

OECD Taxation Working Papers No. 9

Taxation and Innovation

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https://dx.doi.org/10.1787/5kg3h0sf1336-en

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ACKNOWLEDGEMENT

Financial support for this research was generously provided by the Italian Government through the "Alessandro Di Battista" research Fellowship during my secondment at the Centre for Tax Policy and Administration (CTPA), OECD, Paris. A preliminary version of this paper was prepared for the Working Party No. 2 on Tax Policy and Tax Statistics of the Committee on Fiscal Affairs in 2009. I am grateful to Steve Clark for his input and the staff of the Tax Policy and Statistics Division in CTPA for providing a stimulating research environment. I am also grateful to country Delegates for helpful comments on an earlier draft. I remain responsible for all remaining errors.

TAXATION AND INNOVATION

Pamela Palazzi

1. Introduction

Innovation is the cornerstone of sustained economic growth and prosperity. In a globalised world, innovation is a key driver of competitiveness between businesses and it plays a critical role in the rapid growth of emerging economies. At the same time, the global financial crisis has increased the relevance of a better understanding of the role that innovation can play in restoring sustainable growth while giving focus to the issue of constrained public resources and effective public expenditure. Especially in the current context of a global financial and economic downturn, it is particularly important that tax policies continue to provide efficient incentives to fostering innovation.

For the purposes of this paper, 'innovation' refers to ways to transform an idea into a new, improved product, service or process, leading to increased profits and/or reduced costs. The Oslo Manual (OECD (1996)) for measuring innovation identifies four types of innovation. *Product innovation* involves a good or service that is new or significantly improved. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics. *Process innovation* involves a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software. *Marketing innovation* involves a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing. *Organisational innovation* involves introducing a new organizational method in the firm's business practices, workplace organization or external relations.

Today's world is one in which both OECD countries and non-OECD economies increasingly rely on knowledge and services to drive their performance, where investment in intangible assets is vital and where governments look to innovation-induced growth as a spark for re-igniting growth. Governments provide support for the creation and the dissemination of innovation through a variety of channels with the aim to create a conducive policy environment (regulatory policy, sound tax and financial system). Tax policies must form part of a coherent and well-designed innovation strategy that takes account of the interactions and complementarities between its different key drivers and increases overall long term and sustainable growth.

Policy makers are encouraged to assess and design the tax policies to support specific economic objectives and efforts reflecting the current foundation of economic growth to stimulate the economy, especially the creation and the dissemination of knowledge. Scientific and technological innovations enable modern economies to improve competitiveness and productivity, giving us the means to achieve a higher standard of living and better quality of life, to preserve the quality of our environment and to improve our health, enhance public safety and security, and manage our natural and energy resources.

This paper identifies and discusses the linkages between tax and innovation, focusing on its key drivers. Factors that have an impact on innovation, either directly or indirectly, and at the same time may be influenced by tax policies are the following:

- undertaking R&D investments, the creation of intangible assets and adoption of knowledge (either through the self-development, the purchase or licensing of intellectual property and knowledge);
- greening of the economy;
- risk-taking with respect to the creation of newly innovative businesses and venture start-ups; encouraging cooperation and partnerships between private sector firms and research centres;
- encouraging the mobility of high skilled workers, including the education and the training of the work force.

Each section discusses alternative possible tax policies related to the listed key drives and considers how governments could make current tax system work better in order to allow innovation to flourish.

2. The impact of R&D tax provisions on the creation of knowledge and other intangible assets, innovation and economic growth

This section studies the impact of R&D tax provisions on the creation of intangible assets, innovation and economic growth. Sub-section 2.1 introduces the main R&D investment concepts, and tax reliefs and criticism related to intangibles assets. Sub-Section 2.2 discusses the different modelling methods that assess the generosity of R&D tax provisions. Both the B-index and the cost of capital/METR framework will be discussed and evaluated when applied to model investment in intangible assets. The AETR framework will briefly be introduced as well. Sub-section 2.3 focuses on the design of tax policy regarding R&D provisions and innovation policies. The analysis considers the effectiveness of R&D tax incentives, how governments could make current tax systems work better in order to stimulate innovation, and discusses alternative tax and innovation policies.

2.1. Conceptual framework in order to analyse R&D investments

This section introduces the conceptual framework of R&D investment processes and discusses main R&D tax reliefs available; it presents the impact of tax systems on cross-border transfers of intellectual property and focuses on related tax planning strategies.

2.1.1. Different R&D investment processes undertaken by private firms

R&D maybe generally characterized as an activity with an uncertain outcome, where the central objective is to generate and acquire new knowledge capital to be exploited and increase expected streams of profit.

Companies can organize their investment in R&D in different ways. Firms may decide to carry out the R&D activities internally, for instance through the creation of a laboratory. By having a division undertaking the R&D activities, if it is incurring losses on the R&D side, it can offset these losses against some of the more profitable operations thereby reducing the overall tax burden. In the case of high risk R&D investment, firms could also decide to create a separate incorporated company that performs the R&D activities in order to provide limited liability protection. This structure allows the separation of the firm's operating business from the R&D activities that are of higher risk, thereby preventing potential

losses arising from the R&D activities negatively affecting the profits from the business's core activities. Firms may incorporate a separate R&D company, in order to have all of their costs being identified as R&D and thus eligible for tax incentives. Companies might also conduct R&D activities by cooperating with other entities that can be either private, for instance other companies engaged in the same kind of activities or companies whose core business is to perform research, or public entities such as universities. Moreover, firms may find it less costly to outsource their R&D activities to research institutes or liberal professionals – for instance a pool of engineers – through a research contract. Finally, they can decide to purchase or take in license R&D output or intellectual property (IP) already available on the market.

MNE's are increasingly investing in R&D through cost sharing agreements, which allow the parent company and its affiliates or subsidiaries to obtain economies of scale, to share costs and risks of investing in R&D, to influence the location (ownership) of the corresponding intellectual property (IP) and to determine which company will have to pay – and which company will receive – royalties for the use of the IP. Note that this R&D contract is often combined with the creation of new companies in tax havens or the use of hybrid entities to reduce the overall group tax burden – for more details see sub-section 2.3.

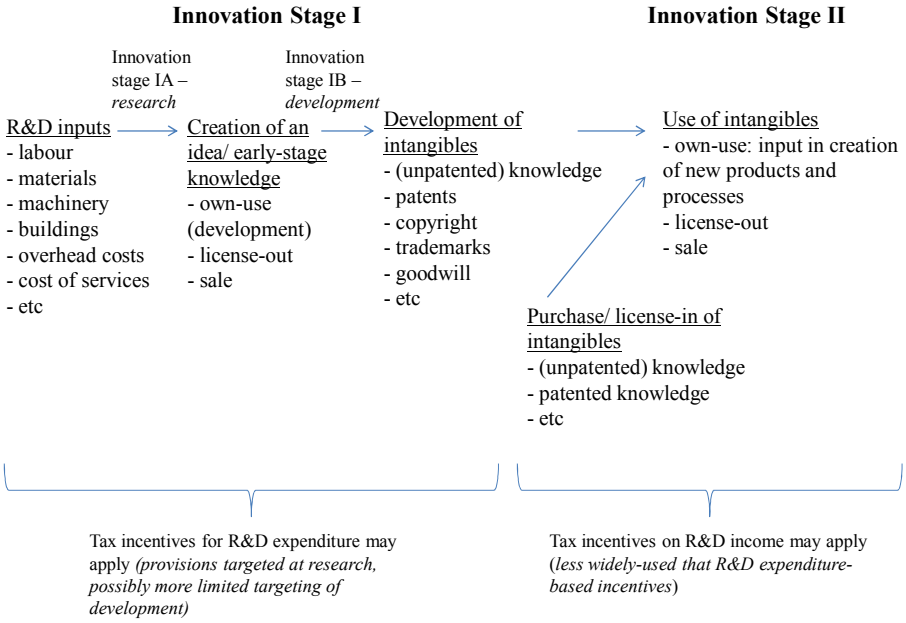
These different ways to undertake R&D activities have an impact on the cost incurred. Direct investment implies costs for materials (current expenditures) and buildings or equipment (capital expenditures). Firms pay service costs in the case of research contracts or a purchase price, rents or royalties in the other cases. The specific nature of the costs incurred has to be considered in calculating the tax base and the tax liabilities. Not only has each input its own tax treatment, it also has an impact on whether the firm is eligible for specific R&D tax incentives and the amount of tax relief that can be claimed. In light of this, Box 2 briefly discusses the Frascati Manual which provides internationally accepted definitions of R&D and classifications of its component activities. The manual contributes to intergovernmental discussions on best practises for science and technology policies.

2.1.2. The R&D value chain – a conceptual framework.

Intangibles are often the natural outcome of the R&D activities that have been undertaken. In many businesses – for instance in pharmaceutical firms, banks or insurance companies – intellectual properties are key elements in the value added chain. Their financial value refers to the amount of the expected extra profits from fully exploiting the intangible compared to the profits in the absence of the intangible. Investment in R&D might therefore increase profits and lead to economic growth.

In order to evaluate the impact of R&D tax provisions on firms' investment and innovation decisions, the innovative process that is underlying the analysis in this paper is defined first. This process is shown schematically in Figure 1.

