treated as an expense or and the case where a portion

[26] Note that this follows the logic of the International Financial Reporting Standard accounting. Internally generated intangible assets are *only* recognised in financial accounts if it is probable that they would generate future benefits for the firm and their cost can be measured reliably. If these conditions are met, their value in the balance sheet reflects the development costs incurred only from the moment technical and commercial feasibility of the asset for sale or use has been established. Research costs are treated as an expense. Then, amortisation starts once commercial production has commenced. However, as it is typically difficult for firms to identify when these conditions are met, internally generated assets are typically not well reflected in financial accounts.

needs to be capitalised. How large the difference in tax benefits arising between these two cases would depend on the share of expenditure from the R&D phase that is capitalised compared to the share that is treated as an expense. The rest of the derivation in this section will consider the case in Equation 3.1 as the most common case.

3.2.3. Economic profit under preferential tax treatment

Building on the case of standard taxation outlined above, Equation 4 reflects in a general manner how IBTIs affect the calculation of firms' post-tax profits. A fully parametrised version of this equation is given in the annex. Several key modelling features of IBTIs[27] are accounted for: the preferential regime rate, the treatment of ongoing and past associated expenses as well as the nexus ratio introduced by BEPS Action 5, as discussed in the following subsection. The impact of other design features such as the treatment of IP losses, or the application of ceilings to limit the tax benefits from the preferential regimes are not explicitly captured but discussed briefly at the end of this section. Equation 4 provides a general expression of economic profit to model preferential taxation, where τ_t^* provides a general expression for the preferential tax rate and A^{**}, a general expression of the total tax deductions over the lifetime of the investment that affect the calculation of the IP tax base. Note that to capture the case of preferential taxation, the asset is assumed to be a qualifying asset.

$$\boldsymbol{R} = \sum_{s=d+1}^{\infty} \frac{\boldsymbol{Q}_{t+s}}{(\boldsymbol{1}+\boldsymbol{i})^{s}} - \sum_{s=d+1}^{\infty} \frac{\boldsymbol{\tau}_{t+s}^{*}\boldsymbol{Q}_{t+s}}{(\boldsymbol{1}+\boldsymbol{i})^{s}} + \boldsymbol{A}^{**} - \sum_{s=0}^{\infty} \frac{\boldsymbol{I}_{t+s}}{(\boldsymbol{1}+\boldsymbol{i})^{s}} \quad \textbf{(4)}$$

Tax relief

IBTIs typically operate as a reduced rate on IP income τ^{IP} or an exemption applicable to IP income $\tau^{IP} = \theta^{IP}\tau$, with θ^{IP} being the applicable exemption rate on IP income. These two instruments, while defined differently, are functionally equivalent.[28] Since IBTIs provide preferential tax treatment to the income generated from the commercialisation of certain types of intangible assets (see Section 2), they increase the post-tax revenues available to the firm. In the presence of preferential tax treatment, qualifying income would be taxed at the preferential tax rate, i.e. $\tau_{t+s}^* = \tau_{t+s}^{IP}$ in Equation 5 for an internally generated intangible asset, as opposed to at the STR as in Equation 3.

Ongoing associated IP expenses

Associated IP expenses include all expenses linked to the IP, which are typically apportioned based on transfer pricing conventions (i.e., approximated by the cost that would have been incurred by a third party). Associated IP expenses may include the cost of

[27] Note that to capture the impact of preferential tax provisions, it is necessary to assume that the intangible asset is protected by an IP right that qualifies for relief. Requiring an asset to be legally protected to benefit from relief is the most common case, although some regimes also allow informally protected assets to qualify (e.g., trade secrets qualify under Category III assets which are restricted to certain taxpayers provided that they are non-obvious, useful and novel). See Section 2 and Box 1.

[28] In most cases, relief is administered via a deduction from the tax base. Unless special provisions are in place to limit the amount of the deduction to the firms' tax liability, the tax deduction may make the firm enter a loss position if the firm has insufficient taxable income to use the deduction in full.

financing or associated current and capital costs that are related to a patented product, e.g., if a company manufactures one patented product and one that is not, its staff and capital expenses should be apportioned between the two products on a 'just and reasonable basis'.[29]

IBTIs can deal with ongoing expenses using what is known as either a 'gross' or 'net' approach, with the 'gross' approach being more generous. For IBTIs applying a 'gross' approach, ongoing IP expenses are deducted at the STR while IP income is taxed at the preferential rate, providing a tax advantage to the firm. In this case, A^{**} in Equation 4 would be given by $A^{**} = A$ in Equation 3.1. This approach is not compatible with the BEPS Action 5 minimum standard which prescribes the use of a 'net' approach, but it was utilised in the past (Evers, Miller and Spengel, 2014[14]).

Under the 'net' approach, associated ongoing IP expenses must be written off at the preferential rate, rather than the statutory tax rate, from the moment that the asset is eligible for preferential tax treatment. This implies that IP income and associated IP expenses will both be taxed at the same preferential rate, ensuring tax symmetry between the rates at which deductions are valued and income is taxed. In this case, A^{**} will be given by $A^{**} = A'$in Equations 4.1 where $A' = f(\tau, \tau^{IP})$. The first term in Equation 4.1 shows that for an internally generated asset, tax deductions are written off at the statutory tax rate in the acquisition (R&D) phase. The second term in Equation 4.1 reflects that when the asset starts being productive, the associated tax deductions are valued at the preferential rate, a symmetric treatment arises between expenses and income from the intangible which only arises after period d.

$$\boldsymbol{A'} = \sum_{s=0}^{d} \frac{\boldsymbol{\tau_{t+s} Z_{t+s}^{B} + Z_{t+s}^{TL}}}{\boldsymbol{(1+i)^s}} + \sum_{d+1}^{\infty} \frac{\boldsymbol{\tau_{t+s}^{IP} Z_{t+s}^{B} + Z_{t+s}^{TL}}}{\boldsymbol{(1+i)^s}} \quad \textbf{(4.1)}$$

Past associated IP expenses

Among IBTIs, there are three approaches regarding the treatment of past expenses upon firms first qualifying for income-based tax support. The first is that no special provisions exist regarding the need to incorporate past expenses in the tax base of a given year, upon the firm first applying for income-based tax relief. The second case is where the regimes require past R&D expenditures to be recaptured at the regime rate before qualifying income can benefit from any tax relief; and the third case is where past R&D expenses are required to be capitalised.

- **No treatment of past expenses:**

In this case, initial deductions are offset at the STR and they do not feed into the second term of A or A'. In other words, IP profits do not need to be reduced by these amounts.[30] This is the case outlined in Equations 3.1 and 4.1.

[29] It is notable that associated IP expenses and qualifying expenditure for the purposes of defining the nexus ratio are not synonyms. For example, the cost of financing is an associated IP expense (on the share that it relates to the IP) and is explicitly excluded as a qualifying expenditure for nexus purposes (OECD, 2015[33]).

[30] Note that this refers to the computation of qualifying IP profits. For nexus compliant regimes, past expenses are used to compute the nexus ratio.

- **Recapturing of past expenses:**

The recapturing of past expenses recognises that past R&D expenditures that have led to the acquisition of the intangible asset are also counted as an associated expense, i.e. all expenses current and past have contributed to the income-generating intangible asset. These provisions require that upon first applying to the regime, the taxpayer needs to deduct past R&D expenses (i.e. associated IP losses) from qualifying profits. This may take place at once, over a certain number of years, or past expenses may add up to a threshold over which IP profits start qualifying for relief. When recapturing of past expenses is required, A^{**} in Equation 4 will be given by $A^{**} = A''$ in Equation 4.2, where $(A'') = f(\tau, \tau^{IP})$. The recapturing of past expenses from the R&D phase is reflected in the second term in Equation 4.2 where R&D expenditures that were previously deducted at the statutory tax rate need to be adjusted at the regime rate. The third term in the equation outlines the treatment of ongoing IP expenses in the commercialisation phase, which is assumed to be also deducted at the regime rate (i.e., following the 'net' approach).[31] In some countries, past expenses contribute to a threshold and only qualifying income above this threshold can benefit from the regime rate (González Cabral et al., 2023[2]). As the outcome of both approaches entails the recognition of past expenses in reducing the tax base for relief, these are both accounted for in the modelling in Equation 4.2.[32]

Recapturing past expenses aims to ensuring intertemporal tax symmetry between the treatment of all associated, past and ongoing expenses and income from the intangible asset. The extent to which this is the case varies with the stringency of development conditions. As past R&D expenses are typically not inflation adjusted, their value in the future is diminished and, as a result, complete symmetry is not attained. The net approach therefore does not achieve full tax symmetry even with recapturing of R&D costs.

$$\boldsymbol{A''} = \sum_{s=0}^{d} \frac{\boldsymbol{\tau_{t+s} Z^{B}_{t+s} + Z^{TL}_{t+s}}}{\boldsymbol{(1+i)^{s}}} - \frac{\sum_{s=0}^{d} \boldsymbol{(\tau_{t+s} - \hat{\tau}^{IP}) Z^{B}_{t+s}}}{\boldsymbol{(1+i)^{d+1}}} + \sum_{d+1}^{\infty} \frac{\boldsymbol{\tau^{IP}_{t+s} Z^{B}_{t+s} + Z^{TL}_{t+s}}}{\boldsymbol{(1+i)^{s}}} \tag{4.2}$$

- **Capitalisation:**

Certain countries require the capitalisation of development costs for the asset to benefit from relief. As discussed in Box 1, only development costs (in the 'D' phase of the R&D phase) can be capitalised provided certain conditions are met. When capitalisation is required, A^{**} in Equation 4 would be given by $A^{**} = A'''$ in Equation 4.3. In this case, capitalisation as described in Equation 4.3 is mandatory, with the only difference being that the resulting capital allowances from the capitalised intangible asset would be deducted at the regime rate in the commercialisation phase over the useful life of the asset $N = \frac{1}{\varphi^{IP}}$ (term 2 in Equation 4.3).[33] The initial value of the asset C^{IP} would be given by Equation 3.2.1.

[31] The most common scenario seems to be that if past expenses are recaptured, then a net approach is pursued for ongoing expenses, however the model could be generalised for countries not following this approach.

[32] The permanent investment framework allows to model the threshold approach as period-by-period revenues are observed. The result of modelling the threshold approach as opposed to the recapturing approach outlined in equation 6.2 do not differ significantly while the specification in 6.2 allows an easier specification to back-out the cost of capital.

[33] It is assumed no other expenses exist beyond the useful life of the asset for this investment.

$$A''' = \sum_{s=0}^{m} \frac{\tau_{t+s} Z^{B}_{t+s} + Z^{TL}_{t+s}}{(1+i)^s} + \sum_{d+1}^{N} \frac{\varphi^{IP} \tau^{IP}_{t+s} C^{IP} + \tau^{IP}_{t+s} Z^{B}_{t+s} + Z^{TL}_{t+s}}{(1+i)^s} \quad \textbf{(4.3)}$$

The recapturing approach typically provides greater tax benefits to the firms than the requirement to capitalise past expenses. This is because under the recapturing approach firms benefit from deducting expenses at the higher STR in the periods leading to the intangible asset being productive. These expenses are recaptured only at a later stage. Capitalisation implies that those initial deductions are deferred in time. As capital allowances are hardly ever indexed for inflation, this implies a lower NPV of such deductions.

3.2.4. The BEPS Action 5 nexus ratio

For regimes following the BEPS Action 5 minimum standard, the nexus ratio establishes the proportion of IP income that qualifies for tax relief. The share of overall income that qualifies for relief is deemed to be equal to the proportion of expenditures directly related to R&D activities that is incurred by the taxpayer itself (Box 1). In general terms, for a nexus ratio of θ_t, only a fraction θ of overall profits at time t would benefit from the regime rate. [34] Hence, the economic profits from the intangible asset would be taxed at a weighted average between the preferential rate and the statutory tax rate using θ_t as weight, as shown in the second term of Equation 5. The nexus ratio is cumulative and can vary over time. In a given period, the tax rate applicable to income would be the nexus-weighted tax rate, $\tau^{*}_{t+s} = \tau^{NW}_{t} = \tau_t - \theta_t(\tau_t - \tau^{IP}_t)$. The total value of expenditure-based provisions, A^{NW} would likewise be a weighted average between the baseline case, i.e. Equation 3.1 and the cases outlined in Equations 4.1 to 4.3. For a simple case of a regime using a net approach and no treatment of past expenses, A^{**} in Equation 5 would be given by A^{NW} in Equation 5.1. Equivalent expressions can be obtained when other design features are accounted for.

$$R = \sum_{s=d+1}^{\infty} \frac{Q_{t+s}}{(1+i)^s} - \sum_{s=d+1}^{\infty} \frac{\tau^{NW}_{t+s} Q_{t+s}}{(1+i)^s} + A^{NW} - \sum_{s=0}^{\infty} \frac{I_{t+s}}{(1+i)^s} \quad \textbf{(5)}$$

$$A^{NW} = \sum_{s=0}^{d} \frac{\tau_{t+s} Z^{B}_{t+s} + Z^{TL}_{t+s}}{(1+i)^s} + \sum_{s=d+1}^{\infty} \frac{\tau^{NW}_{t+s} Z^{B}_{t+s} + Z^{TL}_{t+s}}{(1+i)^s} \quad (5.1)$$

Equation 5 provides a range of all possible values of the post-tax economic profit, and consequently of EATRs and cost of capital, for intangible assets with nexus ratios between 0 and 1. Where no preferential tax treatment applies, Equation 5 would collapse to the baseline case in Equation 3. If all income is eligible, e.g., in the case of an intangible asset that is the result of a firms' own R&D efforts, Equation 5 would collapse to Equation 4. Variation in the nexus ratio between these two boundary cases would illustrate the tax treatment of intangible assets generated using a mix of acquisition strategies in Table 1. In other words, Equation 5 is

[34] The nexus ratio is cumulative and therefore the share eligible for relief may vary across periods, hence the subscript in Equation 5. Even after the IP has been developed, firms may continue to incur development costs to further enhance the asset. Depending on whether the additional cost incurred constitutes qualifying expenditure or not, this may have an impact on the nexus ratio for the respective period. For example, if the firm continues developing the asset by subcontracting some costs to a related party, the nexus ratio for that period decreases; however, if the firm subcontracts these costs to an unrelated party the nexus ratio would increase.

a general case that embeds all possible tax outcomes from full taxation to full preferential taxation.

3.2.5. Other design features: Time-varying tax relief

In certain cases, the tax benefits granted by income-based incentives are only available to firms over a limited period after which the full rate applies. This is the case for instance of temporary CIT exemptions (tax holidays for R&D businesses or temporary reduced rates), which are common among dual category regimes. Certain types of tax incentives link relief to the firm meeting certain requirements such as making a sizeable investment or having a specific firm size.[35]

In order to capture these regimes, consider that H^* denotes the period for which the reduced rate $\tau^{IP}, 0 \leq \tau^{IP} < \tau$ applies. Equation 6 contains the expression for the post-tax economic profits where the second term represents the taxation of income during the first H^* periods, and the third term refers to the taxation at the full rate from that moment onwards. A^{TH} would likewise need to be adapted. In 6.1, it is assumed that expenses are deducted at the same rate as income is taxed.

$$\boldsymbol{R} = \sum_{s=d+1}^{\infty} \frac{\boldsymbol{Q}_{t+s}}{(\boldsymbol{1}+\boldsymbol{i})^{s}} - \sum_{s=d+1}^{H^*} \frac{\boldsymbol{Q}_{t+s}\boldsymbol{\tau}_{t+s}^{IP}}{(\boldsymbol{1}+\boldsymbol{i})^{s}} - \sum_{s=H^*}^{\infty} \frac{\boldsymbol{Q}_{t+s}\boldsymbol{\tau}_{t+s}}{(\boldsymbol{1}+\boldsymbol{i})^{s}} + \boldsymbol{A}^{TH} - \sum_{s=0}^{\infty} \frac{\boldsymbol{I}_{t+s}}{(\boldsymbol{1}+\boldsymbol{i})^{s}} \qquad \textbf{(6)}$$

$$\boldsymbol{A}^{TH} = \sum_{s=0}^{H^*} \frac{\boldsymbol{\tau}_{t+s}^{IP}\boldsymbol{Z}_{t+s}^{B} + \boldsymbol{Z}_{t+s}^{TL}}{(\boldsymbol{1}+\boldsymbol{i})^{s}} + \sum_{s=H^*}^{\infty} \frac{\boldsymbol{\tau}_{t+s}\boldsymbol{Z}_{t+s}^{B} + \boldsymbol{Z}_{t+s}^{TL}}{(\boldsymbol{1}+\boldsymbol{i})^{s}} \qquad (6.1)$$

These expressions allow for an important distinction in the design of IBTIs.