Figure 1. R&D tax provisions in the innovation and investment process



First of all, it is worth referring to the R&D definition contained in the Frascati Manual (see OECD (2002), and Box 1, which clarifies that the term covers three activities: basic research, applied research and experimental development. *Basic research* is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view. *Applied research* is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective. *Experimental development* is systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed. This distinction between Research and Development activities is important because tax incentives may be granted to basic and applied research activities but may have a more limited application to experimental development activities.

Firms invest in research and development in order to create intangible assets such as a stock of knowledge, patents, trademarks, copyright, goodwill, etc. These intangible assets may be used as an input in the creation of innovative products, processes and services or they may be directly marketable, for instance by licensing or by the sale of patents. The analysis in the present section will focus not only on the impact of R&D tax provisions on the self-development of intangible assets but also on the use of intangible assets that can be licensed or purchased from other firms in the creation of innovative products, processes and services that are commercialised as shown in Figure 1.

Stage I of the innovation process consists of research and development processes, as explained in more detail in sub-section 2.1.3. Basic and applied research, including experimental or theoretical work, is undertaken primarily to create new knowledge which may be licensed or sold, or used within the firm as input in a development sub-stage of the innovation process The latter is directed at producing new materials, products or devices brought to the market in stage II, or installing new processes, systems and services, or improving substantially those already produced or installed .

The different innovation stages are best be described by means of an example. During the research activity (stage I.A in Figure 1), an automotive company develops a theoretical concept of an airbag. This idea is further developed (stage I.B) by making prototypes and improving the airbag, leading to a fully developed product, which is the airbag as we currently know it (and a patent might be taken). This intangible R&D capital (the airbag) can be sold or licensed to other automotive companies or can be used internally and built into cars (stage II of the innovation process). It is key to include stage II in analyzing the innovation process, as the value of the patent is determined by the increase in profits that the firm will realize by selling or licensing the fully developed concept of the airbag, either patented or not (output of sub-stage I.b) or by incorporating the airbag in the cars that the firm sells itself.

Box 1. FRASCATI MANUAL: Proposed standard practice for surveys on research and experimental development

According to the Frascati Manual, research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.

The Frascati Manual is the result of a joint work between the OECD and national experts; it's a standard for R&D surveys in OECD member countries and worldwide: reliable and comparable statistics and indicators to monitor innovation area are of crucial importance in the knowledge-based economy. Although this Manual is a technical document which is mainly intended as a reference work, it's a cornerstone of efforts to increase the understanding of the role played by science and technology by analysing national systems of innovation. Furthermore, by providing internationally accepted definitions of R&D and classifications of its component activities, the Manual contributes to intergovernmental discussions on best practices for science and technology policies.

The several issued editions made an effort to strengthen various methodological recommendations and guidelines for improving R&D statistics. While all countries may not be able to comply with the recommendations as stated, there is consensus that these are standard to which all should aspire.

Several aspects of this basic illustration are noteworthy. First, labour and physical capital types and proportions may differ between stages within the innovation stage I. Basic and applied research activity (I.a) may require more highly-skilled labour and may employ less plant and heavy equipment than developing activity (I.b) leading to the creation of new products and processes up to the point of commercialization. This is relevant as labour and physical capital types have different pre-tax user costs (e.g. different wage rates, economic depreciation rates).

Second, the tax treatment of the input costs in stage I.A may differ markedly from that in stage I.B. In particular, tax incentives for current and capital costs may apply in full to research expenditures, but may have more limited application in the development phase as not all countries with R&D tax incentive programmes recognize development expenditure up the point of commercialization as expenditure qualifying for R&D tax incentives.

Third, the basic framework in Figure 1 treats knowledge capital (patented or unpatented) as a distinct output of stage I. This is important for tax policy analysis, as it allows for the calculation of effective tax rates on intangible capital that take account of its economic depreciation separately from the economic depreciation of physical capital as an input to research and development. Standard effective tax rate (METR) modelling approaches that do not separately treat knowledge capital are unable to assess the effective tax rate on knowledge capital – instead they assess the effective tax rate on factor inputs in R&D (namely, physical capital and labour assumed to result in stage II applications. This argument and its applications will be elaborated in the section on modelling).

Fourth, the framework addresses alternative uses of knowledge capital, which may attract different tax treatment. In particular new knowledge created by an R&D performer may be exploited in various ways. Where knowledge capital of an R&D performing firm is deployed by that firm in stage II, revenue on the sale of output of stage II (as an input) would normally be subject to corporate income tax at the basic CIT rate. Where instead (or in addition) the knowledge capital is licensed to another firm, the return to the performer would be taxed as royalty income. Where knowledge capital is sold, capital gains taxation may apply.

2.1.3. Tax reliefs for costs and income from R&D: an empirical overview.

Policymakers share the goal of encouraging R&D in order to boost innovation, but tax incentive measures vary substantially between OECD countries depending on their specific innovation strategy. By implementing tax incentives on the R&D cost and/or income side, countries indicate that they want to be competitive in or encourage different aspects of the R&D process. This paragraph investigates policies put in place by governments to encourage either stage I of the innovation process (the creation of knowledge) or stage II (the use or exploitation of intangible assets) – See Figure 1.

Some countries provide R&D incentives (e.g., tax credits for companies conducting in-house R&D activities. Firms that increase their long-term investments in innovation will be rewarded with a subsidy on their additional R&D activity performed measured by expenditures on R&D, and R&D related foreign direct investment. The aim followed by this policy is to make the country a more attractive place for world class innovation that will boost investment, expand skills and help anchor the local arms of leading multinationals in the country. Under generous tax provisions, as applied for example in Australia, high-skilled workers are targeted as well as capital investments (laboratories, materials, equipments, etc.). Moreover, it's worth noting that these R&D tax incentives are provided regardless the location of the resulting output of R&D investment (e.g. patents).

A number of OECD countries do not provide R&D incentives but nevertheless try to encourage business R&D investment or to attract foreign R&D through the general fiscal framework. In Switzerland, the 26 cantons have their own tax policies and may use them to attract national and foreign R&D. Germany, Finland, Iceland and Sweden also do not have R&D tax incentives but some of these countries have a growing interest in using tax instruments to meet certain science and technology policy goals such as stimulating R&D in SMEs or fostering co-operation between public research and industry.

Various jurisdictions are offering low effective tax rates on income from intangibles, specifically on income (like royalties) from intellectual property. Although not necessarily a key objective, such policies could aim at attracting MNEs headquarters and IP holding companies by providing incentives on the income side. Ireland, for example, has been a favourable location for intellectual property for many years because of its exemption of patent income from corporate taxation. More recently, the Netherlands has introduced an incentive that provides preferential tax treatment of the use of self-developed IP (stage II of the innovation process as represented in Figure 1). The reduced rate applies to all net earnings derived from self-developed IP, including net earnings from internal exploitation and licensing to another party. The Dutch system aims to boost the creation of innovation (stage I of the innovation process as represented in Figure 1) by reducing the tax burden in stage II of the investment process. (See Box 3 on the patent box and innovation box rules introduced in the Dutch Tax Plan 2010). The Dutch tax system also includes an R&D tax credit in the wage tax and income tax.

Within the U.S., there are similar concerns. Many U.S. States exempt intangible property (patents and copyrights) from state and local property taxes. Moreover the U.S. tax system can be attractive as it allows an offset to domestic tax on foreign royalty income, using excess foreign tax credits on other (e.g. high-taxed foreign dividend) income.

Other tax incentives on intangible income are offered in the form of a partial exemption or reduction in the tax rate on royalty income, as for instance in Hungary, Switzerland, Korea and Belgium where 80% of the gross patent income may be not taxed (so-called "patent deduction system"). Countries might also reduce the capital gains tax (through the implementation of a lower target rate) as is the case in France and Greece. Interestingly enough, most countries that offer generous royalty tax incentives also have a low corporate income tax rate. As mentioned before, a low basic corporate income tax rate is in itself an important factor in providing incentives for the exploitation of patents. Cyprus,[1] for example, offers a 10% corporate tax rate and is increasingly popular as an IP location in the European Union.

In some countries, the provision of R&D tax incentives (subsidizing costs) is conditional on the location of the resulting IP holding company. In such cases, countries may aim to prevent profits on the exploitation of IP being shielded from domestic home country tax.. Note also that some countries provide a favourable tax treatment of intangible income conditional on the location where the R&D activities are carried out or where the costs have accrued / have been incurred.

2.1.4. Rationale for implementing R&D tax provisions

Companies invest in R&D in order to create knowledge that can be applied to develop new products, lower production costs, or can be licensed or sold to others, with the aim of maximizing profits for their shareholders. However, monetary benefits from R&D may spillover without charge to other firms and individuals that are able to benefit from the knowledge created by the R&D performers. Thus, one of the main rationale for R&D tax provisions is the presence of positive external effects, for instance because of knowledge spillovers of R&D activities to other firms and economic activities.

While Patents are granted to encourage R&D by raising the private return, R&D performers may be unable to obtain a patent protecting the knowledge gained, and even if a patent is granted, protection may be limited in time and coverage. Moreover, knowledge created by R&D that gets embodies in new products and producers may become understood and accessible to others, who then benefit from business applications. Spillover benefits may also accrue to individuals (e.g. scientists, engineers) that carry out the R&D and are able to exploit that knowledge when working for another firm.

The existence of these positive externalities creates a form of 'market failure', from society's perspective. When making their R&D investment plans, private firms can be expected to only take into account the private returns from R&D and ignore the external return – that is, the difference between the social return including R&D spillover benefits, and the private return. As a consequence, competitive markets will under invest in private R&D as the market does not factor in all public/social benefits of investment in R&D. Thus the private market cannot be expected to generate the socially optimal level of R&D activity This outcome encourages policy makers to consider the use of R&D tax incentives in order to encourage private firms to increase their R&D spending to levels that maximize social welfare.

Another way to look at this rationale to stimulate R&D through the tax system is the inability for R&D performers to receive an appropriate return on their investment in R&D. This can be the case when knowledge embodied in personnel is lost when workers move to another firm or when other companies copy a firm's invention. This problem arises when firms self-develop intangible assets. Agents that

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[1] "Footnote by Turkey: 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. Turkey recognizes the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of United Nations, Turkey shall preserve its position concerning the "Cyprus" issue."

undertake research in the expectation of earning a profit mayl not be willing to take on the risks and costs of such activity where rewards from doing so evaporate due to imitation, once IP is marketed.

To give firms an incentive to produce socially desirable new innovations, intellectually property rights allow the creator of the non-rival good to appropriate the returns of the innovation. However, as intellectual property rights (IPR) make a (non-rival) good/new process excludable, it might give rise to inefficiency in terms of diffusion and dissemination of innovation since its price will be above the marginal cost of producing it. In other words, granting an IPR to an entity (for instance to let the creator to be the owner of the related benefit) is tantamount to conferring a monopoly which results in prices above the price that would prevail in a competitive market (Dixon and Greenhalgh (2002)). Companies that purchase or license IP, instead of self-developing it, will face this market inefficiency as they will have to pay a higher purchase price or royalties than what would be the case in the absence of this IP monopoly. The tax system might then be used to correct for this distortion in order to encourage knowledge dissemination.

Another market failure relates to asymmetric information in the capital markets, both in case of self-development of IP or in case intangible assets that are purchased or licensed, which implies that financing R&D might be more costly than financing investment in tangible assets. Financial institutions may impose higher interest rates (in excess of what would be charged with symmetric information) because of the highly uncertain (risky) return on R&D and uncertain value of IP. This situation likely derives from the high depreciation rate of the IP but also from the lack of similar market transactions that can be used to determine a correct IP market value, and because the value of IP might be strongly firm-specific. In such cases, asymmetric information leads to increased risk for financial institutions to recover their loan in case of the firm's default, fund constraints and under investment relative to an efficient outcome based on symmetric information.

2.1.5. Tax treatment of R&D expenses and reporting issue

Investment in research and development can take different forms. Unlike physical capital, R&D is intangible in nature and usually created using a combination of inputs such as labour (e.g. the wages of scientists), materials (e.g. test tubes), machinery (e.g. microscopes), buildings (e.g. laboratories), overhead costs (e.g. utilities or salaries and wages for support staff), including marketing expenses, licensing costs of tangible and intangible capital (e.g. software) and costs for services (e.g. external consultation regarding the feasibility of the R&D project). Each of these inputs differs not only in their characteristics, being either current expenses or capital investment, but might also receive a different tax treatment.

It is also important to point out that patents and other intellectual property can be purchased, obtained by taking a license or self-developed. In most countries, these different ways to obtain a patent imply a different tax treatment. The International Accounting Standard guidelines are discussed in Box 2.

While accounting systems require that costs incurred in the creation of an asset, regardless of its nature, have to be suspended and capitalized until the asset is employed in the firm's production and start generating benefits, some tax systems allow that the cost of current expenses and the cost of the capital used in the creation of intangible assets to be immediately expensed. This treatment provides a tax subsidy, with economic costs being deductible when they occur, even though they are inputs in the creation of an intangible that will yield revenue only in the future. Under this approach, the inputs are considered independently from why they are used; i.e. they are not considered by the tax system as inputs in the creation of an intangible 'asset' which will yield a future return. This could be considered as a mismatch between accrued taxable revenue and corresponding costs. It is for this reason that other tax systems require that the costs of all of these inputs be capitalized during the period that the intangible is created and subsequently amortized over the intangible's useful life. . This approach, where tax rules follow the

accounting system in determining the tax base, implies that the cost of the inputs can only be amortized from the moment that the intangible starts being used and creates revenues.

Box 2. International Accounting Standard (IAS 38) guidelines: Immediate expensing versus capitalisation and tax depreciation of the intangible asset

Intangible asset

An intangible asset is an identifiable non-monetary asset without physical substance. The intangible asset is a resource that is controlled by the enterprise as a result of past events (for example, purchase or self-creation) and from which future economic benefits (inflows of cash or other assets) are expected. The 3 critical attributes of an intangible asset are (IAS 38.8):

- Identifiability;
- Control (power to obtain benefits from the asset);
- Future economic benefits (such as revenues or reduced future costs).

An intangible asset is identifiable when it is (1) separable, meaning that can be separated and sold, transferred, licensed, rented, or exchanged, either individually or as part of a package, or (2) arises from contractual or other legal rights, regardless of whether those rights are transferable or separable from the entity or from other rights and obligations (IAS 38.12).

Examples of possible intangible assets include computer software, patents, copyrights, motion picture films, customer lists, mortgage, servicing rights, licenses, import quotas, franchises, customer and supplier relationships, marketing rights.

Intangibles can be acquired by separate purchase, as part of a business combination, by a government grant, by exchange of assets or by self-creation (internal generation).

Recognition criteria

IAS 38 requires an enterprise to recognise an intangible asset, whether purchased or self-created (at cost) if, and only if (IAS 38.21):

- It is probable that the future economic benefits that are attributable to the asset will flow to the enterprise,
- And the cost of the asset can be measured reliably.

This requirement applies whether an intangible asset is acquired externally or generated internally. IAS 38 includes additional recognition criteria for internally generated intangible assets.

The probability of future economic benefits must be based on reasonable and supportable assumptions about conditions that will exist over the life of the asset [IAS 38.22]. The 'probability of future economic benefits' recognition criterion is always considered to be satisfied for intangible assets that are acquired separately or in a business combination (IAS 38.33).

If an intangible item does not meet both the definition of and the criteria for recognition as an intangible asset, IAS 38 requires the expenditure on this item to be recognised as an expense when it is incurred (IAS 38.68).

Initial Recognition: Research and development costs

- Charge all research cost to expense (IAS 38.54).
- Development costs are capitalized only after technical and commercial feasibility of the asset for sale or use has been established. This means that the enterprise must intend and be able to complete the intangible asset and either uses it or sells it and demonstrates how the asset will generate future economic benefits (IAS 38.57).

If an enterprise cannot distinguish the research phase of an internal project to create an intangible asset from the development phase, the enterprise treats the expenditure for that project as if it were incurred in the research phase only.

Initial Recognition: Internally Generated Brands, Mastheads, Titles, Lists

Brands, mastheads, publishing titles, customer lists and items similar in substance that are internally generated should not be recognised as assets.

Subsequent Expenditure

Subsequent expenditure on an intangible asset after its purchase or completion should be recognised as an expense when it is incurred, unless it is probable that this expenditure will enable the asset to generate future economic benefits in excess of its originally assessed standard of performance and the expenditure can be measured and attributed to the asset reliably.

Costs incurred in self-developed patents are frequently treated as current business expenses and thus deducted entirely in the current year (often on the premise that they are the result of R&D which is generally a current business expense). However some countries provide an option to amortize the self-created patent costs provided the useful life is known and relatively short.

Acquired patents are typically treated as intangible fixed capital assets. As a result of the transaction, the intangible's purchase price is monetized and this 'market' value will then have to be depreciated. In most cases the government prescribes a method of depreciation and the period over which the patent can be depreciated. For both tax and accounting purposes, the historical price (original value/acquisition value) is used. Fair market valuation is typically not used for depreciation purposes of patents and trademarks.

2.1.6. R&D tax reliefs

This section reviews various types of R&D tax incentives based on expenditures inundertaking R&D, and in particular tax provisions that reduce the effective (net of tax) cost of purchasing or acquiring the services of inputs used to undertake R&D, primarily physical capital and labour. Secondly, some examples of a low/reduced tax rate on income derived from R&D will be discussed. The subsequent section returns to the issue of tax relief for R&D through reduced taxation on income derived from R&D as a consequence of tax planning techniques aimed at minimizing the tax burden on income from the use of knowledge capital and mobile intangible assets.

R&D tax provisions can take different forms. Most countries implement R&D tax credits or special allowances for R&D expenditure. Countries also implement accelerated tax depreciation allowances, or immediate expensing of R&D investment and some may provide for an even more generous tax treatment by allowing for an additional deduction – in excess of the immediate expensing of the invested amounts – as a percentage of the actual R&D investment expenses. Countries could also levy a reduced corporate income tax rate on profits generated by intangible investments (e.g. on domestic and/or foreign royalties), and they may provide for more generous loss-offset provisions in case of R&D investment. Countries may provide assistance also with respect to the financing of R&D investment by allowing for more favourable interest deduction arrangements, for instance by foreseeing less strict thin capitalization rules and thereby lower the cost of fund for firms. Countries also reduce the labour taxes on gross earnings of employees involved in the creation of intangibles, for instance by levying reduced employer social security contributions.