- **If the preferential tax treatment is conditional on the existence of a productive intangible asset** (as in the case of IP regimes that require the capitalisation of expenses), $H^* = H$, where H is the number of years during which preferential tax treatment applies in Equation 6.1, i.e., the useful life of the IP asset or as determined in tax law.[36]

If the preferential tax treatment is rather conditional upon the firm meeting certain R&D or innovation criteria, e.g. a tax holiday for R&D businesses, then preferential tax treatment is assumed to apply from the onset of the investment or in other words, the preferential tax treatment is not tied to the existence of a productive intangible asset. Considering a gestation lag, $d > 0, \boldsymbol{H}^* = H - d$ in Equation 6.1, implying that the firm foregoes e.g. $d = 2$ years of tax benefits.

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[35] This is in contrast to IP regimes that tend to link preferential tax treatment to the income from a given intangible. More detail is provided in Table 3 in González Cabral et al. (2023[2]).

[36] Note also that the varying rates may also affect the calculation of A. However, as our model considers a current expenditure which is immediately deducted and hence expensed in one period this issue does not arise. In situations where firms are required to capitalise past expenses and deductions are granted in the form of capital allowances for the intangible asset, reduced taxation is attached to the existence of capital allowances (time-limited), hence the issue of a varying rate is not relevant for the cases covered this far.

3.3. Alternative commercialisation strategies (Case 2)

Instead of exploiting the asset itself or licensing it out to other domestic firms, the firm might decide to sell the intangible asset after x periods. This corresponds to Case 2 in Table 1. In this case, the firm sells the intangible asset in period $t + d + x$ for an amount V_x, i.e., the firm disinvests. The value of the sale, V_x, might be a function of the economic value of the asset at the time of the sale, thus affected by economic depreciation and inflation, potentially including a certain mark-up. Any differences between the value of the sale and the value of the asset after tax depreciation will generate a capital gain, ξ. The post-tax sales value can be written, in general terms, as a function of inflation, economic depreciation and capital gains and taxation of such gains either, $\boldsymbol{V_x^T} = f(\pi, \delta, \xi, \hat{\tau})$. If a preferential tax treatment is applied to the income from sale of the asset, i.e. Case 2 in Table 1, the post-tax value of the sale in Equation 7 would be modified to read $\boldsymbol{V_x^T} = f(\pi, \delta, \xi, \hat{\tau}^{IP})$ where $\hat{\tau}^{IP}$ would be the preferential tax rate applying to capital gains.

$$\boldsymbol{R} = \sum_{s=d+1}^{d+x} \frac{(\boldsymbol{p}+\boldsymbol{\delta})(\mathbf{1}+\boldsymbol{\pi})^{s}(\mathbf{1}-\boldsymbol{\delta})^{s-d-1}(\mathbf{1}-\boldsymbol{\tau}_{t+s})}{(\mathbf{1}+\boldsymbol{i})^{s}} + \boldsymbol{A}^{*} - \mathbf{1} + \frac{\boldsymbol{V_x^T}}{(\mathbf{1}+\boldsymbol{i})^{d+x}} \tag{7}$$

3.4. Alternative acquisition strategies

3.4.1. Acquired intangibles (Case 3, 4)

Apart from generating assets internally, firms can also acquire existing intangibles from other firms. In this case where the firm has acquired the asset, either independently or as part of a business combination and they can be separately identified, the modelling framework needs to be only slightly adjusted. The investment the firm makes constitutes the acquisition cost of the intangible asset and since the R&D was not performed by the firm and the asset is readily available, the gestation lag is simply zero (Figure 1). Box 1 summarises the accounting treatment of acquired intangibles, which are typically initially recognised by the acquisition cost and carried at its cost less any accumulated amortisation.

To consider the impact of standard taxation for the case of acquired intangibles, i.e. Case 3 and Case 4 (based on Equation 7) in Table 1, it suffices to modify Equation 3 by setting $d = 0$, reflecting that there is no gestation lag, and $A^* = A^c$ as defined in Equation 3.2 setting $d = m = 0$, where C^{IP} would represent the cost of acquisition and costs directly related to the intangible asset acquired that need to be capitalised in the case of an acquired intangible. It is assumed that the intangible asset, valued at C^{IP}**,** is typically amortised over its useful life at a rate φ^{IP}. The same assumptions can be applied to derive the formulae if acquired R&D intangibles is eligible for preferential taxation, using Equation 4 and Equation 4.3. It is important to note that for regimes compliant with the BEPS Action 5 minimum standard, an acquired intangible asset that is not further developed would carry a nexus ratio of zero, implying that Equation 7 collapses to the baseline case outlined in Equation 3, applying the same parameters outlined above for the case of an acquisition.

3.4.2. Intangibles generated through outsourced R&D (Case 5, 6)

In the event that the firm outsources R&D to a third party, the investment of the firm is the payment to the subcontractor, which constitutes the initial investment. The subcontractor would take time to produce the output of their R&D, as the gestation lag applies to the subcontractor as well. This means that the firm only receives the intangible asset with a lag, i.e. the delivery lag, which for simplicity is assumed to be equal to the gestation lag for an internally developed asset, d (Figure 1). The same equations as for internally generated assets, i.e. Equation 3 for standard taxation and Equation 4 and the subequations can be used to obtain Cases 5 and 6 (based on Equation 7) in Table 1. Depending on the definition of qualifying expenditures where applicable, intangibles that are the result of subcontracting may not qualify for preferential tax treatment. Likewise, under the nexus requirements under the BEPS Action 5 minimum standard, intangibles that are the result of outsourced R&D to related parties and that are not further developed cannot benefit from preferential tax treatment. In such cases, Equation 7 collapses to 3.

4. Empirical calibration

This section outlines the parameters and additional assumptions used to calibrate the model in Section 3 to yield estimates of the impact of IBTIs ETRs. The availability of IBTIs is surveyed in 48 countries, including all OECD countries, EU countries and six major economies (Argentina, Brazil, China, South Africa and Thailand). IBTIs are available in 2021 in 26 out of the 48 countries, 21 out of 38 OECD countries and 17 out of 27 EU countries. Table A.1 lists all IBTIs covered in this paper which are assigned a unique identifier for tractability. The model is calibrated to the case of an internally generated intangible asset (Case 1 in Table 1), with the calibration to other cases outlined in Section 4.4.

4.1. Calibrating the R&D investment

4.1.1. Pre-tax rate of return, gestation lag and revenue decay

When considering the case of an R&D investment that is successful in generating an intangible asset, assumptions on the innovation life cycle are required. These mainly relate to (i) the mean lag between the deployment of the R&D investment and the moment the asset starts generating income; (ii) the rate of private return that the firm expects and (iii) rate at which the revenues associated with the investment decay. It is widely recognised that it is very difficult from an empirical standpoint to estimate these parameters independently due to the lack of natural experiments and the lack of variation in R&D data, which leads to identification issues (Hall, 2007[3]; Hall, Mairesse and Mohnen, 2009[21]). These parameters also are highly project-, industry- and time-specific. Any estimates of these parameters would also be driven by estimation methods and underlying assumptions. Nonetheless, some mean values of these parameters can be obtained from the literature. Table 2 provides a summary of the parameters used in this calibration.

The evidence suggests that the gestation lag is on average around two years long (Pakes and Schankerman, 1979[4]). The lag has been found to be longer for basic research compared to more applied research (Bureau of Labor Statistics, 1989[22]). Recent survey estimates conducted by the Bureau of Economic Analysis support a lag of 2 years, with slightly over 1% of the population reporting 3 years and less than 1% reporting a 4 year lag (Li and Hall, 2020[10]). In line with the literature, the average lag for the model is assumed to be 2 years.[37] Annex C reports a sensitivity analysis to different gestation lags. A longer gestation

[37] It is important to note that the first modelling efforts focus on the case where the investment is a successful one. Although uncertainty is a key trait of R&D investments, this feature is assumed away in this model.

lag decreases the EATR as it decreases the profitability of the investment in NPV terms and pushes up the cost of capital.

The rate of return that investors derive from their R&D investment is set at 30%. Hall et al. (2009[21]) review estimates in the literature confirming the great variability of estimates across units of observations and methodologies, with the likely range for the private rate of return being around 20-30%. Most estimates of tangible capital investments use a rate of return of 20%, which is also used in Evers et al. (2015[11]) for internally generated patents. However, given that there are risks and uncertainty associated with an R&D investment, the paper considers a pre-tax return of 30% in line with the assumption used in previous OECD work on the measurement of expenditure-based tax incentives (González Cabral, Appelt and Hanappi, 2021[9]).[38]

Knowledge-based assets lose value and hence revenues decline, albeit in a different manner to tangible assets. The literature has sought to inform the pattern and rate of decay of appropriable revenues. In line with previous literature, this paper calibrates the depreciation rate of R&D capital to be equal to 15%, the benchmark figure typically used in empirical work. Depreciation rates of R&D are shown to vary by industry and over time and can be influenced by the pace of technological progress, the degree of market competition or by ease of appropriability of returns (Mead, 2007[23]; Li and Hall, 2020[10]). A rate of decay of 15% implies that revenues are close to 0 by the 20th period which approximates the number of years of protection which are granted to patents (WIPO, 2004[24]). This could be a way of interpreting the indicators as referring to an R&D investment that is ultimately patented and eligible for relief.

Table 2. Model calibration parameters

Key variables	Variable in Annex B	Rate
Pre-tax rate of return	p	30%
Economic depreciation rate	δ	15%
Gestation lag	d	2
Share of initial investment in the R&D phase	ω	50%
Share of capitalised R&D costs in the development phase	θ	100%
Real interest rate	r	3%
Inflation	π	1%
Nominal interest rate	i	4.03%

4.1.2. Nature and timing of the investment

The investment is considered to take the form of current expenditure, e.g., the labour costs of hiring researchers**.** Current R&D expenditure constitutes the largest component of R&D investments, representing around 90% on average of the cost composition for R&D investments, with little variation observable on average across industries (OECD, 2021[25]). In previous work measuring expenditure-based tax incentives, the typical composition of R&D investment considered a 90% weight for current inputs and 10% for capital inputs (OECD, 2021[26]; OECD, 2021[27]). This composition allows the variation in eligible R&D expenditures across countries to be captured. Given that the focus of this paper is on the income stream

[38] Due to the presence of spillovers, the social return to R&D is typically larger than the private return, leading to the well-known finding that the structure of market incentives may yield R&D investments below the socially optimal level. Since this paper focuses on the incentives to the investor, the pre-tax rate of return, p, is calibrated to be the private rate of return.

from the intangible asset and the impact of the preferential tax provisions, the composition of the initial investment is stylised in the modelling.

The firm is assumed to invest at the R&D and commercialisation phases. Some investment takes place in the R&D phase to create and develop the asset, and another part of the investment takes place in the commercialisation phase to put the asset in the market.[39] This split of the investment costs recognises the need to further invest to commercialise the IP while at the same time creating expenses throughout both the acquisition and commercialisation phase of the investment. This is a necessary feature to account for the differential treatment of past associated expenses (those incurred during the acquisition phase) and ongoing associated expenses (those incurred during the commercialisation phase) for the IP when accounting for the preferential tax treatment granted by income-based incentives (Table A.2).[40] The share ω in Table 2 represents the share of initial investment that takes place in the R&D phase and has been set arbitrarily to 50%. This parameter can be varied providing more weight to one phase compared to the other. Despite the split, the firm is assumed to invest one unit in net present value terms, i.e. $I_t = \omega$ at time t and $I_{t+d} = \omega * (1 + r)^{d+1}$. For ease of exposition, the investment in each of the phases is assumed to occur at the beginning of the R&D and of the commercialisation phase.[41] Given the assumptions above, the general expressions of A in Section 4 can be spelled out for an investment in current expenditure.

4.2. Income-based tax incentives

Four key design parameters, contributed by countries as part of the OECD KNOWINTAX survey, are used in the modelling, all referring to the year 2021:

- the preferential tax rate,
- the treatment of ongoing associated IP expenses,
- the treatment of past associated IP expenses, and
- the application of nexus conditions.

The full rate that would apply in the absence of preferential tax treatment is the combined corporate tax rate obtained from the OECD Tax Database (OECD, 2021[28]).[42] The estimates are calibrated to the case of large firms except for Korea where regime applies solely to SMEs.

[39] Note that the nature of the current investment in the commercialisation phase may be treated as R&D or simply as an associated current expense. Given that expenditure-based R&D tax incentives are not modelled, the

[40] Note that in models such as Evers et al. that use the one-period perturbation formulation, the case of recapturing of past expenses is modelled in the same manner as income-based tax incentives using a net approach for ongoing expenses. This is because the modelling is constrained by the one-period perturbation specification that does not allow the consideration of differences in the treatment of past and ongoing expenses. The modelling in Evers seeks to capture that in essence the goal of recapturing mechanisms is to introduce the symmetric treatment of income and expenses.

[41] In the model this is captured by a share of the investment occurs at the beginning of the R&D phase and another share at the beginning of the commercialisation period. Alternatively, one could model a continuous investment occurring throughout each of the two phases.

[42] The preferential tax rate is adapted where subnational taxes and surcharges are accounted for in the combined tax rate.

For countries that require the capitalisation of R&D costs, this paper assumes full capitalisation of R&D costs.[43] In all cases where capitalisation is required, a 20-year period is assumed which aligns with the usual period for which patents are granted (Table 5). In the model, after the 20-year period ends, any remaining profits are taxed at the full rate. In the case of acquired R&D intangibles, the same length is assumed for the amortisation of the acquired asset.

For IBTIs restricting relief to a set number of years, the R&D investment is assumed to take place in the first year of eligibility for relief. This is the case of the China (CHN1, CHN2), Czech Republic, Romania and Thailand (THA1) (Table A.2). This means that the effective period of exemption of profits is the number of years of preferential tax treatment discounted by the gestation lag (see Section 3.2.5).

4.3. Other tax and macroeconomic parameters

Additional economic parameters include the real interest rate which is fixed at 3% and the inflation rate at 1%, in line with the macroeconomic scenario used in OECD Corporate Tax Statistics (OECD, 2021[27]). For the purpose of simplification, the investment is assumed to be financed by retained earnings and the analysis abstracts from personal income taxes. The impact of allowances for corporate equity (ACE) provisions are not accounted for in this initial estimation (OECD, 2021[27]). In essence, any impact of financing decisions is not discussed in this paper.

4.4. Cases modelled and additional assumptions

The main estimates are derived for the case of an intangible asset that is 1) the result of R&D, 2) that represents a qualifying intangible asset and 3) that the firm decides to commercialise in the same country (e.g. licenses it out to other domestic performers) or keeps the IP for their own use (Case 1). The model is used to exploit variation in the types of acquisition strategies that will determine eligibility for relief. Estimates for alternative acquisition strategies, i.e., for the case where the firm acquires existing IP or subcontracts R&D to other parties (Cases 3 and 5 in the matrix in Table 1) require certain parameter changes as discussed in Section 3.4. For acquired R&D intangibles, the formulae is equal to Equation 2.d with $\theta = d = 0$. As discussed, when preferential treatment is modelled, the premise is that the asset is deemed to qualify for income-based tax relief and is both a successful investment generating a return. The firm is assumed to have other sources of income (i.e., it is not tax exhausted) and applies for income-based tax support for the first time upon receiving income from the qualifying intangible asset.