In summary, tax relief for R&D is a broader concept that includes:

- tax incentives for R&D expenditure, lowering the cost of undertaking R&D, (section 2.1.6.1) and
- low/ reduced tax rates on income derived from R&D (section 2.1.6.2).

2.1.6.1 Tax incentives for R&D expenditure.

Tax incentives for labour (current expenditures)

a) *Enhanced allowance for R&D labour costs*. Normal income tax treatment of wage/salary expense would provide immediate expensing. Under an enhanced allowance for R&D wage expenses, an R&D performer would be provided with a tax deduction for more than 100 per cent of qualifying current wage/salary costs.

b) *Reduced employer social security contribution (SSC) on gross labour income*. Employer SSC relief may be provided in respect of labour income of employees engaged in R&D activity, for example by lowering the upper gross income threshold beyond which employer contributions are

zero at the margin, or by waiving employer and employee social security contributions in certain cases (e.g. expatriates resident in the host country to perform R&D for a limited period, normally working for a foreign parent company).

Tax incentives for physical capital expenditures

a) *Accelerated depreciation of R&D capital costs*. A common tax incentive for investment in physical capital (machinery and equipment, buildings) used in R&D is accelerated depreciation. By allowing the acquisition cost of capital of a given type (e.g. machinery and equipment) to be depreciated at a faster rate when used to carry out R&D – meaning that depreciable capital costs can be deducted earlier than under normal non-accelerated rules – the present value of depreciation allowance claims is increased. As depreciation allowances are deductions against the corporate income tax base (taxable profit), their value depends on the statutory corporate income rate applied to that base.

To illustrate, consider the case where tax depreciation rules normally allow machinery and equipment to be written off, on declining-balance basis, at rate α. For a firm that is profitable and taxable in each period, so that depreciation claims are not restricted, the present value of the stream of capital cost allowances on one currency unit of investment is given by:

$$uZ_t^{norm} = u\sum_{s=t}^{\infty} \frac{\alpha(1-\alpha)^{s-t}}{(1+r+\pi)^{s-t+1}} = \frac{u\alpha}{r+\pi+\alpha} \qquad (1)$$

where (u) denotes the statutory corporate income tax rate, (r) denotes the firm's real discount rate, and (π) denotes the rate of inflation. The example considers the case where the tax system does not provide for inflation-adjustment of capital costs.1

Where machinery and equipment used in R&D is depreciated at a declining-balance rate α^R that exceeds the rate α applied to non-R&D use, the present value of allowances on one unit of investment is:

$$uZ_t = u\sum_{s=t}^{\infty} \frac{\alpha^R(1-\alpha^R)^{s-t}}{(1+r+\pi)^{s-t+1}} = \frac{u\alpha^R}{r+\pi+\alpha^R} \qquad (2)$$

This relief exceeds that under normal rules (uZ^{norm}), with capital costs written off at a faster rate ($\alpha^R > \alpha$). For a taxable profitable firm, the tax incentive provided by accelerated depreciation is measured by the additional amount of tax relief provided (the difference between the two present value calculations):

$$u(Z_t - Z_t^{norm}) \qquad (3)$$

However, note that the effective purchase price of one currency unit of capital is given by (1-uZ) – that is, the effective purchase price of one currency unit, minus the present value of 'normal' depreciation claims on that purchase (uZ^{norm}), minus the tax incentive $u(Z-Z^{norm})$.

b) *Enhanced depreciation allowance for R&D capital costs*. Normal treatment of depreciable capital costs allows 100 per cent of qualifying investment expenditure to be depreciated. Under an enhanced allowance, more than 100 per cent can be depreciated. Consider an enhanced allowance

for R&D capital depreciated on a declining-balance basis at rate α^R, where the enhancement variable exceeds one ($\theta>1$):

$$uZ_t = u\theta\sum_{s=t}^{\infty}\frac{\alpha^R(1-\alpha^R)^{s-t}}{(1+r+\pi)^{s-t+1}} = \frac{u\theta\alpha^R}{r+\pi+\alpha^R} \tag{4}$$

c) *Volume-based investment tax credit for R&D expenditures*. A volume-based or flat investment tax credit is calculated as a fraction λ of qualifying R&D expenditures (physical capital and in some cases, current expenses as well). For illustrative purposes, consider the case where qualifying expenditures are limited to capital, and let I_t denote expenditures on qualifying physical capital in period t. The volume-based investment tax credit earned in period t is calculated as:

$$ITC_t^{vol} = \lambda \cdot I_t \tag{5}$$

For a volume-based credit, the investment tax credit rate (ϕ) is given by the fraction λ:

$$\phi = (ITC_t^{vol} / I_t) = \lambda \tag{6}$$

As an investment tax credit is not deducted from the corporate income tax base (taxable profit), but rather is deducted against corporate income tax liability, its value does not depend on the statutory corporate income rate.

d) *Incremental investment tax credit for R&D capital costs*. An incremental investment tax credit provides a tax credit (deduction from tax otherwise payable) calculated as a fraction λ of current investment expenditure in excess of investment expenditure in prior years.2 The simplest incremental investment tax credit design is where the reference year is the previous year, in which case:

$$ITC_t^{incr} = \lambda \cdot (I_t - I_{t-1}) \tag{7}$$

The corresponding incremental investment tax credit rate is given by:

$$\phi = \lambda - \frac{\lambda}{(1+\rho)} = \frac{\rho\lambda}{(1+\rho)} \tag{8}$$

Possible targeting dimensions

Tax incentives for current and capital R&D expenditures may be targeted along a number of dimensions. Targeting may involve a separate tax relief instrument applied solely to R&D (e.g. R&D investment tax credit), or may involve a generally applicable tax instrument (e.g. depreciation allowance) that provides *relatively* more generous tax treatment to R&D expenditure than to non-qualifying expenditure.

a) *Research vs. development*. Efficiency may call for targeting research (R) rather than development (D) where available evidence finds that positive spillover benefits are greatest with R, and the main purpose of the incentive is to correct for this positive externality. Where instead the main policy aim is to offset tax impediments to investment expenditure, then targeting R over D may introduce a tax distortion (assuming that R&D performers determine the most productive

investment allocation) and efficiency losses. At the same time, targeting R may significantly reduce the foregone revenue loss of the program. This raises the question of whether it may be desirable, when taking into account efficiency and revenue considerations, to target R and D equally, and possibly at a lower effective rate to contain revenue loss.

b) *Capital vs. labour*. Efficiency may call for a larger subsidy for (physical) capital expenditure than labour costs – that is, providing a larger percentage reduction in the user cost of capital, compared with the user cost of labour – where the main policy aim is to address tax impediments to investment. Where instead the aim is to encourage R&D on account of spillover benefits, then in principle the tax incentive design should not distort a firm's factor input decision. This would call for equal percentage reductions in the user cost of capital and labour to leave capital/labour ratios unchanged from the no-subsidy case.

c) *Small vs. large*. A relatively limited number of large companies may account for the bulk of business R&D spending. Policy makers may be interested in targeting R&D tax relief to small companies – for example, by providing small companies with more generous depreciation allowance and/or investment tax credit treatment – to address financing constraints of small firms, and/or if spillover benefits are perceived to be greater with R&D undertaken by small firms. Small R&D performers may attract inbound merger and acquisitions (M&A), bringing spillover advantages stemming from R&D performed elsewhere. Another possible rationale for targeting small firms is to address information asymmetries which may negatively impact the cost of capital of primarily small firms.

d) *Existing vs. new (greenfield and M&A) investment.* Policy makers may be interested in targeting new investment (e.g. M&A by foreign companies), if evidence suggests that a higher percentage of such investment is additional (due to tax incentive relief), or provides greater spillover benefits.

e) *Sectoral targeting*. In many countries, R&D tends to be concentrated in certain industries. There may be policy interest in targeting these industries, if the likelihood of encouraging additional R&D is greater in sectors that undertake R&D for non-tax reasons (recognizing the higher tax administration costs of monitoring R&D tax claims for firms in all sectors). Alternatively, policy makers may wish to target sectors that are regarded as important to support for economic, security or other reasons, and that undertake substantial R&D, but mostly in other (e.g. larger) countries.

f) *Collaborative R&D (with universities, R&D centres of excellence)*. Where R&D activity tends to gravitate to collaborative R&D activity involving universities, and or other 'centres of excellence', this tendency may be reinforced (and possibly the quality of tax-assisted R&D higher) if such ventures receive public support including tax incentives for private R&D firms.

g) *Foreign branches of resident companies.* R&D by foreign branches of resident companies may generate spillover benefits in the domestic economy, with the output of R&D being the property of resident companies. However, spillover benefits may also be realized by non-resident firms competing in the same market as foreign branches. To the extent that foreign firms are better able to exploit the knowledge and gain a competitive advantage, this may reduce the relative competitiveness of domestic companies.

h) *Resident-owned versus non-resident owned domestic R&D performers*. In the past, parent companies of MNEs have tended to undertake the bulk of R&D for their group. However, data show that R&D activities of MNEs are increasingly internationalized. This may reinforce interest in not excluding non-resident owned companies from R&D incentive programmes. At the same

time, this raises the question of whether non-resident owned R&D performers are likely to exploit the fruits of their R&D at home.