5. Results: The impact of income-based tax support

This section presents estimates of the extent of tax benefits offered to investments in R&D related intangibles that qualify for IBTIs. These estimates refer to 36 IBTIs available in 26 countries in 2021 and are based on the calibration in Section 4. The main results consider an investment that is the result of the taxpayers' own R&D effort (internally

43 In case where partial capitalisation applies, a share of R&D costs would be expensed, and the remainder capitalised and written off in capital allowances. The greater the share of capitalised costs the further from immediate expensing the firm gets and the least generous the regime would be.

generated), which is then commercialised by licensing it out to another domestic firm or used by the taxpayer in its own production (base case in Table 1). The impact of alternative acquisition strategies, i.e., when the firm outsources the R&D to other firms or acquires existing R&D intangibles, are also considered (Section 5.3 and 5.4). This section discusses the effect on the EATR (which measures the impact for investments at the extensive margin), while the effect of income-based tax support on the cost of capital and on the B-Index (which measures the impact for investments at the intensive margin) is discussed in Annex C.[44] The IBTIs are referred to using the unique codes listed in Annex A.

5.1. Income-based tax incentives lower taxes paid on profitable investments

IBTIs shift down the distribution of EATRs with varying effects on the dispersion of EATRs across country groups. Figure 3 shows the change in the distribution of the EATR when IBTIs are accounted for. IBTIs shift the distribution of the EATRs for an internally generated intangible downwards compared to the case where standard taxation applies. Among countries with IBTIs, the dispersion of EATRs seems to slightly increase when accounting for preferential income taxation in the sample, but this increased dispersion appears to be largely driven by OECD countries. Among EU countries, the distribution of EATRs becomes less dispersed when preferential taxation is included, suggesting greater harmonisation in the treatment of R&D intangible assets in the EU area when IBTIs are included.[45]

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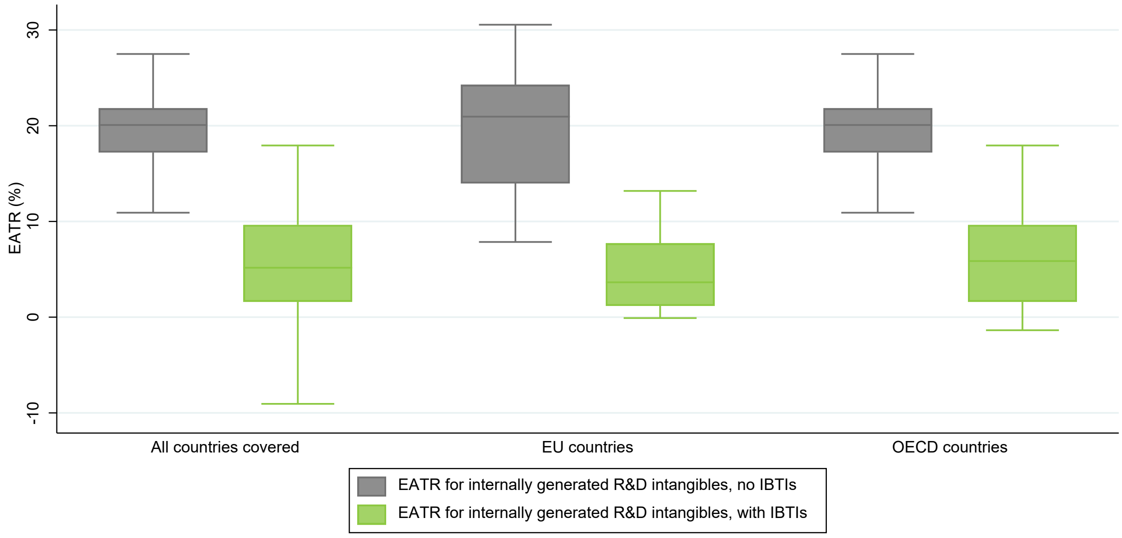
[44] The EATR may be more suitable in this context as IBTIs apply to the profits arising from R&D intangibles, which implies that the R&D investment has been successful in generating a profit. Being an income-based tax incentive, IBTIs may affect more directly decisions on profitable investments than they would the marginal investment decision.

[45] This result hinges only on accounting for IBTIs and does not account for expenditure-based tax support which may alter the results. However, this finding would hold for very profitable investments where EATRs would tend to the marginal tax rate at which income is taxed.

Figure 3. Distribution of EATRs with and without IBTIs, countries with IBTIs, 2021



Note: The chart plots the distribution of EATRs for 36 IBTIs available in 26 countries with IBTIs in 2021 out of the 48 countries covered in this study. This includes 28 IBTIs available in 21 out of 38 OECD countries; and 19 IBTIs available in 17 out of 27 EU countries in 2021. The number of IBTIs is higher than the number of countries covered as some countries offer multiple IBTIs (Table A.1).
Source: OECD

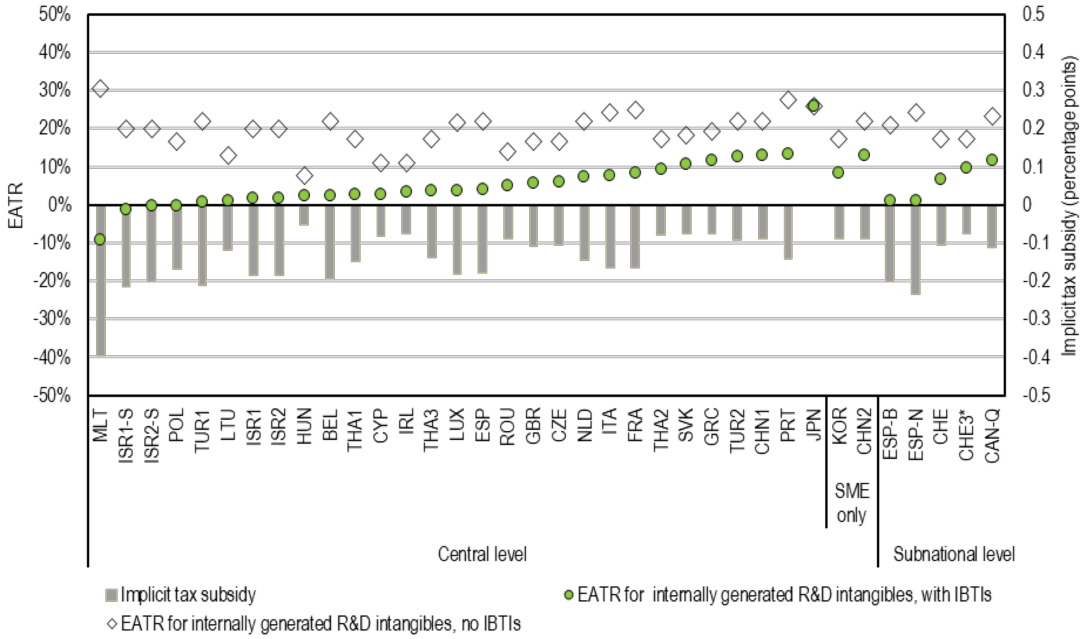
At the sample average, IBTIs reduce the overall tax liability that the firm faces on an internally generated R&D investment by 69%, with significant variation across countries. EATRs fall from an average of EATR of 19.6% without support to an EATR of 6% when IBTIs are accounted for, as shown in Figure 3. IBTIs imply a reduction in the EATR by 13.5 percentage points on average. The extent of the reduction varies across countries from over 100% in Israel (ISR1-S, ISR2-S), Malta and Poland to less than 50% in Canada (CAN-Q, CAN-S), China (CHN1), Greece, Japan, the Slovak Republic, Thailand (THA2) and Türkiye (TUR2) in 2021. The extent of the reduction in EATRs due to the use of IBTIs is larger for EU countries than OECD countries reaching 76% of the baseline EATR for the EU compared to 68.5% for the OECD. This leads to an average EATR of 4.4% in the EU and 6.4% among OECD countries with income-based tax support.

Besides acting as a country-specific benchmark, the EATR with no IBTIs has interest in its own right as it would be the relevant rate for similar investments that would not qualify for tax support such as for instance those informally protected, e.g., by trade secrets, in most countries (see footnote 26). In this calibration, the baseline EATR lies just below the STR as the investment is assumed to be in current expenditure, which is immediately deductible, but it does not fully align due to the presence of a gestation lag and the fact that the investment takes place in two phases (at the onset of the development and commercialisation phases).[46]

[46] The timing difference between when investment takes place and profits appear lowers the profitability of the investment in NPV terms.

Figure 4. EATR for internally generated R&D intangibles, 2021

Estimates of the implicit tax subsidy from IBTIs, inframarginal investments (EATR)



Note: The estimates consider an R&D investment with a gestation lag of two years after which the intangible asset starts generating profits. Baseline refers to an equivalent investment that does not benefit from income-based tax support. Preferential tax treatment is obtained by the difference between the baseline and the cost of capital including income-based support. The results assume all IP income qualifies for relief. CHE assumes that the firm has sufficient other income (non-qualifying IP or non-IP income) that is taxed at higher rates so that it is not subject to the 70% maximum relief limitation. CHE* assume that the maximum relief limitation is binding. Source: OECD.

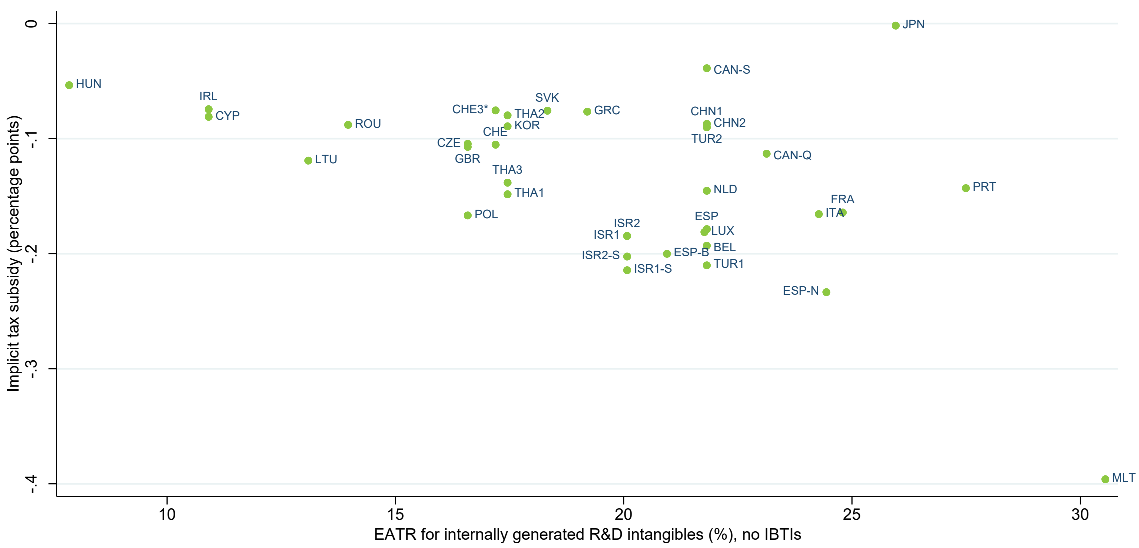
The EATR for an IBTI-supported R&D investment ranges from -9% to 25.8% across the countries considered. In the absence of income-based support the rates would vary from 10% to 31%. Among the countries considered, the lowest EATRs are observed in Malta, Israel (ISR1-S, ISR2-S) and Türkiye (TUR1), while the highest rates are observed in the Japan, Canada (Saskatchewan, CAN-S) and Portugal. Countries with the lowest EATR tend to offer the greatest tax-related incentives to investments in internally generated intangibles.

In several countries, IBTIs imply that R&D investment receives a net tax-subsidy. A negative EATR implies that an overall tax subsidy is provided to profitable investments. In this calibration, negative EATRs occur in four countries: Israel (ISR1-S, ISR2-S), Malta and Poland. This result occurs where the total value of deductions over the lifetime of the project is larger than the tax burden stemming from the preferential tax rate at which income is taxed. In such cases the first component of the EATR (tax liability on the marginal investment) is negative and the tax to be paid on profits (tax liability on the inframarginal investment) does not raise enough to offset the initial tax subsidy.

5.2. The design of incentives can drive differences in implicit tax subsidies

To isolate the impact of IBTIs, estimates of implicit tax subsidies can be computed as a deviation from the baseline country-specific tax treatment. Implicit tax subsidies can be computed as the difference between EATR with IBTIs and without IBTIs (circles vs diamonds in Figure 4) and provide a within country comparison of preferential tax treatment). Implicit tax subsidies are displayed as a bar in Figure 4. In percentage points, Malta, Spain (Navarra, ESP-N) and Israel (ISR1-S) are the countries providing the greatest preferential tax treatment compared to their baseline tax system, with a decline in the EATR of 40 percentage points (from a baseline EATR of 31%),23 percentage points (from a baseline EATR of 24%), and 21 percentage points (from a baseline EATR of 20%), respectively. Implicit tax subsidies are typically larger in countries with greater EATRs under standard taxation, i.e., with no IBTIs (Figure 5). Such countries can sustain higher levels of taxation on other incomes, while offering reduced tax rates to income from qualifying intangibles through IBTIs.

Figure 5. EATRs and implicit tax subsidy for internally generated R&D intangibles, 2021



Note: The charts capture only countries with income-based tax support in 2021. Source: OECD

The extent of implicit tax subsidies granted through IBTIs is strongly affected by differences in the design of these provisions. Figure 6 decomposes the preferential tax treatment measured in Figure 4, to analyse the contribution of each of the four design elements captured in the estimation of implicit tax subsidies.[47]

1. **Tax relief:** This factor measures the difference between the taxation at the full rate compared to the reduced rate available under the IBTI. This bar is larger for countries offering a greater reduction from the headline rate in absolute terms.
2. **The treatment of ongoing expenses:** This factor measures the correction in the tax base due to the requirement that associated ongoing expenses associated with the intangible be deducted against qualifying income as opposed to ordinary income. The size of this factor is proportional to the distance between the full and the reduced rate.
3. **The treatment of past expenses:** This factor measures the correction in the tax base due to the requirement some treatment of associated past expenses either by

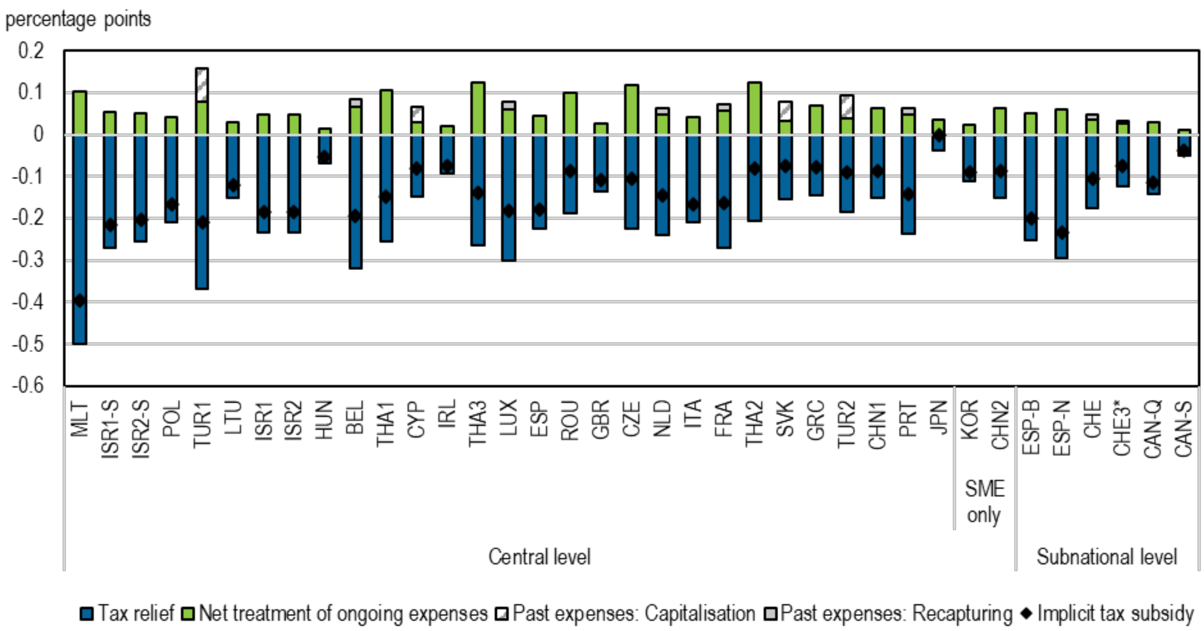
[47] This decomposition is achieved by switching-on and off each of the design elements (i)-(iii) for each of the regimes, keeping everything else constant. The relative weighting of each design feature may vary with alternative calibrations of the investment.

requiring that they are deducted against IP income as opposed to ordinary income (recapturing method in light blue) or capitalised into the value of the asset (dark blue).