Aside from targeting criteria, other factors that characterize the type of R&D tax incentives include:

- the particular tax that is relieved (e.g. corporate income tax, versus employer social security contributions);
- existence or not of claw-back features that partly withdraw tax relief, by drawing it back into the tax base (or the base of another tax);
- carryover provisions for unclaimed R&D tax incentives, dependent on the incentive type;3
- non-wastable incentives (refundable in cash where they cannot be claimed due to insufficient tax base), versus wastable (non-refundable) incentives;
- incentives with flow-through provisions (enabling the transfer of unused corporate tax incentives to shareholders), versus those without.

2.1.6.2 Tax incentives for R&D income

A common criticism of corporate income tax (CIT) is that it discourages investment in physical capital and other assets relative to the no-tax case, and relative to certain 'neutral' corporate tax system designs with a different tax base (e.g. a cash-flow tax). Tax distortions to investment in physical capital under a basic CIT may be alleviated by reducing the statutory CIT rate. It may be necessary to attract mobile R&D activities or to maintain their existing levels.

Box 3. The PATENT BOX in the Netherlands

The favourable tax treatment on intangible income was introduced in 2007 and is an optional system. The Dutch company must have a patent from which it derives net earnings. The patent itself can be Dutch, European or foreign but it must have been developed by the Dutch corporation which bears the corresponding risks. The net earnings derived from self-developed intangible assets – patented intellectual property – is taxed at a corporate tax rate of 10 per cent. The amount of net earnings (royalties or profits from the sale of the patent) that can benefit from the reduced rate in the patent box is capped at four times the total amount of R&D development costs of all intangible assets allocated in the box. Profits earned by using the patent are included in the patent box if the patent has contributed at least 30 per cent to these profits. Recently, the patent box has been extended to also include certain limited revenues obtained from innovative activities, without the creation of a patent. In that case, a R&D declaration is required to be eligible.

In the Tax Plan 2010 the patent box system was converted to an innovation box, as the patent box system was found to be not very efficient and too complicated. The basic rules of the patent box remain the same. It is still optional and a Dutch company still needs to obtain a patent or R&D declaration for IP that is self-developed or has been developed for the Dutch company which bears the corresponding risks. All applicable ceilings – e.g. the cap at four times the total amount of R&D development costs and the applicable limitations with respect to the revenues obtained from innovative activities related to a R&D declaration – are withdrawn. In addition, the reduced rate has been further lowered to 5 per cent on qualifying income from R&D.

Examples of low/reduced tax rates on income derived from R&D include:

- a targeted preferential tax rate on royalty income earned on the licensing of intangible property (e.g. a reduced tax rate on foreign royalty income).
- targeted tax relief provided by a reduction in the corporate income tax rate applied to profits derived from sales of new products/processes – in practice such an approach may be impractical,

imposing significant tax administration and compliance costs, given difficulties in measuring income from innovation. See BOX for the Patent Box system in the Netherlands;

- non-targeted tax relief provided by a reduction in the basic corporate income tax rate on profits derived from new products/processes, where the reduced CIT rate applies other forms of income and possibly broadly to all types of business income. For instance, tax holidays or exemption on a proportion of profits or over several years since the R&D investment is undertaken.

Targeting CIT relief to R&D performing firms may be attractive to policy makers for a number of reasons. First it could limit the amount of foregone tax revenue. Second, targeting R&D performing firms may be an attractive pro-growth strategy, recognizing that R&D and innovation are critical to production efficiency gains and economic growth.

2.1.7. The valuation of intangible assets

Intangible property valuation has become an important tax issue in modern knowledge economies. There is an increasing need to explore further how various EPO (European patent office) and non-EPO countries apply valuation guidelines set by the OECD and by accounting standards organizations, how effective these guidelines are and which other administrative guidelines from national governments are available to help determine the value of intangible property for business and tax purposes.

Compared to other investments, intangibles – such as patents, knowledge, trademarks – show some particular risky characteristics that make assessing their value quite sensitive to volatile variables and uncertainty. One should also keep in mind that multinationals can ensure that new IP is owned wherever desired, regardless of where the activities giving rise to that IP are carried out. Therefore, the bigger the role and the value of the IP in the business, the stronger the impact of changing its location on the allocation of the MNE's taxable income among its affiliates.

The OECD is currently undertaking work to improve the valuation guidelines of intangibles. This work is welcomed by the business community and national governments, especially because the valuation of patents and other intangibles following the arm's length pricing principle is currently not fully developed and lacks transparency. It is commonly recognized that determining whether transfer prices – related to intangible transactions – respect the arm's length standard set by OECD Model Tax Convention is often difficult both for multinational enterprises and for tax administrations. This is mainly due to the natural uniqueness of most intangibles, which makes the application of the comparable pricing or transaction methods more difficult and which leaves a lot of uncertainty for both enterprises and government authorities. Hence, while the value of the intangible is prone to negotiation, it offers income shifting opportunities to multinational enterprises in the case of intangible-related transactions, including sales/ purchases of intangibles and payment for services provided under cost sharing agreements.

What is the value of the IP, as for instance a patent, that a firm is self-developing from an economic perspective? Before the firm obtains the actual patent, one might argue that the value of the IP equals the sum of the historical input costs. This can be considered to be a backward looking approach. Once the firm obtains the patent, its value equals the expected present discounted value of the increase in profits as a result of the use of the patent in the firm's production process, the royalty payments that the firm receives in licensing the patent or because the patent is sold. This can be considered to be a forward looking approach. Note that in this case the value of the patent is independent of the historical input costs, which are sunk costs. However, this forward looking approach can also be used to determine the value of the patent before the firm successfully finalizes the intangible investment process and actually obtains the patent. However, in that case, one might argue that the value of the patent equals the present value of the *expected* increase in profits resulting from the successful creation of the patent measured net of R&D input

costs. In this way, the input costs are part of the value of the developing patent as they are not yet sunk costs.

Note that the value of IP from an economic perspective has an impact on the value of the economic depreciation of the asset. Some authors have argued that there is the danger of double expensing and depreciation of R&D input costs, first when the inputs related to the R&D activity are immediately expensed and second when the same costs are capitalized in the intangible asset value and amortized. This seems however not to be correct. The value of IP depends on the expected increase in profits *net* of the historical costs before the patent has been obtained. Moreover, in this case, the asset will not have to be amortized. Once the patent has been obtained, the value of the IP might have to be depreciated over time but in that case, its value no longer depends on the historical costs.

2.1.8. Challenges from investing in R&D in an international environment

This section explores first firms' behavioural effects derived from R&D tax provision and relief when companies undertake innovative investment in a global environment. Afterwards, it considers cross-border transfers of intangible capital and in particular of intellectual property (i.e. patents, software, etc.) in light of ongoing tax competition amongst countries. The third sub-section briefly discusses empirical evidence and figures on the migration of the location of intellectual property and on the ratio of Technological receipts/Business R&D expenditure. Finally, the section provides some common examples of IP tax planning strategies implemented by MNEs and SMEs aimed at lowering the net cost of R&D expenditure and minimizing the tax burden on profits using intangible assets.

2.1.8.1. Firms' behavioural effects: Tax driver of R&D.

Firm's innovative investment decisions - from undertaking research and development to the choice of the location of its intellectual property - will be affected not only by the available domestic and foreign R&D tax provisions, including the tax relief for R&D expenditure and the tax depreciation rules for purchased IP, but also the application of domestic and foreign tax systems to returns on investment and the way that these tax systems interplay.

The firm's investment decision with respect to Intellectual Property, knowledge, patents or trademarks, consists of two stages, as discussed in relation to Figure 1. In the 'research and development' stage, R&D activities are carried out and R&D expenditures and costs are incurred. In the second phase, the Intellectual Property, knowledge, patents and trademarks are used in the production of goods and services that are sold on the market or can be given in licence or sold. In this second stage, the intangible assets create a stream of income. Firms will consider the tax benefits and the tax burden both on the cost and the income side. Thus, the decision on where and how to undertake R&D activity will be influenced by R&D expenditures and related tax provisions granted in particular jurisdiction, whereas the choice of the IP location, and therefore partly also where the R&D has taken place, may depend also on the tax treatment of the return generated by the intangible assets.

In addition to non-tax factors that influence the decision of where to undertake R&D (e.g. the available infrastructure, the quality of the labour force), a firm's decision on innovative investments and the location of the intellectual property is affected by the amount of R&D tax provisions and credits, as well as by a number of other important tax arrangements and provisions. The corporate tax in the residence and host country – for instance if the firm invests abroad or transfers its IP to a foreign holding company, the tax treatment of dividends, capital gains, interest and royalty income – not only at the corporate level but possibly also at the intermediary and personal bondholder/shareholder level, and the rate of withholding taxes in the residence and host country may also have an influence. Other regulatory tax schemes that play a role are the presence of double tax treaties and, where applicable, the EC Interest and

Royalties Directive, the presence of CFC rules or other anti-avoidance rules, the transfer pricing rules in the residence and host country and the tax rules regarding cost sharing agreements.