4. **The presence of development conditions:** In this case of an internally generated intangible the nexus ratio is equal to one for all cases. The nexus ratio will be separately analysed in the following subsection. Differences in design captured in Figure 4 therefore come from variation in factors (1)-(3) above.

Figure 6. The contribution of design to implicit tax subsidies, 2021

Implicit tax subsidies for inframarginal investments in internally generated R&D intangibles



Note: This figure decomposes the implicit tax subsidies (bar in Figure 4) to disentangle the composition of each design feature and is hence tied to the calibration parameters outlined in Section 4.
It is important to note that EATRs are not static indicators and are dependent on the calibration parameters that comprise the R&D investment, e.g., the pre-tax rate of return, the gestation lag, etc. The contribution of each of these elements to the overall rate would vary with changes to the underlying calibration parameters, shifting the weight of each element to the overall implicit tax subsidy. IP income in Switzerland can benefit from a 90% exemption of qualifying IP income from cantonal taxation. However, this exemption is subject to a cap: only 70% of a firm's total profits (IP or non-IP) can be exempt. CHE assumes that the firm has sufficient other income (non-qualifying IP or non-IP income) that is taxed at higher rates so that it is not subject to the 70% maximum relief limitation. CHE* assume that the maximum relief limitation is binding.
Source: OECD.

Generally, the requirement to deduct ongoing expenses at the preferential tax rate reduces the generosity of regimes by about 4.5 percentage points on average, compared to a simulated situation where those are deducted at the statutory rate. All countries in the sample require IP income to be net of associated expenses (Table A.2). This 'net approach' reduces the overall subsidy firms can obtain from IBTIs compared to a case where firms could follow a gross approach and deduct ongoing expenses at the statutory tax rate (the green bar is in the positive domain). On average, the use of a net approach reduces preferential tax treatment by 27.4% (the average increase of the green bar is 4.5 percentage points) among OECD countries (30% and 5.5 percentage points, respectively, for all countries in the study). Evers et al. (2015[11]) find in their study of IP regimes in European countries in

2014 that some regimes allowed for associated IP expenses to be deducted against ordinary rather than IP income, i.e. 'gross' approach.[48] If countries allowed a 'gross approach', the positive 'ongoing expenses' bar would disappear from Figure 6, increasing the implicit tax subsidy that firms obtain from IBTIs. This approach is no longer allowed for regimes compliant with the BEPS Action 5 minimum standard.

Where special provisions are in place that require either the recapturing or capitalisation of past expenses, IBTIs are modestly less generous all else equal. Where countries require an adjustment to be made to the tax base to account for past expenses, this decreases the generosity of IBTIs, compared to situations where these are not in place. This can be seen in the past expenses factor (grey bars) in Figure 6, which takes a value of 4.9 percentage points on average – a 27% decrease in preferential tax treatment for countries with such provisions among OECD countries (27% and 4.8 percentage points, respectively, for all countries in the study).. Whether recapturing or capitalisation leads to a less generous outcome depends on the overall design of the recapturing provision but also on the share of the overall cost of the asset that is capitalised.

Overall, the preferential tax rate available under IBTIs outweighs the impact of the treatment of current and past expenses in the tax base in this calibration. In most countries, the decrease in the regime rate alone is around 61% of the full rate (i.e., the statutory tax rate) for OECD countries (65% for all countries in the study). The preferential tax treatment provided to the income is sufficient in this calibration to outweigh the corrections to the tax base (through the treatment of past and ongoing expenses) in this calibration. This would be particularly the case the more profitable the investments are.

[48] Note that the BEPS Action 5 minimum standard requires regimes within the scope of the FHTP work, to apply a net approach, i.e., associated IP expenses need to be deducted from qualifying IP income (Table A.2).

Other design differences cause variation in the extent of preferential tax support granted through income-based tax support.

- **Dual category and IP regimes:** Implicit tax subsidies appear proportionally lower for dual category regimes than for IP regimes in this calibration: IP regimes reduce EATRs by 71% reduction compared to a 62% reduction for dual category regimes covered in the study. Although seemingly less generous, dual category regimes apply to a broader set of income streams including non-IP income. Both the nature of the tax instrument, its policy goal and revenue forgone may differ.
- **The interaction of tax support and the gestation lag for time bound incentives**: Some of the IBTIs covered take the form of tax holidays for R&D performing firms or temporary reduced tax rates for innovative enterprises (upon achieving a certain status) (Table A.2 and González Cabral et al. (2023[2]) Table 3). As such regimes do not connect eligibility for IBTIs to the stream of income from the R&D intangible, they may be poorly targeted to promoting investment in internally generated R&D intangibles as they fail to account for the presence of a gestation lag (Box 2).[49]
- **Other design features not captured in the modelling:** The presence of limitations to tax benefits may curtail the extent of preferential tax treatment available through IBTIs. Limitations to tax benefits may take the form of domestic minimum taxes or caps based on taxable income, which typically apply to ensure a minimum level of taxation but are seldom specific to the income-based tax incentive itself (Table A.2). The assumption in the indicators captured in Figure 4 is that the firm has other sources of income such that it is not bounded by such general limitations. In other words, indicators of the EATR on internally generated intangibles should be interpreted as an upper bound of the generosity of income-based tax support for R&D and innovation.

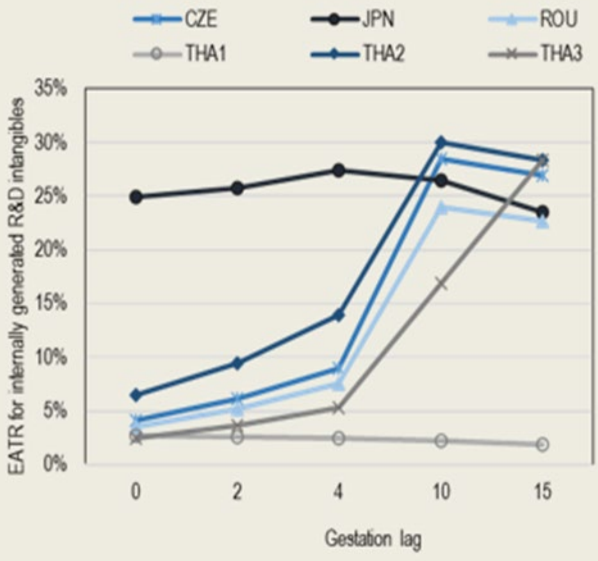
[49] Note that this point does not reflect upon the merits of expenditure-based with respect to income-based tax incentives or on the merits of tax with respect to direct support measures. It rather reflects upon the impacts of using IBTIs that do not link preferential tax treatment to income, compared to those that do.

Box 2. Tax holidays or status related incentives are not well-suited to support risky, long-term investments in R&D and innovation

Tax incentives in the form of tax holidays have been found to distort investment decisions towards short-lived investments (Mintz, 1990[29]; Klemm, 2010[30]). Being very broad-based instruments, they typically target all income of the firm, which may often be found to be overly costly and may lead to some profit shifting concerns (PCT, 2015[31]). In addition to these effects, as shown below, tax holidays or temporary reduced tax rates are also poorly suited to supporting investments that are uncertain or may take time to become profitable. This may be particularly the case for R&D which is by nature risky and uncertain.

The figures in this box show estimates of the EATR for projects that have the same level of profitability before tax but that have different gestation lags (0, 2, 4, 10 and 15) for countries where tax holidays or temporary reduced rates are offered. Gestation lags have been found to last between 2-4 years (Li and Hall, 2020[10]; Pakes and Schankerman, 1979[4]); with certain sectors and R&D activity, e.g. basic vs applied research observing longer gestation lags (Bureau of Labor Statistics, 1989[22]). As the gestation lag increases, the period of preferential income taxation decreases implying an increase in the EATR on internally generated intangible.

EATR for internally generated R&D intangibles, selected countries, 2021



The firm is less able to benefit from preferential taxation while it has forgone the initial deduction at the full rate. A jump is observed whenever the gestation lag is close to matching the end of preferential tax treatment (five years in Japan and ten years in the Czech Republic or Romania) showcasing the inability to benefit from both deductions and preferential income tax treatment. Countries offering temporary reduced rates such as tax holidays would impose lower EATRs and costs of capital on projects with a short gestation period, providing a more attractive environment to locate and increase investments in R&D with a quick development phase. Such instruments may be poorly targeted to promote R&D investments that require more time to develop.

Note: For each project, the pre-tax rate of return required by the investor is recalculated to obtain the required pre-tax rate of return that would make pre-tax economic profits equal across all different projects. The goal of this exercise is to eliminate the effect of the gestation lag in lowering the profitability of the investment. Regimes non-compliant with the standard will not generate necessarily the effect of promoting R&D but could simply lead to a relocation of IP to benefit from support. A key point on tax holidays is how depreciation allowances are treated (Celani, Dressler and Hanappi, n.d.[32]). In this case, the investment is expensed and none of the countries covered allow a carry-over of such initial investment cost to after the tax holiday period. A similar chart based on the cost of capital exhibits a similar increasing pattern as the cost of capital increases the greater the gestation lag.

5.3. Alternative acquisition strategies

The way IP is acquired may lead to differences in the generosity of preferential tax treatment available to firms. This is due to the interaction of different acquisition approaches with developing conditions included in many regimes. Firms can obtain their IP by (a) performing R&D in-house, (b) by outsourcing the R&D to other firms or (c) by acquiring an existing IP asset, or through a combination of the above (Table 1). Although these strategies are often combined (as will be discussed in Section 5.4), considering the impact that different acquisition choices in isolation helps characterise the boundary cases and better understand the result of combining different strategies. Panel A of Figure 7 contains a distribution of EATRs for an investment in an R&D intangible asset across alternative acquisition strategies and Panel B contains estimates of the EATR if firms were to use different acquisition strategies to obtain the IP, including preferential tax treatment where applicable. The EATRs for different acquisition strategies are compared to the baseline case of no preferential tax treatment. Access to preferential tax treatment varies with the acquisition strategies that are eligible for support in each country (Table A.3).[50]

Assuming away the impact of IBTIs, acquired R&D intangibles face EATRs that are 2.9 percentage points higher than internally generated IP as acquisition costs are written off as capital allowances. Comparing baseline tax treatment for acquired and internally generated R&D in Figure 6, internally generated R&D intangibles are generally subject to a more favourable tax treatment because R&D expenses are typically immediately deductible. This means that in the absence of a gestation lag, the EATR should equal the marginal tax rate at which income is taxed (preferential tax rate or the statutory tax rate). For acquired R&D intangibles, the costs of the investment are written off over a longer time period (as the acquired asset amortises). This means that the average EATR is higher for the acquired case compared to the internally developed case, 22.5% and 19.6% respectively. A second effect that can be seen in this figure is that in NPV terms, intangible assets developed through R&D are slightly less profitable pre-tax as there is a timing lag for profits to be generated as opposed to acquiring pre-existing intangibles.

Outsourcing R&D costs allows firms to access IBTIs in most countries as long as costs are outsourced to unrelated parties, leading to EATRs that are reduced by 13 percentage points relative to treatment without IBTIs. The baseline average EATR equals 19.6% while that of an intangible that results from unrelated party outsourced R&D faces an EATR of 6.9%. For regimes following the BEPS Action 5 minimum standard, own R&D and outsourcing to unrelated parties are qualifying expenditures. This means that the access to IBTIs is the same in these cases (Figure 7 Panel B).[51] Some countries have stricter development conditions for outsourced R&D requiring a greater link between the R&D undertaken by the taxpayer itself and income eligible for relief.[52] This implies that intangibles acquired through outsourcing R&D costs to unrelated parties have slightly higher average EATRs than those internally generated (Figure 6 Panel A), 6.9% and 6% respectively.

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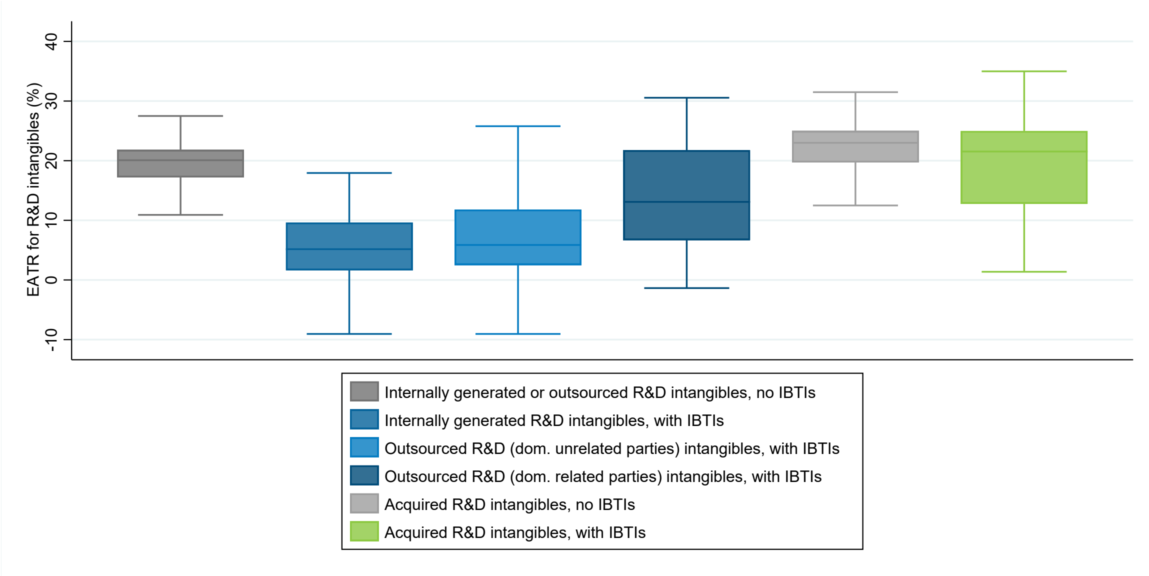
[50] For countries applying the nexus ratio, acquisition strategies will be determined by the definition of qualifying expenditures for the purpose of the nexus ratio (Box 1 for a summary of the nexus ratio and Table A.2 for a description of development conditions).

[51] This would change if the gestation lags were assumed different for the two cases, for instance if one assumes that by outsourcing R&D to a specialised company the firm will receive R&D output sooner.

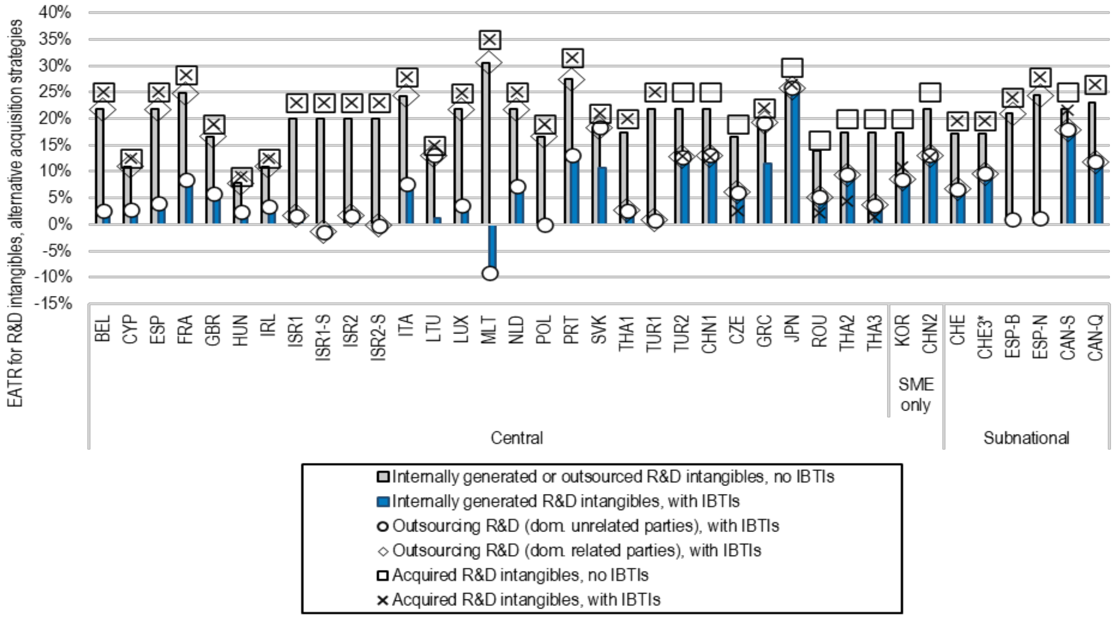
[52] This is the case in Lithuania and the Slovak Republic where outsourcing costs are not qualifying expenditure for the purposes of calculating the nexus ratio, and hence only intangibles generated through internally generated R&D are eligible for relief. In this case, internally generated intangibles have an EATR of 1.2% and 11% in Lithuania and the Slovak Republic compared to 13% and 18% for IP generated through both related and unrelated R&D (Figure 7 Panel B).

Figure 7. EATRs for R&D intangible assets: Alternative acquisition strategies, 2021

Panel A: Distribution of EATRs, by acquisition strategy



Panel B: Country specific results



Note: The estimates consider an R&D investment with a gestation lag of two years after which the intangible asset starts generating profits in the case where the asset is developed through own R&D or outsourced R&D, and a lag of 0 years if the asset is acquired. Baseline for acquired R&D intangibles or R&D performance (own R&D and outsourced R&D as the gestation lag is assumed the assume) represent the applicable EATR without IBTIs. The model is domestic, so R&D costs are assumed to be outsourced to other parties operating in the same country. This implies that certain regimes using a 'jurisdictional approach' contemplated in the BEPS Action 5 report may allow outsourcing of R&D to related parties as a qualifying expenditure (OECD, 2015[33]; González Cabral et al., 2023[2]). Korea, Israel, Switzerland, Thailand and Türkiye follow this approach. In addition to this, Türkiye and Korea also allow acquired R&D intangibles to qualify as long as the R&D took place domestically. Outsourcing costs to related parties abroad or acquiring IP that have not been developed domestically (for Türkiye and Korea) would not be eligible acquisition strategies and would not benefit from preferential tax treatment. This implies that certain acquisition strategies may benefit from preferential tax treatment subject to the location of R&D. The model abstracts from cross-border considerations.

Acquiring pre-existing IP or outsourcing R&D to related parties typically leads the firm to face higher tax liabilities. EATRs on acquired assets or assets developed through outsourced R&D to related parties are respectively 13 percentage points and 7 percentage points higher than internally developed assets (average EATR of 6%) (Figure 7 Panel A). This is because in both cases most countries require the further development by the taxpayer of the R&D intangible to benefit from IBTIs (Table A.3).[53] Development conditions are typically in place to prevent the tax motivated transfer of the R&D intangible to benefit from IBTIs (Griffith, Miller and O'Connell, 2014[34]). As a result, the decision to outsource R&D costs to related parties instead of outsourcing to unrelated parties increases the EATR faced by the firm by on average 6.7 percentage points from an average 13.6% EATR across all countries covered. In Figure 7, where outsourcing to related parties is ineligible for support, diamonds overlap with blue bar. Where acquired R&D intangibles cannot benefit from relief, the crosses align with the boxes. Where development requirements are not IP specific, acquired R&D intangibles or IP resulting from outsourced R&D to related parties could in principle be eligible for relief.

Some countries allow a broader set of acquisition strategies at the expense of restricting the location of R&D. Outsourcing to related parties domestically is allowed under IBTIs in certain countries implementing the BEPS Action 5 nexus ratio through the 'jurisdictional approach' (González Cabral et al., 2023[2]). This is the case in Korea, Israel, Switzerland, Thailand and Türkiye. For these regimes, in Figure 7 the diamond overlaps with the circle (internally generated IP). This means that outsourcing to related parties domestically will still allow the firm to benefit from IBTIs. If firms in these countries were to outsource R&D to foreign related parties, there would be no eligibility for IBTIs and diamond would overlap with the blue bar instead. In Korea and Türkiye (TUR2), all acquisition strategies are eligible as long as the underlying R&D has occurred only within the country. While this represents seemingly a more generous treatment towards the type of acquisition strategies the firm can use, it represents a more stringent criteria in terms of the location of R&D, i.e., only domestic vs worldwide treatment in other countries.

5.4. The impact of the BEPS Action 5 nexus approach

The BEPS Action 5 nexus approach creates variation in the extent of preferential tax treatment firms can access depending on the mix of acquisition strategies used in creating the IP. The previous section has considered the impact that obtaining an R&D intangible asset through different acquisition strategies has on the extent of income-based relief offered across countries. However, firms typically combine several acquisition strategies in creating an intangible asset. Countries applying the nexus approach as introduced by the BEPS Action 5 minimum standard, define qualifying profits to be proportional to the qualifying expenditures incurred by the taxpayer in obtaining the asset (Box 1). This creates a tighter link between R&D and the extent of income that can qualify for relief. The ultimate acquisition mix used to obtain the intangible directly affects the nexus ratio and hence the extent of tax relief for which an investment is eligible.

The nexus ratio implies that more tax benefits are available to firms with more qualifying expenditure. Firms without qualifying expenditure essentially do not benefit from IBTIs. The application of the nexus ratio implies that firms face a distribution of EATRs on their R&D investment, with the applicable EATR given by the nexus ratio.[54] A nexus ratio of zero implies that none of the expenditure

[53] For countries applying the nexus ratio, outsourcing costs to related parties and acquisition costs enter the denominator of the nexus ratio and hence they are not eligible for relief (Box 1). These strategies require the further development of the asset by the taxpayer. The application of the nexus uplift that allows qualifying expenditures to be increased by 30% of overall expenditure when the denominator is being calculated. This provides some recognition for acquisitions costs and outsourcing costs, as discussed in Section 2.

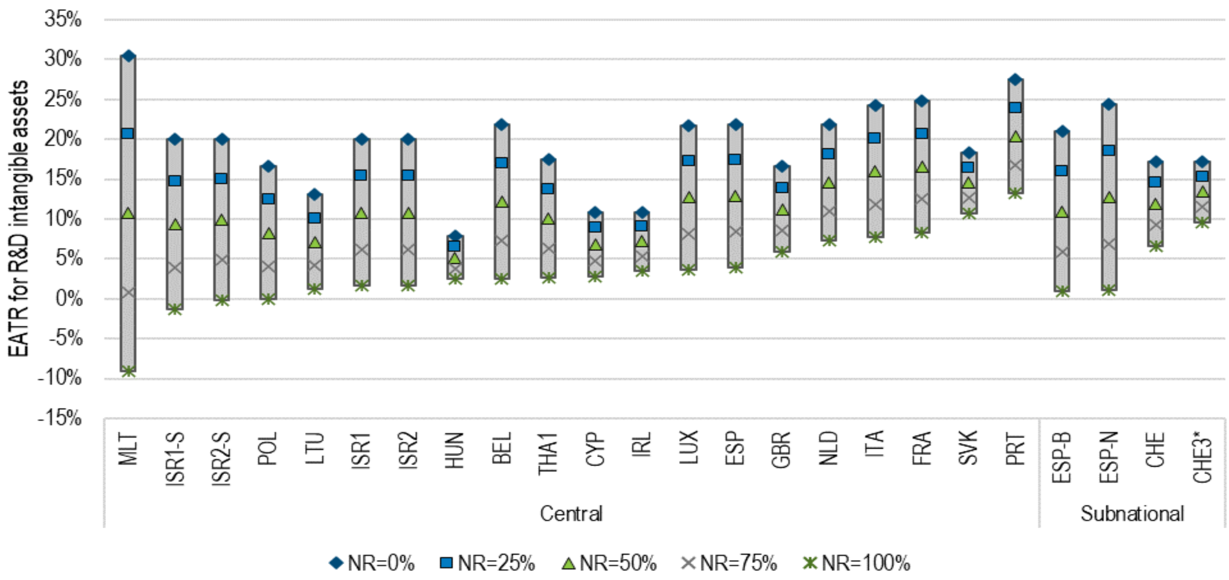
[54] The same applies for the cost of capital (see Annex C.1).

incurred in generating the asset is deemed qualifying expenditure. For example, an intangible asset generated by R&D outsourced to related parties and which is not further developed by the taxpayer is rarely eligible for relief. [55] A nexus ratio of one, which is the other boundary case, represents the case where all expenditure incurred in generating the asset is deemed qualifying expenditure and hence all income from the asset benefits from preferential tax treatment. For example, an intangible asset generated by the taxpayer itself.

Within a given country, firms face a distribution of EATRs on their R&D intangible investments based on their mix of acquisition strategies. Figure 8 simulates the range of estimates of the EATR for a qualifying R&D intangible asset for alternative values of the nexus ratio. The case of full eligibility for relief (nexus equals one) aligns with the case represented in Figure 4 and the case of no eligibility (nexus equals 0) aligns with the no IBTIs case in Figure 4. The values of the nexus ratio in between the two boundary cases are the result of the firm mixing alternative acquisition strategies with differing impacts on the eligibility of income-based support. Putting together the EATR for different values of the nexus ratio, which are the result of mixing alternative acquisition strategies over the lifetime of the intangible asset, provides a distribution of rates applicable to IP assets developed using alternative development mixes within a country. [56]

Figure 8. The impact of alternative values of the nexus ratio on firms' EATRs, 2021

IBTIs applying the BEPS Action 5 nexus ratio



55 The calculation of the nexus ratio includes an 'uplift' of 30% to qualifying expenditure (typically own R&D and R&D outsourced to unrelated parties) to provide some room for acquisition costs and outsourcing to related parties, as long as qualifying expenditure does not exceed overall expenditure. In this paper this is embedded in the percentage in Figure 8.

56 The nexus ratio leads to both between and within firm variation. It will lead to between firm variation if acquisition strategies vary with firm characteristics. For instance, the share of outsourced R&D is significantly larger for large firms than for SMEs or young firms **Invalid source specified.**. The nexus ratio will lead to within firm variation if the acquisition mix varies across the R&D intangibles that the firm has on its portfolio.

Note: For Türkiye and Korea the incentives are not modelled because nexus applies by limiting R&D to activity occurring in the country, but do not use the nexus ratio as such in the calculation of qualifying profits. The chart is reduced to countries that implement a nexus ratio in line with the BEPS Action 5 minimum standard and have been subject to the review of the Forum on Harmful Tax Practices (Table A.2). See Section 4 for calibration and modelling assumptions.

The greater the dispersion in the EATRs between the case with no IBTIs (where the nexus ratio equals zero) and the full eligibility case (where the nexus ratio equals one) may provide greater incentives to shift to qualifying forms of support. By defining a qualifying asset, qualifying income and qualifying acquisition strategies, income-based tax incentives introduce a bias towards certain forms of IP protection and favour certain acquisition or commercialisation strategies. While the motivation behind such restrictions may be to limit the misuse of preferential tax incentives, it also implies that firms' decisions may be distorted. The greater the dispersion between the case of full and no eligibility in Figure 9, the greater the gap in the tax treatment of qualifying vs non-qualifying assets, and the greater the extent to which IBTIs may influence the decision to invest in intangible assets that confer access to preferential taxation. This implies that IBTIs may provide a greater incentive to (a) protect assets formally through for instance patenting[57]; (b) promote R&D is performed by the taxpayer itself or through qualifying acquisition strategies; (c) promote the commercialisation of the R&D intangible in ways that can result in accessing IBTIs. Countries with a more concentrated EATR distribution, e.g., Hungary, Ireland or Portugal, offer a more neutral tax treatment to intangible assets, regardless of the acquisition, protection and commercialisation strategy chosen. A higher dispersion may also reflect the intention to differentiate taxation of different types of income, e.g., offering lower taxation to more mobile forms of income such as intangible related income.

6. Final remarks

This paper presented a methodology that adapts the forward-looking effective tax rates framework to the case of intangible assets. It measures the impact of IBTIs on firms' incentives to invest in marginal (cost of capital and B-Index) and inframarginal investments (EATR). The model captures different phases of an intangible asset investment from acquisition to commercialisation and analyses the impact of tax policy for firms that use different acquisition and commercialisation strategies in acquiring their R&D intangible. The model is calibrated empirically to provide estimates of the impact of income-based tax support on EATRs and cost of capital for 26 countries, including all OECD countries and EU countries with income-based tax support in 2021.

Overall, the model highlights that EATRs for assets qualifying for IBTIs are substantially lower than those that do not qualify for IBTIs. IBTIs reduce EATRs by 13.5 percentage points on average (or 69%) for R&D intangibles that are the result of the firms' own R&D performance, i.e., the base case in this study. The average EATR for internally generated R&D intangibles accounting for IBTIs is equal to

[57] In most countries, IP cannot benefit from support unless it is formally protected, with some exceptions (e.g., Italy in 2021; or waives for small taxpayers under Category III of BEPS Action 5). Informal protection is a common way for firms to protect their IP **Invalid source specified.**. Where informal forms of protection are not eligible for preferential tax treatment, the firm faces a decision between registering the IP formally and accessing the tax benefits from the IBTI or keeping the IP informal and waiving any IBTIs. This decision depends on whether the benefits from using the tax incentive (preferential tax treatment) are high enough to outweigh any potential costs (e.g., the cost of registering the patent from a pecuniary perspective, the need for disclosure of the innovation). Previous literature has documented an increase in the number of patents (transfer, number of applications filed or granted) upon the introduction of IP regimes **Invalid source specified.**. However, IBTIs may provide an incentive to protect IP that may not have been protected otherwise (e.g., patents with marginally lower innovation content) **Invalid source specified.**.

6%. This highlights that significant concessionary tax treatment is available to qualifying assets in many OECD countries and EU countries. Governments may wish to consider the policy implications of offering these preferential tax rates, in particular given the empirical evidence that suggests that income-based incentives may be less effective at encouraging investments, and may create windfall gains (PCT, 2015[31]).[58] Countries may also wish to consider the efficacy of these incentives in light of the ongoing implementation of the GloBE Rules which will a minimum effective corporate tax rate for in-scope firms (OECD, 2021[35]; OECD, 2022[36]).

The model highlights the impact of key design features in determining the generosity of these incentives, and the distortions that can result. The paper highlighted that EATRs vary strongly depending on the acquisition strategy through which a firm acquired the associated R&D intangible, and on the nexus ratio. By defining a qualifying asset, qualifying income and qualifying acquisition strategies, IBTIs introduce a preference towards certain forms of IP protection and favour certain acquisition or commercialisation strategies. While the motivation behind such restrictions is to limit the misuse of preferential tax incentives, it also implies that firms' decisions may be distorted. On the contrary, countries with a more concentrated EATR distribution offer a more neutral tax treatment to intangible assets, regardless of the acquisition, protection and commercialisation strategy chosen.

The model reveals the impact of BEPS Action 5 through the nexus ratio in limiting the generosity of IBTIs in certain circumstances. Overall, the model highlights that the nexus ratio can entirely undo the impact of IBTIs where firms do not carry out qualifying expenditure themselves but rather acquire the asset from third parties.

The model is stylised but could be extended. First, the model can be extended to consider the impact of financing decisions, which are currently abstracted from. Second, since firms typically perform R&D and commercialise it in different countries, the model can be extended to consider the case of a cross-border investment. Third, the model can be extended to incorporate expenditure-based tax incentives, since in most cases firms can combine both expenditure-based and IBTIs as part of their investment. Finally, the model could be extended to account for caps and limits on the use of incentives, including the Global Minimum Tax (OECD, 2022[36]). Advancing the understanding of how different IBTIs are designed enables the interpretation of the revenue forgone and uptake of these provisions, which are also analysed as part of the KNOWINTAX project (Appelt et al., 2023[1]).