Intellectual property rights are often created in relatively high-tax jurisdictions. As a result, tax departments in multinationals (and their advisers) frequently look at ways of structuring operations in an attempt to reduce the overall tax burden, usually involving a number of territories and the transfer of, or the creation of an interest in, intellectual property. Profit migration, which is an important part of MNEs tax planning activities and strategies, shifts profits that are generated in high-tax jurisdictions to lower tax jurisdictions (with profit shifting being that portion of a corporation's profits that legally and within risk tolerances can be migrated to lower-tax countries). Note that profit migration might also involve the shift of technology and service jobs to countries like India, Belgium, Netherlands, Ireland or Singapore, where MNE's can take advantage of lower labour and operating costs and/or favourable tax treatment.

Multinationals can develop IP so that it's owned in a high-tax jurisdiction in order to maximize the deductibility of the R&D expenditure and accept that future profits will be taxable at high rates in that jurisdiction. Alternatively, future profits will be taxed at low rates but R&D expenses will be deductible at lower effective rates if an IP company undertaking R&D and exploiting IP is located in a low-tax jurisdiction. This strategy will be less attractive if the probability of failure with respect to the development of IP is very high. In that case, companies may prefer to apply losses against taxable income in a high-tax country. This consideration has become increasingly important as a result of the global economic and financial crisis that has increased the losses of many companies. A strategy that would minimize the tax burden would of course be to develop the IP in a high-tax country but to migrate it at the lowest tax cost possible to a low-tax jurisdiction once the IP has been created (Russo (2007)) and started producing taxable income.

2.1.8.2. The tax impact on outbound and inbound transfers of intellectual property (IP)

Tax policy makers are encouraged to provide an enabling tax structure for transfers of intellectual property (e.g. through licensing agreements), both outbound and inbound. Outbound intellectual property (IP) transfers expand profit opportunities for domestic R&D performers, while at the same time expand profit opportunities for IP recipients abroad that profit from accessing foreign IP for their production purposes. Similarly, inbound IP transfers enhance profit opportunities for domestic firms that find it more efficient to license (or purchase) IP developed abroad, rather than developing the IP internally.

Outbound intellectual property transfers

Outbound IP transfers may be encouraged through a number of tax-related channels:

- wide network of tax treaties, accessing moderate non-resident withholding tax rates on royalties.
- moderate corporate tax rate, flexible foreign tax credit system.
- cost sharing agreements and similar structures.

On the demand side, most IP importing countries charge withholding tax to foreign IP licensors, levied at a statutory or treaty-negotiated rate on (deductible) royalty payments made by resident IP users/licensees. Relatively high withholding tax rates on royalties paid to foreign IP providers/licensors, for the use of IP, tend to discourage (outbound) transfers to those countries. Depending on the market for the underlying intangibles, the tax burden may not be on an IP provider/licensor legally responsible to pay the tax, but on the IP user/licensee. In particular, the tax burden may be shifted back to the IP user, through higher royalty charges to cover the withholding tax charge. Where arrangements (e.g. tax treaties)

mitigate withholding tax, the royalty charge may be less, with reduced costs implying a more active IP transfer market.

A wide network of bilateral tax treaties that secure moderate non-resident withholding tax rates on royalty payments provide a direct mechanism to minimize the potential tax burden of withholding tax on IP licensees. Therefore, by pursuing an enabling tax treaty network, policy makers encourage IP transfers (where secured bilaterally, reduced withholding tax rates tend to encourage tax-planning, calling for domestic tax base protection rules – see the discussion below on inbound IP transfers).

On the supply side, where scope exists for IP providers/licensors to reduce net domestic income tax paid on foreign royalty income, IP providers may find it more profitable to license into foreign markets, and to do so by licensing directly from their home country. Under competitive market conditions, some part of domestic tax relief may be passed forward to reduced royalty charges, implying a larger foreign market.

Net domestic tax on royalty income is reduced with a reduction in the general corporate income tax rate. Some countries may decide to target a reduced tax rate to foreign royalty income, despite complications arising from this approach. Other arrangements could include flexible 'foreign tax credit' rules designed to avoid double taxation of foreign income – one example is allowing 'excess foreign tax credits' on relatively high-tax foreign dividend income to offset domestic tax on foreign royalty income (e.g. as under U.S. foreign tax credit rules).

Net domestic tax on foreign royalty income may also be reduced through cost sharing agreements and similar structures involving the use of an offshore IP holding company to avoid or at least defer paying domestic tax on foreign royalty income. Such structures may also permit reductions in net domestic tax on domestic income (e.g. where an IP holding company lends offshore profits to a domestic R&D performer). Such tax relief may be viewed as excessive, in particular where IP developers are given generous tax assistance in undertaking R&D leading to the creation of IP. In such cases, interests in protecting the domestic tax base while also avoiding other tax distortions may understandably limit the amount of tax relief in respect of foreign royalty income accruing offshore that governments are prepared to provide.

Inbound intellectual property transfers

Inbound IP transfers may be similarly encouraged through tax-related channels:

- moderate non-resident withholding tax rate on royalties.
- moderate corporate tax rate (general rate)

On the demand side, inbound IP transfers are generally impeded by a relatively high withholding tax rate on royalties paid to foreign IP providers. In particular, the tax burden may be shifted back to domestic IP users/licensees through higher royalty charges, to cover the withholding tax. This suggests a moderate statutory withholding tax rate, and depending on that rate, possible interest in negotiating with tax treaty partners a reduced rate to apply bilaterally. Where arrangements (e.g. tax treaties) mitigate withholding tax, the royalty charge may be less, with reduced costs implying a more active IP transfer market.

Where the withholding tax rate is reduced in country A, tax-planning incentives are generally greater for foreign licensors to artificially increase royalty charges to related domestic affiliates (licensees) in country A (in particular where royalties are paid to a tax haven IP holding company) in order to shift taxable profit out of country A. At the same time, the incentive to actively increase royalty charges are greater, the higher is the statutory corporate income tax rate (providing an additional reason to avoid a high income tax rate/narrow tax base approach).

Thus policy makers are encouraged to ensure that relatively low royalty withholding tax rates are accompanied by robust transfer pricing rules and administrative procedures to guard against the use of non arm's length transfer prices on intangibles. Where the tax administration is insufficiently *resourced* to enforce such rules (e.g. given difficulties in finding comparable, arm's length prices that should apply on related party transactions), greater caution may be called for in lowering royalty withholding tax rates.

2.1.8.3. Shifting the location of intellectual property: empirical evidence

Table 1 shows the number of patent applications filed in selected countries in the period 2005-2007. This information is obtained from WIPO – the World international Patent Office – and draws on the data that the applicant is obliged to provide when filing a patent.

Table 1. Patent ownership, 2005-2007

Residence of the applicant	Total applications filed and patents owned by companies resident in the country	Patents with foreign inventors only and no co-ownership[1]	
Brunei Darussalam	12	12	*100%*
Barbados	760	739	*97%*
Seychelles	20	18	*90%*
Bahamas	86	77	*90%*
Gibraltar	15	13	*87%*
Cayman Islands	94	81	*86%*
Bermuda	309	258	*83%*
Cyprus[1]	153	126	*82%*
Liechtenstein	209	158	*76%*
San Marino	17	12	*71%*
Mauritius	18	12	*67%*
Panama	63	42	*67%*
Luxembourg	456	286	*63%*
Malta	39	21	*54%*
Ecuador	13	6	*46%*
Hong Kong, China	70	31	*44%*
Monaco	41	18	*44%*
Virgin Islands (British)	628	236	*38%*
Puerto Rico	24	9	*38%*
United Arab Emirates	46	17	*37%*
Switzerland	10,366	3,529	*34%*
Ireland	1,113	348	*31%*
Netherlands Antilles	336	104	*31%*
Chinese Taipei	370	108	*29%*
Belgium	2,936	691	*24%*
Sri Lanka	5	1	*20%*
Saudi Arabia	142	27	*19%*
Costa Rica	16	3	*19%*
Iceland	153	28	*18%*
Finland	5,285	898	*17%*
Singapore	1,311	178	*14%*
Venezuela	9	1	*11%*
Portugal	186	17	*9%*
Lithuania	33	3	*9%*

Malaysia	167	14	*8%*
Denmark	3,234	251	*8%*
Canada	7,195	471	*7%*
United Kingdom	15,408	994	*6%*
United States	141,729	8,874	*6%*
Viet Nam	17	1	*6%*
Austria	3,084	167	*5%*
Norway	1,711	92	*5%*
Germany	48,556	2,578	*5%*
Czech Republic	340	18	*5%*
China	10,344	406	*4%*
Australia	5,848	223	*4%*
Hungary	417	15	*4%*
Bulgaria	59	2	*3%*
Slovenia	231	7	*3%*
Italy	7,114	168	*2%*
Spain	3,181	73	*2%*
South Africa	1,064	23	*2%*
Israel	4,498	94	*2%*
India	2,108	44	*2%*
Croatia	194	4	*2%*
Mexico	414	8	*2%*
Egypt	109	2	*2%*
Korea	15,582	261	*2%*
Russian Federation	1,625	27	*2%*
New Zealand	981	15	*2%*

Note: "Footnote by Turkey: 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. Turkey recognizes the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of United Nations, Turkey shall preserve its position concerning the "Cyprus" issue."

Source: OECD, Patent Database, April 2009.