[58] For example, by providing investors a reduced taxation on an activity that would have occurred even in the absence of support.

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Annex A. IBTIs and design features

Table A.1. Income-based tax incentives for R&D and innovation modelled

ID	Regime name	Introduction	IP regime
BEL	Deduction for innovation income	2016	x
CAN-Q	Déduction incitative pour la commercialisation des innovations (DICI) (Québec)	2021	x
CAN-S	Saskatchewan Commercial Innovation Incentive (SCII)	2017	x
CHE	IP box	2020	x
CHN1	Reduced rate for high & new tech enterprises (HNTE)	2008	
CHN2	Tech-based SMEs (TSMEs)	2017	
CYP[59]	IP Box regime (new regime)	2016	x
CZE	Investment incentives for R&D centres	2012	
ESP	Partial exemption for income from certain intangible assets (Federal regime)	2004	x
ESP-B	Partial exemption for income from certain intangible assets (Basque country)	2008	x
ESP-N	Partial exemption for income from certain intangible assets (Navarra)	1997	x
FRA	Reduced corporation tax rate on IP income	1965	x
GBR	Patent Box	2013	x
GRC	Tax patent incentives	2018	x
HUN	IP regime for royalties and capital gains	2003	x
IRL	Knowledge development box	2016	x
ISR1	Preferred enterprise regime	2011	
ISR1-S	Special Preferred enterprise regime	2011	
ISR2	Preferred technology enterprise regime	2017	x
ISR2-S	Special preferred technology enterprise regime	2017	x
ITA	Taxation of income from intangible assets	2015	x
JPN	Tax incentive for specified business in the National Strategic Zones	2017	
KOR	Tax reduction for transfer or leases of technology	2014	x
LTU	IP taxation regime	2018	x
LUX	IP regime	2018	x
MLT	Patent Box regime	2019	x
NLD	Innovation box	2017	x
POL	IP box	2019	x
PRT	Partial exemption for income from certain intangible property	2014	x

[59] Note by Türkiye:

The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Türkiye recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Türkiye shall preserve its position concerning the "Cyprus issue".

Note by all the European Union Member States of the OECD and the European Union:

The Republic of Cyprus is recognised by all members of the United Nations with the exception of Türkiye. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

ID	Regime name	Introduction	IP regime
ROU	Exemption for taxpayers engaged in R&D and innovation	2017	
SVK	Patent Box	2018	x
THA1	International business centre	2019	
THA2	Activity-based tax incentive	2003	
THA3	Merit-based tax incentive	2015	
TUR1	Technology development zones regime	2001	x
TUR2	5/B regime	2015	x

Note: The column 'ID' assigns unique identifiers to each of the regimes covered in this paper. Regimes modelled are those which are available in 2021. The regime in Italy has been repealed as of tax year 2021 and from the same tax year, relief will be provided instead through an expenditure-based tax incentive in the form of an R&D tax allowance. In 2021 (and up to tax year 2024 at the latest) the repealed regime continues to apply transitorily to taxpayers who already applied for it in the previous years and did not opt for the new expenditure-based tax allowance.
The column 'IP regime' takes the value 'x' where the regime is an IP regime and is blank when it refers to a 'dual category' regime. Dual category regimes are IBTIs that provide preferential tax treatment to IP and non-IP income. The scope of dual category regimes is therefore broader than IP regimes, which solely provide relief to IP income.
Source: González Cabral et al. (2023[2]).

Table A.2. Key design features of income-based tax incentives, 2021

ID[1]	Regime rate (number of years if time bound)[2]	Full rate[3]	Past expenses[4]	Ongoing expenses	Nexus ratio in spirit of BEPS Action 5[5]	IP losses[6]	Limitations to tax benefits[7]
BEL	3.75%	25%	R	Net	**Y**	R	Ceiling (TI)
CAN-S*	21% (10-15 years)	25%	-	Net	N(i)	NA	-
CAN-Q*	17%	26.5%	-	Net	Y(i)	NA	Ceiling (TI)
CHE*	8.11% (11.39%)	19.7%	R	Net	**Y**	R/RV	Ceiling
CHN1	15%	25%	-	Net	N	NA	-
CHN2	15%	25%	-	Net	N	NA	-
CYP	2.5%	12.5%	K	Net	**Y**	SL	Ceiling (TI)
CZE	0% (10 years)	19%	-	Net	**N**	NA	Ceiling (X)
ESP	10%	25%	-	Net	**Y**	RV/R	-
ESP-B*	7.2%	24%	-	Net	**Y**	RV/R	-
ESP-N*	8.4%	28%	-	Net	**Y**	RV/R	-
FRA	10.33%	28.41%	R	Net	**Y**	R	-
GBR	10%	19%	-	Net	**Y**	R	-
GRC	0% (3 years)	22%	-	Net	N	NA	-
HUN	4.5%	9%	-	Net	**Y**	MRV	Ceiling (TI)
IRL	6.25%	12.5%	-	Net	**Y**	RV	-
ISR1	7.5%	23%	-	Net	**Y**	SL	-
ISR1-S	5%	23%	-	Net	**Y**	SL	-
ISR2	7.5%	23%	-	Net	**Y**	SL	-
ISR2-S	6%	23%	-	Net	**Y**	SL	-
ITA	13.91%	27.81%	-	Net	**Y**	R	-
JPN	23.79% (5 years)	29.74%	-	Net	N	NA	Ceiling (TI)
KOR	15%	20%	-	Net	**Y**	SL	Domestic minimum tax
LTU	5%	15%	-	Net	**Y**	SL	-
LUX	5%	24.94%	R	Net	**Y**	R	-
MLT	1.75%	35%	-	Net	**Y**	RV/R	-
NLD	9%	25%	R	Net	**Y**	R	-
POL	5%	19%	-	Net	**Y**	SL	-

PRT	15.75%	31.5%	R	Net	**Y**	SL	-
ROU	0% (10 years)	16%	-	Net	N	NA	-
SVK	10.5%	21%	K	Net	**Y**	MRV	-
THA1	3%	20%	-	Net	**Y**	SL	-
THA2	0% (8 years)		-	Net	N	NA	-
THA3	0% (13 years)		-	Net	N	NA	Ceiling (X)
TUR1	0%	25%	K	Net	**Y**	SL	-
TUR2	12.5%	25%	K	Net	**Y**	SL	-

Note: [1] *= Subnational regimes [2, 3] Rates refer to those applicable to royalty income, special rates may apply to capital gains. The full tax rate reflects the combined statutory tax rate as reported in the OECD Tax Database (OECD, 2023[37]), which incorporates the central and subnational statutory CIT rates and includes certain CIT surcharges. The preferential tax rate is adjusted to match the full rate. Number of years indicate the period during which regime is available displaying the most generous tax treatment if the length of preferential tax support varies. IP income in Switzerland can benefit from a 90% exemption of qualifying IP income from cantonal taxation. However, this exemption is subject to a cap: only 70% of a firm's total profits (IP or non-IP) can be exempt. The 8.11% rate applies to qualifying IP income and assumes that the firm has sufficient other income (non-qualifying IP or non-IP income) that is taxed at higher rates so that it is not subject to the 70% maximum relief limitation. If the firm had enough qualifying IP income that the 70% maximum relief limitation did apply, the rate applied to IP income in the city of Zurich would increase steadily to 11.39% (100% IP Income). [4] Past expenses refer to requirements to recapture or capitalise and are treated separately from the nexus application. R=Recapturing; K=Capitalisation; ND=No deduction; "-"= No treatment of past expenses; [5] This column seeks to capture the existence of ratios based on qualifying expenditures to determine qualifying income in the spirit of the BEPS Action 5 nexus ratio. Bold implies that the regime has been reviewed by the FHTP and found to be compliant with the BEPS Action 5 minimum standard. The regime in Greece has been amended to be in compliance with the BEPS Action 5 minimum standard from 1 January 2022. Note that subnational regimes are in-scope of the FHTP work only upon meeting certain requirements (OECD, 2015, pp. pp. 61-62 par 145-146[33]). [6] R=Recapture Method ; RV=Reduced value method; MRV=Modified Reduced Value Method; SL=Separate Loss. [7] TI=Taxable income, X=Expenditure.
Source: González Cabral et al. (2023[2]), see source for data notes.

Table A.3. IP development conditions and implications for eligible acquisition strategies, 2021

ID	IP development required	Eligible IP, by type of acquisition strategy				Other eligible IP	
		Internally generated	Outsourcing (unrelated)	Outsourcing (related)	Acquired R&D intangibles	Existing	Applied not yet granted
BEL	x	x	x	d	d	x	x
CAN-S		(x)	(x)	(x)	(x)	(x)	(x)
CAN-Q	x	x	xr	xr	d	x	x
CHE	x	x	x	d	d	x	
CHN1		(x)	(x)	(x)	(x)	(x)	(x)
CHN2		(x)	(x)	(x)	(x)	(x)	(x)
CYP	x	x	x	d	d		x
CZE		(x)	(x)	(x)	(x)	(x)	(x)
ESP	x	x	x	d	d		
ESP-B	x	x	x	d	d	x	
ESP-N	x	x	x	d	d		
FRA	x	x	x	d	d	x	x
GBR	x	x	x	d	d	x	x
GRC	x	x	d	d	d		
HUN	x	x	x	d	d	x	
IRL	x	x	x	d	d	x	x
ISR1	x	x	xr	xr	d	x	x
ISR1-S	x	x	xr	xr	d	x	x
ISR2	x	x	xr	xr	d	x	x
ISR2-S	x	x	xr	xr	d	x	x
ITA	x	x	x	d	d		x

ID	IP development required	Eligible IP, by type of acquisition strategy				Other eligible IP	
		Internally generated	Outsourcing (unrelated)	Outsourcing (related)	Acquired R&D intangibles	Existing	Applied not yet granted
JPN		(x)	(x)	(x)	(x)	(x)	(x)
KOR	x	x	xr	xr	xr		
LTU	x	x	x	d	d	x	x
LUX	x	x	x	d	d	x	x
MLT	x	x	x	d	d		x
NLD	x	x	x	d	d	x	x
POL	x	x	x	d	d	x	x
PRT	x	x	x	d	d		
ROU		(x)	(x)	(x)	(x)	(x)	(x)
SVK	x	x	d	d	d	x	x
THA1	x	x	xr	xr	d		
THA2		(x)	(x)	(x)	(x)	(x)	(x)
THA3		(x)	(x)	(x)	(x)	(x)	(x)
TUR1	x	x	xr	d	d		
TUR2	x	x	xr	xr	xr		

Note: In the table, 'x' refers to eligible '(x)' to potentially eligible 'xr' eligible but restricted, and 'd' eligible only subject to development conditions.
Source: González Cabral et al. (2023[2]), see source for data notes.

Annex B. Additional formulae

Section 3 has provided general expressions of economic profit, R for intangible assets that are the result of firms' R&D efforts, based on the net revenue Q_t, the level of investment in each period I_t, the impact of taxation through the extent of total tax deductions, A and the taxation of economic profits. These expressions can be further spelled out. In the base case, the firm invests in R&D in time t and does not invest nor disposes of the asset in other periods, hence $dI_t = 1$, $dI_{t+j} = 0 \ \forall \ j > 0$. The firm's investment in R&D in time t will take d years to materialise into productive capital and generate profits for the firm. Starting from period $d + 1$, the net revenue hereafter obtained by the firm in any period $t + d + 1$ would be given by $Q_{t+d+1} = (p + \delta)K_{t+d}(1 + \pi)^{t+d+1}$; where net revenue depends on the past value of the capital stock, p represents the net private return on R&D and π is the inflation rate as discussed in Section 3.2.1. Using these relationships, Equations A.2-A.5 in this annex spells out the expressions of R outlined in Section 3 and Table 2. In order to simplify these expressions, assume that the tax rate applicable and the nexus ratio are constant over time; or in the case of Equation A.6 within the period during which preferential tax treatment applies. Expressions of A, A^* and A^{**} are provided in the main text.

Table B.1. Expression of economic profit and net income with and without taxation

Net income (EATR denominator) (eq. 1)	$$Net\ income = \frac{p}{(1+r)^d(r+\delta)}$$	(A.1)
Economic profit in the absence of taxation (eq. 2)	$$R^* = \frac{(p+\delta) - (r+\delta)(1+r)^d}{(1+r)^d(r+\delta)}$$	(A.2)
Economic profit under standard taxation (eq. 3)	$$R = \sum_{s=d+1}^{\text{Ủ}} \frac{(p+\delta)(1+\pi)^s(1-\delta)^{s-d-1}(1-\tau_{t+s})}{(1+i)^s} + A^* - 1$$ $$= \frac{(p+\delta)(1-\tau)}{(1+r)^d(r+\delta)} + A^* - 1 \ \ if\ \forall t\ \tau_t = \tau$$	(A.3)
Economic profit under preferential taxation (eq. 4)	$$R = \sum_{s=d+1}^{\text{Ủ}} \frac{(p+\delta)(1+\pi)^s(1-\delta)^{s-d-1}(1-\tau_{t+s}^{IP})}{(1+i)^s} + A^{**} - 1$$ $$= \frac{(p+\delta)(1-\tau^{IP})}{(1+r)^d(r+\delta)} + A^{**} - 1 \ \ if\ \forall t\ \tau_t^{IP} = \tau^{IP}$$	(A.4)
Economic profit including the BEPS Action 5 nexus ratio (eq. 5)	$$R = \sum_{s=d+1}^{\text{Ủ}} \frac{(p+\delta)(1+\pi)^s(1-\delta)^{s-d-1}(1-\ \tau_{t+s}^{NW})}{(1+i)^s} + A^{NW} - 1 = \frac{(p+\delta)(1-\tau^{NW})}{(1+r)^d(r+\delta)} + A^{NW} - 1$$ $$if\ \forall t\ \theta_t = \theta\ \wedge\ \tau_{t+s}^{NW} = \tau^{NW}$$ $$\tau^{NW} = \theta\tau^{IP} + (1-\theta)\tau = \tau - \theta(\tau - \tau^{IP})$$	(A.5)

Economic profit with time-varying rates (eq. 6)	$R = \sum_{s=d+1}^{H^*} \frac{(p+\delta)(1+\pi)^s(1-\delta)^{s-d-1}(1-\tau_{t+s}^{IP})}{(1+i)^s} + \sum_{s=H^*}^{\acute{U}} \frac{(p+\delta)(1+\pi)^s(1-\delta)^{s-d-1}(1-\tau_{t+s})}{(1+i)^s} + A^{**} - 1$ $= \frac{(p+\delta)(1-\tau^{IP})}{(1+r)^d(r+\delta)}\left(1-\left(\frac{1-\delta}{1+r}\right)^{H^*}\right) + \frac{(p+\delta)(1-\delta)^{H^*}(1-\tau^{IP})}{(1+r)^{H^*+d}(r+\delta)} + A^{**} - 1 f\ \forall t\ \tau_t^{IP} = \tau^{IP}\ \wedge \tau_t = \tau$	(A.6)

Note: Table 2 contains the variable descriptions. These expressions are the result of parametrising the general Equations 3-7 in the main text.
Source: OECD.

Calculating indicators of effective tax rates and cost of capital

EATR

As shown in Equation 1, the EATR can be computed using the expressions of R contained in Equations 3-7 and presented in more detail in A.2-A.6 and adjusting the expressions of pre-tax profits, R^* and net income to account for the lag in the generation of income as shown in Equation A.1 and A.2. Note that when no gestation or delivery lags are considered, $d = 0$, the expressions below collapse to those reported by Klemm (2008[8]) for the permanent investment case.