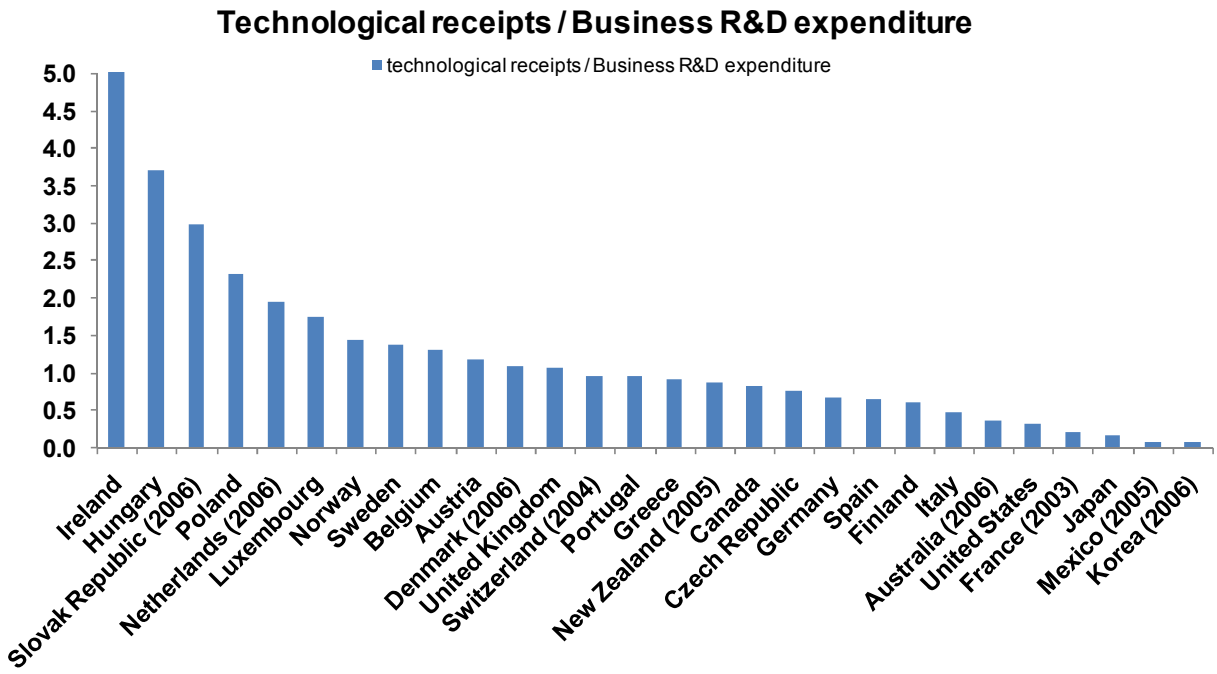
The second column shows the total number of patents that are filed by entities, usually firms, which have their legal residence in a particular country. The following columns highlight respectively the number and the share of these patents whose inventors do not reside in the country where the patent is filed. In the United States, for instance, 141,729 patents have been filed in the period 2005-2007. About 6 per cent of these patents have been invented by foreign businesses. For example, IBM-US has filed a patent that has been invented by an IBM lab in Germany.

The percentage of foreign investors is usually interpreted as an indicator of the internationalization of R&D. However, a careful analysis of the data – notably of the countries in grey – shows that this interpretation might be dubious. Many of the countries that have a high share of patents invented by foreign businesses are low-tax countries with no track records regarding innovation. This might indicate that IP location is driven by tax-minimizing purposes.

Additional information would be required further in order to determine the number of patents of each OECD member country that is held in a particular low-tax country. This analysis might reveal the importance of IP tax shifting in OECD countries, and might indirectly reveal the application of particular favourable tax treaties between countries, the absence of strict CFC regulations, the use of hybrid entities

by MNEs, the presence of attractive R&D tax incentives and frequent tax planning strategies. However, the data that is currently available does not include patent values, which strongly limits the type of analysis that can be undertaken. Better quality data is therefore required. One way to proceed would be to study information from the Technology Balance of Payments and for instance the outbound royalties and in particular the royalty flows towards low-tax countries for each country (and by affiliation). An interesting indicator is the ratio of technology (e.g. royalty) receipts divided by the amount of R&D carried out in a country, as shown in Figure 2. More explanation on the underlying data can be found in Annex 1.

Figure 2. Ratio of technological receipts and the business R&D expenditure.



Source: OECD, PB ratio from Technology Balance of Payments and from joint OECD/Eurostat questionnaire, October 2009

This data is obtained from the Technology Balance of Payments and shows a ratio which indicates the amount of technological income (technological receipts) from foreign countries compared to the R&D expenditure incurred by resident enterprises in carrying out R&D activities. A ratio exceeding 1 (e.g. Ireland, Hungary, Netherlands, Luxembourg) implies a high amount of technological income compared the corresponding amount of R&D activities undertaken within the country, and may reveal tax induced cross border transactions and tax planning. A limitation of this ratio is of course that it compares income and expenditure in the same year, while current R&D investments may only earn income in the future.

2.1.8.4. Tax-planning with intellectual property

IP Tax planning and MNEs

To remain competitive today MNE's executives make tax issues and strategies a part of their decision-making process, with tax incentives and disincentives potentially influencing a company's structure and activities across jurisdictions. Given the increasing importance of IP, as a value and as tax driver, special consideration is normally given to IP in the development of a MNEs global tax strategy.

Business evolution and product/service expansion is often driven by investment in and/or acquisition of technologies (patented processes) and brands and for many companies these assets are major profit drivers and therefore major tax drivers. Intellectual properties are often developed and owned in the parent company jurisdiction or other high-tax jurisdiction. IP ownership may be highly centralized or decentralized and the legal ownership may or may not coincide with the beneficial or economic ownership and intercompany transfer pricing policy may not properly reflect and reward the true economic or beneficial owner of key intangibles.

Multinationals can ensure that new IP is owned wherever desired, regardless of where the activities giving rise to that IP are carried out. In fact, multinationals have different ways at their disposal to transfer technology between subsidiaries of the same group. For instance, multinationals can use R&D companies to carry out R&D on a "contract research" basis on behalf of an "IP company". The latter pays to the R&D company a fee for the research services provided which will not be high (equal to the costs occurred, increased by an arm's length mark-up) because it will be the IP company who bears the risk that the R&D may not lead to an intangible of high value and who pays for the costs of financing the development of the IP (Russo (2007)).

In order to maximize the use of R&D tax provisions and to minimize taxes, different companies of a multinational group might participate in the development of IP under a so-called "cost-sharing agreement". All companies will then pay a part of the development cost on the basis of a pre-agreed split of the costs and will share the ownership and the right to use the IP. The companies engaged in a cost sharing agreement benefit from sharing costs (economy of scale) and risks of the R&D project and from receiving in exchange the right to exploit the technology at a favourable price.

An increasing popular strategy is a cost sharing agreement between a parent and an entity located in the tax haven, where once technology is developed, both companies acquire the rights related to the use of it, having shared in the costs. However, the parent adopts the IP in its own business (without paying fees or royalty as it is one of the beneficial owners), while the tax haven entity can license an operating sibling in a high-tax location (as it has acquired the rights to exploit the technology abroad).

Note also that in most cases, the pure legal ownership of the IP – for instance the registration of a patent – will normally be in the name of one company. However, this type of ownership is usually not relevant for tax purposes.

Some recent studies (Grubert, Mutti (2007)) have pointed out that a cost sharing agreements typically completed with the creation of a hybrid entity structure. A hybrid entity is an entity that is incorporated from the host country's point of view, and a branch from the parent home country's perspective, or vice-versa. This distinction allows MNEs to avoid immediate taxation of inter-subsidiary payments that would otherwise occur under the anti-abuse Controlled Foreign Company (CFC) provisions. The result is that deductible royalties paid to a tax haven hybrid entity will not be subjected to immediate tax and a greater share of the R&D return is left abroad in a low-tax location.

Another common device is to take successful, patented ideas in a high-tax jurisdiction, possibly providing generous R&D expenditure relief, and then develop new generations of them – with the help from an offshore research division. The ownership of the new version (and profits of licensing it) can then legally be shared between the parent company and the firm's offshore unit. The question is how those profits (and royalties) are shared and what price the parent company receives when it transfers the intellectual property to its offshore subsidiary. Tax codes usually follow the OECD's arm's length pricing guidelines, requiring that tax codes require that prices charged by one affiliate to another, in an intercompany transaction involving the transfer of goods, services, or intangibles, yield results that are consistent with the results that would have been realized if uncontrolled taxpayers had engaged in the same