Cost of capital and EMTRs

For each of the expressions of R, an expression for the cost of capital can be derived by solving for the pre-tax rate of return that just makes the investor break even after tax, i.e. $R = 0$ and solving for p, for each of the expressions of R in Equations 3-7 or A.2-A.6. As an example, Equation A.7-A.9 contains the expressions of the cost of capital, B-Index (tax component of the cost of capital) and the EMTR in its tax-exclusive and -inclusive form.[60]

$$\tilde{p} = \frac{(1-A^{NW})(1+r)^d(r+\delta)}{1-\tau^{NW}} - \delta \qquad \textbf{(A.7)}$$

$$B - Index = \frac{1-A^{NW}}{1-\tau^{NW}} \qquad \text{(A.8)}$$

$$EMTR_{TE} = \frac{(\tilde{p}+\delta) - \left((r+\delta)(1+r)^d\right)}{\tilde{p}};\ EMTR_{TI} = \frac{(\tilde{p}+\delta) - \left((r+\delta)(1+r)^d\right)}{r} \qquad \text{(A.9)}$$

Decomposing the tax liability from the EATR

The EATR can alternatively be written by splitting the tax liability of the inframarginal investment into two components: (i) the tax liability arising from the marginal investment case and (ii) the tax on the economic profit.[61]

[60] Although not reported in this paper, the EMTR measures the effect of taxation on the marginal investment by taking difference between the required pre-tax rate of return (the cost of capital) and the real interest rate in its numerator and expressing it as a rate dividing it by the cost of capital. In the presence of preferential tax treatment given the low values of the cost of capital which can also enter the negative domain, it is preferable to use the real interest rate, i.e. the tax-exclusive definition as used in Creedy and Gemmell **Invalid source specified.** or Devereux et al. **Invalid source specified.**. In general terms, the tax-inclusive definition is typically desirable due to the fact that the EATR can be expressed as a weighted average between the statutory tax rate and the tax-inclusive EMTR.

[61] See Gonzalez Cabral et al. (2021[9]) for a graphical representation and interpretation of different cases.

$$\boldsymbol{EATR} = \frac{\widetilde{\boldsymbol{p}} - \left((\boldsymbol{r}+\boldsymbol{\delta})(\boldsymbol{1}+\boldsymbol{r})^{\boldsymbol{d}} - \boldsymbol{\delta}\right)}{\boldsymbol{p}} + \frac{(\boldsymbol{p}-\widetilde{\boldsymbol{p}})\boldsymbol{\tau}^{\boldsymbol{NW}}}{\boldsymbol{p}} = \frac{(\widetilde{\boldsymbol{p}}+\boldsymbol{\delta}) - \left((\boldsymbol{r}+\boldsymbol{\delta})(\boldsymbol{1}+\boldsymbol{r})^{\boldsymbol{d}}\right)}{\boldsymbol{p}} + \frac{(\boldsymbol{p}-\widetilde{\boldsymbol{p}})\boldsymbol{\tau}^{\boldsymbol{NW}}}{\boldsymbol{p}} \quad \textbf{(A.10)}$$

Tax liability on the marginal investment

Tax on economic profits

This equation is useful to understand the reason for the negative EATRs in Figure 4 for Israel (ISR1-S, ISR2-S), Malta, Poland and Türkiye (TUR1). In all these cases the cost of capital of an internally generated intangible including IBTIs falls in this calibration below the minimum adjusted after-tax return of the investment (adjusted real interest rate) as the total value of deductions over the lifetime of the project is larger than the regime rate at which income is taxed (Figure C.1.). The investment incurred in the R&D phase (ω) is deducted at the STR while the investment $(1-\omega)$ incurred during the commercialisation phase is deducted at the regime rate following the 'net approach'. No treatment of past expenses is required under these four regimes. The weighted rate applicable to the total value of deductions thus outweighs the reduced rate at which income is taxed. Hence, the cost of capital becomes negative, indicating a subsidy to the marginal investment. The first component of the numerator of the EATR (tax liability on the marginal investment) becomes negative. The tax paid on profits being subject to the preferential tax rate, which is the second component of the numerator of the EATR (tax liability on the inframarginal investment), does not raise enough to offset such subsidy, leading to an overall negative tax liability for the inframarginal investment and hence results in a negative EATR.

Definition of the tax base: Base case

Three key design elements that affect the calculation of the tax base are considered in the modelling: the treatment of ongoing expenses, past expenses and the BEPS Action 5 nexus ratio. Although general expressions of the total value of tax deductions, A^{**} in Equation 4, have been provided in the Section 3, Table B.2 lays out expressions of A for alternative combinations in the treatment of past and ongoing expenses based on the empirical calibration in Section 4. In the base case, the nexus ratio equals one and is therefore simplified, see Section 3.2.4 for the impact of the nexus ratio. Equations A.11-A.14 can be plugged into equations in Table B.1 (or Section 3) to obtain expressions of economic profit, the key variable to derive indicators of the EATR, EMTR and cost of capital, accounting for the different design features of income-based tax support.

Table B.2. Expressions of the tax base for different combinations of design features: Base case

Treatment of past expenses	Treatment of ongoing expenses		
No treatment	Gross	$A^{**} = \omega\tau + \left[\frac{(1-\omega)(1+r)^{d+1}\tau}{(1+i)^{d+1}}\right] = \omega\tau + \left[\frac{(1-\omega)\tau}{(1+\pi)^{d+1}}\right]$	(A.11)
	Net	$A^{**} = \omega\tau + \left[\frac{(1-\omega)\tau^{IP}(1+r)^{d+1}}{(1+i)^{d+1}}\right] = \omega\tau + \left[\frac{(1-\omega)\tau^{IP}}{(1+\pi)^{d+1}}\right]$	(A.12)
Recapturing	Net	$A^{**} = \omega\tau - \left[\frac{\omega(\tau-\tau^{IP})}{(1+i)^{d+1}} + \frac{(1-\omega)(1+r)^{d+1}\tau^{IP}}{(1+i)^{d+1}}\right] = \omega\tau - \left[\frac{\omega(\tau-\tau^{IP})}{(1+i)^{d+1}} + \frac{(1-\omega)\tau^{IP}}{(1+\pi)^{d+1}}\right]$	(A.13)
Capitalisation	Net	$A^{**} = \theta\omega\tau + \left[\frac{\tau^{IP}\varphi^{IP}C^{IP}}{i(1+i)^{d}}(1-(1+i)^{-N}) + \frac{(1-\omega)(1+r)^{d+1}\tau^{IP}}{(1+i)^{d+1}}\right] = \theta\omega\tau + \left[\frac{\tau^{IP}\varphi^{IP}C^{IP}}{i(1+i)^{d}}(1-(1+i)^{-N}) + \frac{(1-\omega)\tau^{IP}}{(1+\pi)^{d+1}}\right]$	(A.14)

		$C^{IP} = (1-\theta)\omega$ Full capitalisation: $\theta = 0$; Partial capitalisation: $0 < \theta < 1$	

Note: For the cases where recapturing and capitalisation are required, only the case of net treatment is displayed as it is currently the only relevant scenario identified among the countries covered. These expressions parametrise based on the empirical calibration in Section 4 the expressions of A^* and A^{**} in Equations 3-4. The firm invests one unit of current expenditure in net present value terms, with a share ω being invested in the R&D phase (a share θ in the 'R' phase and a share $(1-\theta)$ in the 'D' phase); and the remainder, $(1-\omega)$ being invested in the commercialisation phase. Both investments occur at the onset of each of the phases. To ensure that the firm still invests one unit in NPV terms, the investment in the commercialisation phase equals $(1-\omega)(1+r)^{d+1}$. For alternative acquisition strategies, see Section 3.4. Equation A.14 provides the case of acquired R&D intangibles where full capitalisation is considered $\theta = 0$. The rate at which deductions are valued may need to be adapted between the preferential or the full tax rate.
Source: OECD.

Annex C. Additional results

The impact of income-based tax support on the cost of capital

IBTIs may also contribute to lower the cost of capital, but this effect is more indirect than for other tax instruments. As for the EATR, the cost of capital including IBTIs (circles) lies below the cost of capital for a comparable non-qualifying investment (diamonds) (Figure C.1 Panel A). Expenditure-based tax incentives contribute to lower the cost of capital in a more direct fashion by affecting the cost of investment (González Cabral, Appelt and Hanappi, 2021[38]). The effect of IBTIs lowering the cost of capital is rather indirect as they do not affect directly the cost of investing but lower the taxation of future profits (Hall, 2019[39]). IBTIs decrease the cost of capital in OECD countries on average by 0.7 percentage points to an average of 3.5% among OECD countries with income-based support. Panel B shows estimates for the B-Index which is often used particularly in the context of expenditure-based tax incentives to capture the tax elements affecting the cost of capital (Figure C.1 Panel B) (Warda, 2001[40]; Appelt, Galindo-Rueda and González Cabral, 2019[41]).

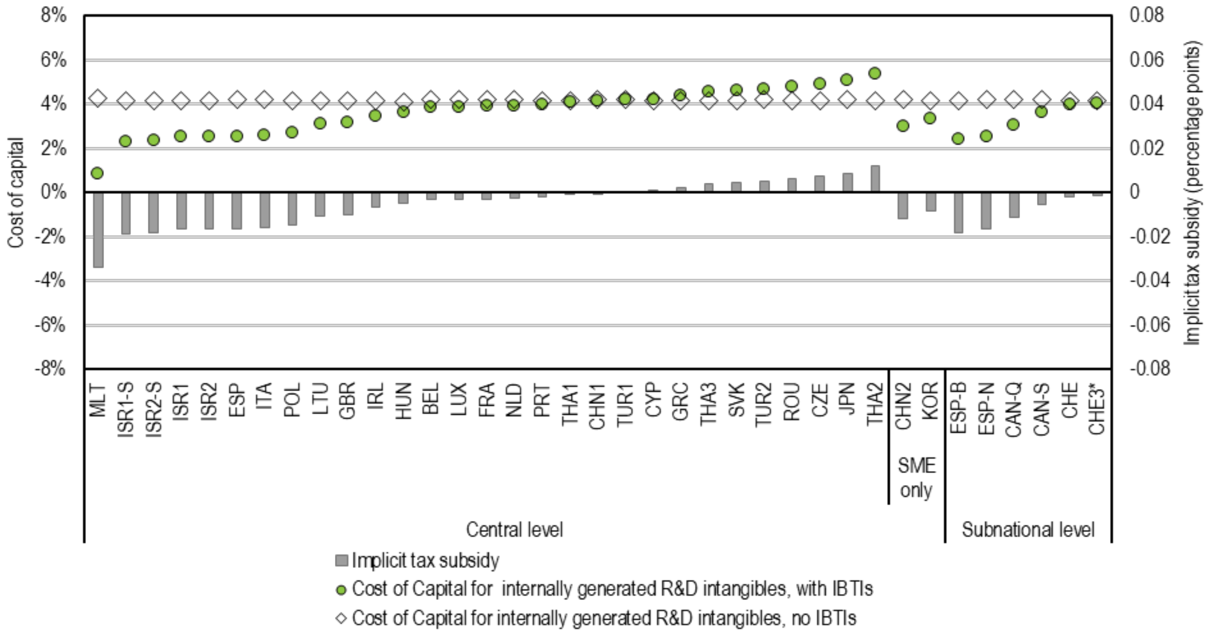
A comparison *across countries* shows that the cost of capital for an investment in an internally generated intangible qualifying for income-based support ranges from 0.01% to 5.4% across the countries considered. Malta, Spain (ESP-B) and Israel (ISR1-S, ISR2-S) are the countries offering more incentives to increase investments in R&D assets with the Czech Republic, Thailand (THA_2) and Japan being among the least generous in this calibration. Ranked by stronger decreases in the cost of capital with respect to a comparable investment (bars in Figure C.1 Panel A), the greatest preferential tax treatment is offered in Malta, Spain (ESP-N) and Israel (ISR1-S).

Under certain circumstances, IBTIs may lead to higher costs of capital than if no support had been granted for the particular investment. This result appears in this calibration for dual category regimes which are not targeted specifically to the existence of an IP asset but that are granted to firms upon meeting certain conditions; and that particularly offer support that is time bounded. This is for instance the case in the Czech Republic, Thailand (THA2 and THA3) and Romania which offer tax holidays to firms doing R&D (Table A.2). The same arises for Japan where there is a five-year exemption to firms engaging in R&D and Greece which offered a three-year deferral of profits from IP embodied in other products in 2021. The common feature of these regimes is that, with the exception of Greece, support is not targeted to the existence of an IP asset but to the firm attaining a certain ‘innovative’ status or performing the activity for the first time. This entails that since R&D takes time to generate profits (gestation lag), the effective period during which firms can benefit from relief is shorter (reduced by the initial periods where no profits were obtained). Forgoing the initial investment deductions does not offset the benefits from the reduced tax rate (taxes would still be due on income at full rate).

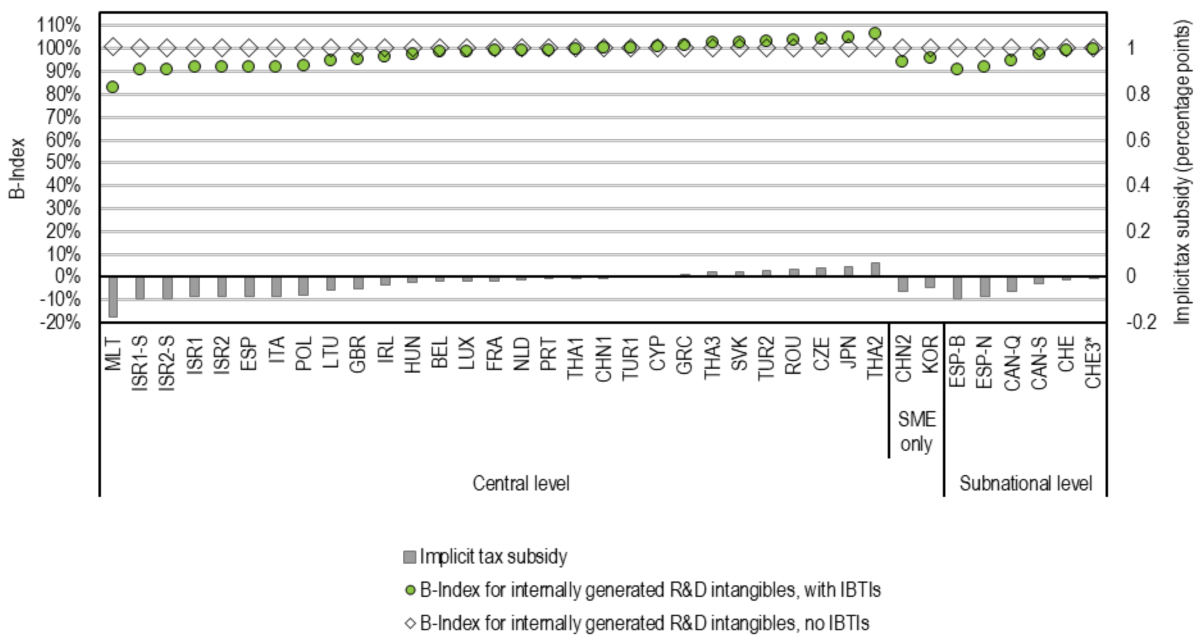
As for the EATR, the implicit tax subsidies granted through the cost of capital are a function of the design features of the tax incentives and the acquisition strategies chosen to generate the IP. As shown by Figure C.1. Panel C, the presence of recapturing or capitalisation provisions for past expenses as well as requirements to apply a net approach with respect to ongoing expenses both decrease the level of implicit tax subsidy. The choice of acquisition strategies will affect the extent to which income-based tax support acts to reduce the cost of capital, depending on the eligible acquisition strategies and the value of the nexus ratio (Figure C.2 Panel A and Panel B).

Figure C.1. Cost of capital of R&D intangibles, 2021

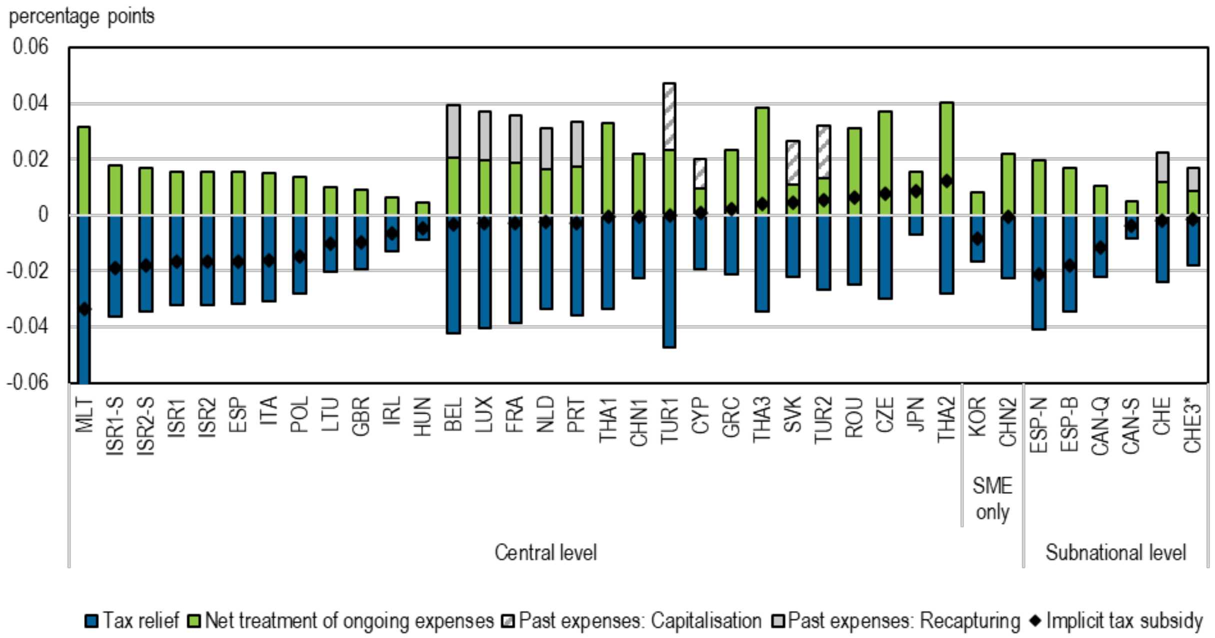
Panel A: Estimates of the implicit tax subsidy from IBTIs, marginal investments



Panel B: Estimates of the implicit tax subsidy from IBTIs, marginal investments: B-Index



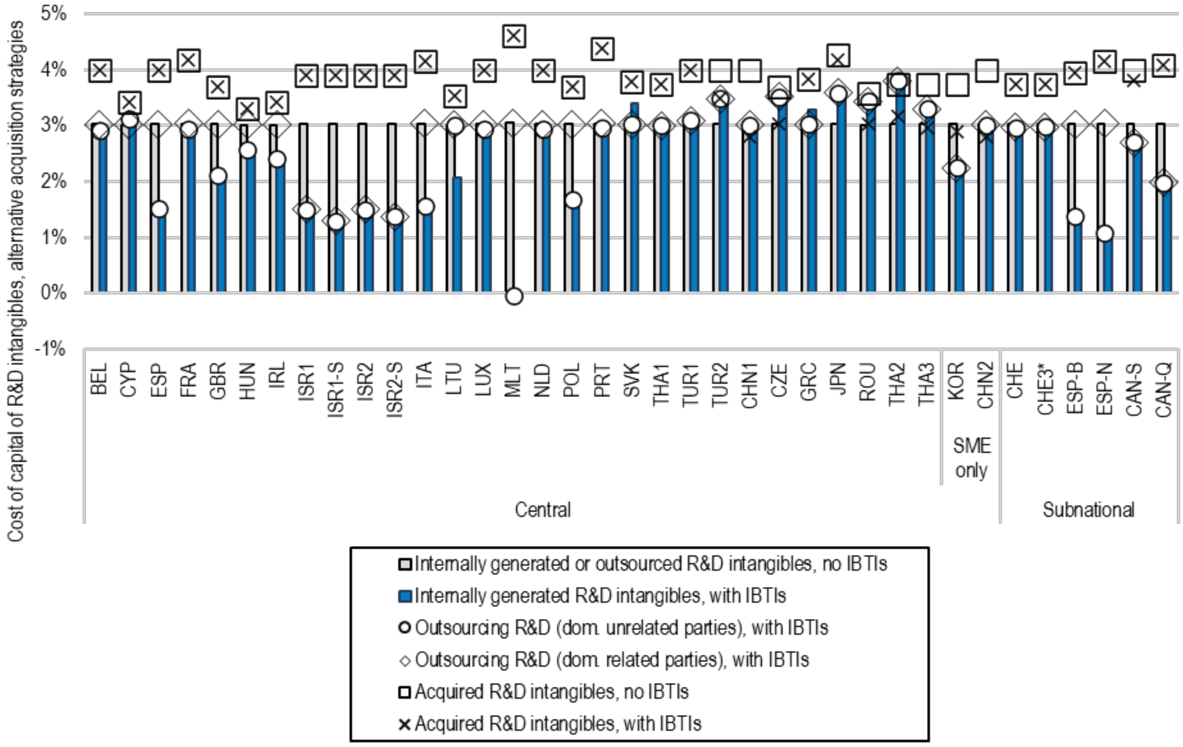
Panel C: Preferential tax treatment for marginal investments (cost of capital for internally generated R&D intangible)



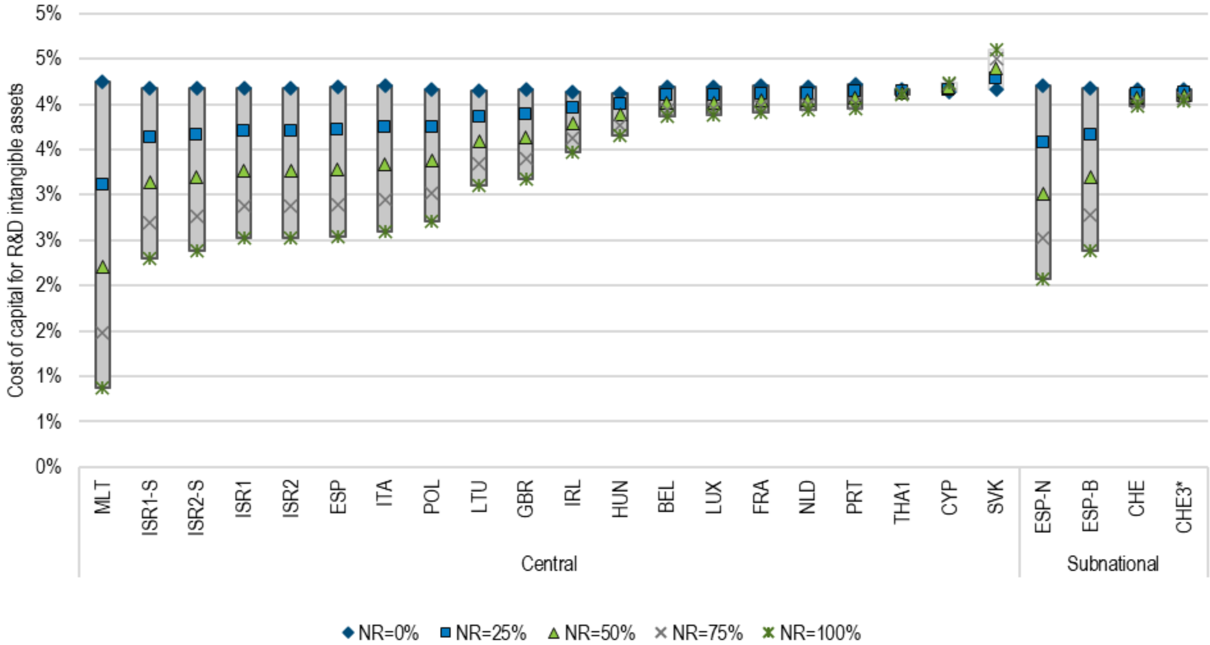
Note: The estimates consider an R&D investment with a gestation lag of two years after which the intangible asset starts generating profits. Baseline refers to an equivalent investment that does not benefit from income-based tax support. Preferential tax treatment is obtained by the difference between the baseline and the cost of capital including income-based support. Estimates in Panel A are ranked based on the value of the cost of capital for R&D intangibles. Panel B decomposes the preferential tax treatment (bar in Panel A) to disentangle the composition of each design feature and is hence tied to the calibration parameters outlined in Section 4. It is important to note that estimates of the cost of capital are not static indicators and are dependent on the calibration parameters that comprise the R&D investment, e.g., the pre-tax rate of return, the gestation lag, etc. The contribution of each of these elements to the overall rate would vary with changes to the underlying calibration parameters, shifting the weight of each element to the overall implicit tax subsidy. IP income in Switzerland can benefit from a 90% exemption of qualifying IP income from cantonal taxation. However, this exemption is subject to a cap: only 70% of a firm's total profits (IP or non-IP) can be exempt. CHE assumes that the firm has sufficient other income (non-qualifying IP or non-IP income) that is taxed at higher rates so that it is not subject to the 70% maximum relief limitation. CHE* assume that the maximum relief limitation is binding.

Figure C.2. Cost of capital for R&D intangible assets, alternative acquisition strategies, 2021

Panel A: Alternative acquisition strategies



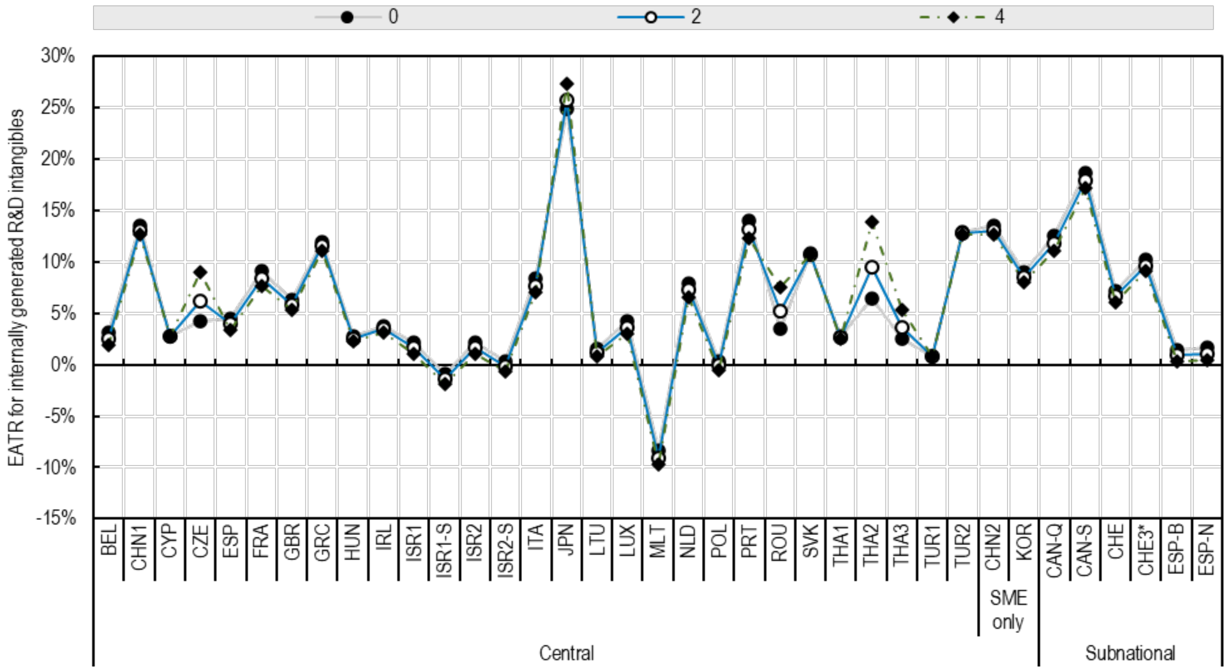
Panel B: Variation in the nexus ratio



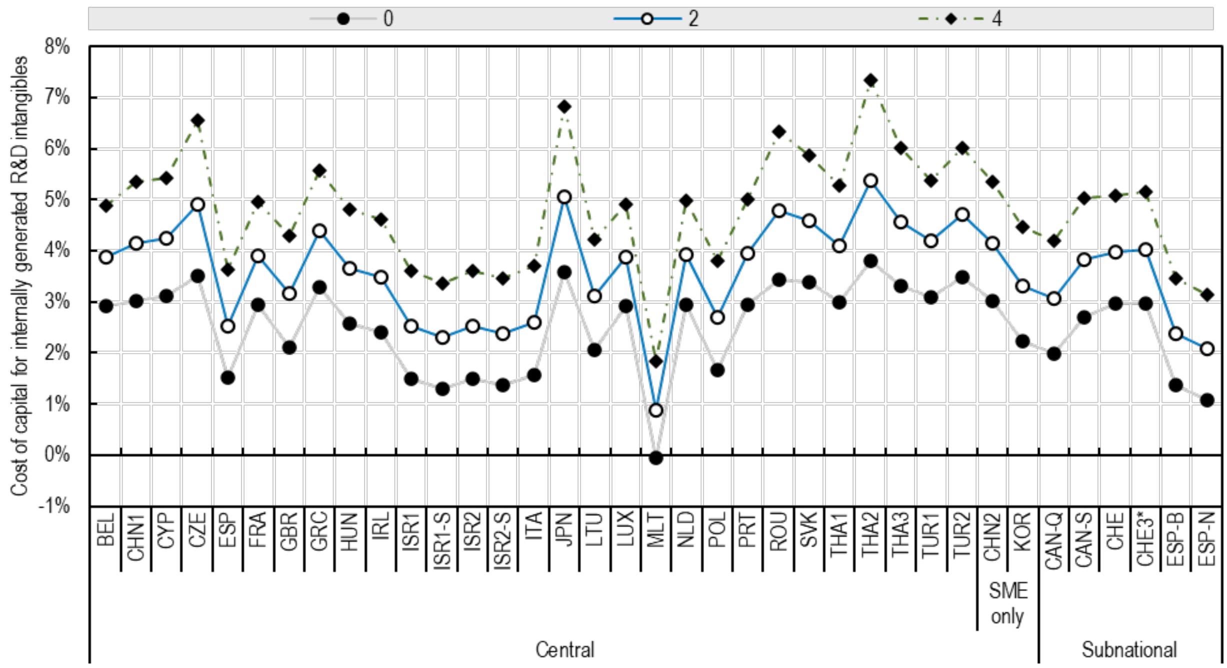
Note: The estimates consider an R&D investment with a gestation lag of 2 years after which the intangible asset starts generating profits in the case where the asset is developed through in-house or outsourced R&D, and a lag of 0 years if the asset is acquired. Since the model is domestic, R&D costs are assumed to be outsourced to other parties operating in the same country. This implies that certain regimes using a 'jurisdictional approach' contemplated in the BEPS Action 5 report may allow outsourcing of R&D to related parties as a qualifying expenditure (OECD, 2015[33]; González Cabral et al., 2023[2]). Korea, Israel, Switzerland, Thailand and Türkiye follow this approach. In addition to this, Türkiye and Korea also allow acquired R&D intangibles to qualify as long as the R&D took place domestically. Outsourcing costs to related parties abroad or acquiring IP that have not been developed in domestically (in the second case) would not be eligible acquisition strategies and would not benefit from preferential tax treatment. In those cases, the corresponding cost of capital will be equal to the baseline case (R&D performance) for outsourcing R&D costs and Baseline (Acquired R&D intangibles) for the Acquired R&D intangibles case. This implies that certain acquisition strategies may benefit from preferential tax treatment subject to the location of R&D. Panel B considers only regimes that implement a nexus ratio in line with the BEPS Action 5 minimum standard and have been subject to the review of the Forum on Harmful Tax Practices.

Figure C.3. EATRs and cost of capital for internally generated R&D intangibles: Alternative gestation lags

Panel A: EATR for internally generated R&D intangible



Panel B: Cost of capital for internally generated R&D intangibles



Note: The chart reproduces estimates of the EATR and cost of capital for an internally generated R&D intangible shown in Figure 4 and Figure C.1 Panel A in Annex C at alternative levels of the gestation lag.