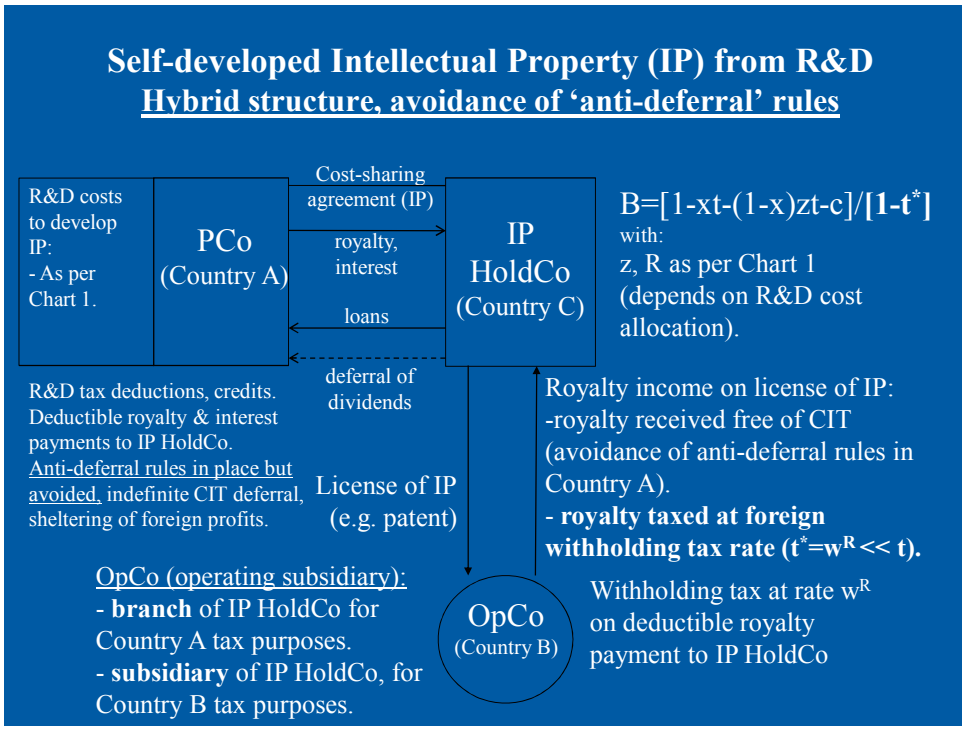
transaction under the same circumstances. However, determining fair terms for inter-affiliate transactions involving intangible assets involves a great deal of subjective judgment, so those determinations are a constant source of conflict between companies and the fiscal administrations in many countries.

The ownership of IP might be transferred to another legal entity (a conduit holding company) in order to better manage and exploit it or (ab)use double tax treaties, for instance enabling access to the EC Directives and/or tax treaty network reducing withholding taxes on royalty flows. Under this kind of cross-border tax planning, a taxpayer acts through a legal entity created in another country such that it obtains treaty benefits that would not be available to the taxpayer directly.

A graphical illustration of an example of IP tax-planning using a 'hybrid' structure

Figure 3 shows how IP tax-planning opportunities could be structured. Tax planning will clearly lead to a greater volume of intercompany transactions. The illustration shows a triangular structure, involving an intermediate affiliate typically located in a tax haven (country B). The strategy of locating the IP in a tax haven aims at reducing the host country tax base (country C). These tax-planning strategies are usually more attractive if country A's anti-deferral rules can be circumvented.

Figure 3. Self-developed Intellectual Property (IP) from R&D
Hybrid structure, avoidance of "anti-deferral" rules



In the illustration, a parent company (PCo) in country A injects equity capital to establish a wholly-owned intermediate subsidiary (IP HoldCo) in a tax haven (country C) to provide conduit financial and licensing intermediation. The intermediary (IP HoldCo) is capitalised by the parent (PCo) with equity to avoid home country tax on interest income and invests the funds in an operating subsidiary (OpCo) in country B. The latter may be the branch of IP HoldCo for country A tax purposes or a subsidiary of IP HoldCo for B tax purposes. IP HoldCo is shown to licence both to OpCo and to the parent PCo an

intangible property (e.g. a patent), which may have been transferred to IntCo under a cost sharing agreement.

The intermediated structure provides tax savings to PCo on its multinational operations; the structure allows the firm to avoid home country tax on foreign interest and royalty payments. The parent company enjoys R&D tax deductions and credits and can deduct royalty and interest payments that are made to IP HoldCo. This structure allows avoiding the anti-deferral rules as, for instance, the parent country's CFC rules. Profits can therefore be held off-shore. In addition, the firm will face tax-induced incentives to over-charge on the royalties that are paid to IP HoldCo in order to maximize the tax savings. The use of non-arm's length prices will increase the profits that are shifted to the low-tax country.

IP tax planning and SMEs

Tax planning, especially with respect to IP, has been the play ground of multinationals for many years. Recently, however, more and more SMEs have started using the tax-planning techniques that have been developed for MNEs. These tax planning techniques have become affordable also for SMEs. This will put corporate tax revenues further under pressure in the future.

Practitioners and tax advisors use the web to attract clients for the tax planning services they provide. These consultancy firms offer support in managing IP and devices that may often go beyond a pure legal tax planning strategy. It involves cross border transactions between high-tax jurisdictions and a tax haven, which typically does not exchange information with foreign tax administrations and allows the creation of businesses and legal entities while keeping anonymous their shareholders.

Information on the following tax planning strategy has been found on the internet by the Italian Internal Revenue. A company that resides in a high-tax jurisdiction, where its market is located, outsources to a foreign consultancy firm the creation of an intangible (a brand) as well as the task to conduct a market survey. The company then starts paying tax deductible service costs to the consultancy firm. The resulting intangible is filed and owned by an IP holding company resident in a tax haven, created only for tax purposes with the help of the consultancy firm. This newly created company has the same shareholders as the outsourcing company, although this information is not known by the high-tax country's tax administration. This company usually does not have any real economic substance or any real presence in the tax haven.

The foreign consultancy firm owns and makes available a royalty conduit company that will intercede in transactions between the owner of the intellectual property rights (e.g. the brand owner in the tax haven) and the final user of those rights (i.e. licensee of the patent) with a view to circumvent fiscal disadvantages. Therefore the conduit company helps to hide from the high-tax country's tax administration that the transaction occurs directly between the company located in the high-tax jurisdiction and the tax haven IP holding company. Otherwise anti-avoidance rules would prevent the deductibility of the royalty payments and high withholding taxes would apply.

The IP formal owner (the IP company located in the tax haven) licenses the intangible to the conduit company that sub-licenses it to the company that resides in the high-tax jurisdiction. Because the conduit company is located in a no/ low tax jurisdiction, eligible for treaty benefits, the royalty payments will be deductible in the high-tax location, which levies also a low royalty withholding taxes because the presence of a double tax treaty network, and subject to no or a low rate of corporate income taxation in the tax haven.

Afterwards, the company in the high-tax jurisdiction buys the intangible asset from the IP holding company, again through the conduit company. This strategy allows the firm to reduce its tax liabilities as

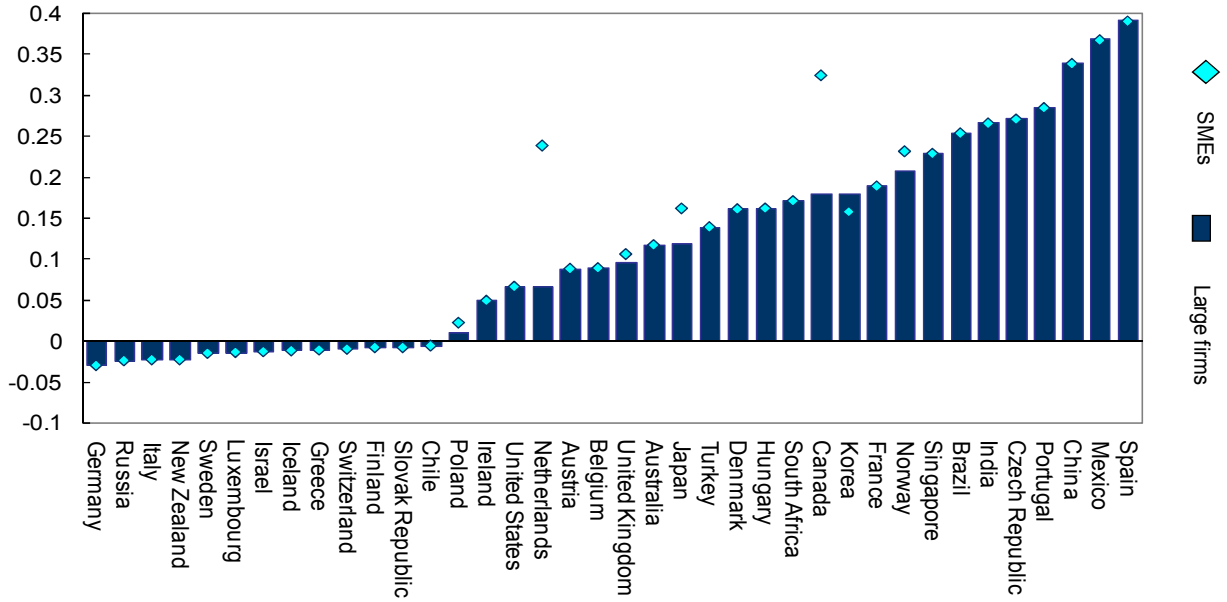
the purchase costs will be deductible in the high-tax country, while it shields a large part of its profits offshore (the funds will be accumulated in a financial institution located in the tax haven characterized by bank secrecy). Moreover, this type of transaction apparently occurs between unrelated parties and therefore escapes CFC regulation as well as transfer pricing rules.

2.2. Tax policy indicators for R&D: measuring the impact of R&D tax provisions

Many countries provide generous R&D tax provisions in order to stimulate innovation. A proper evaluation and the design of improved or alternative R&D tax provisions requires tax indicators which show how generous the available provisions are from firms' perspective and a framework which incorporates the interplay between the tax and other relevant economic variables.

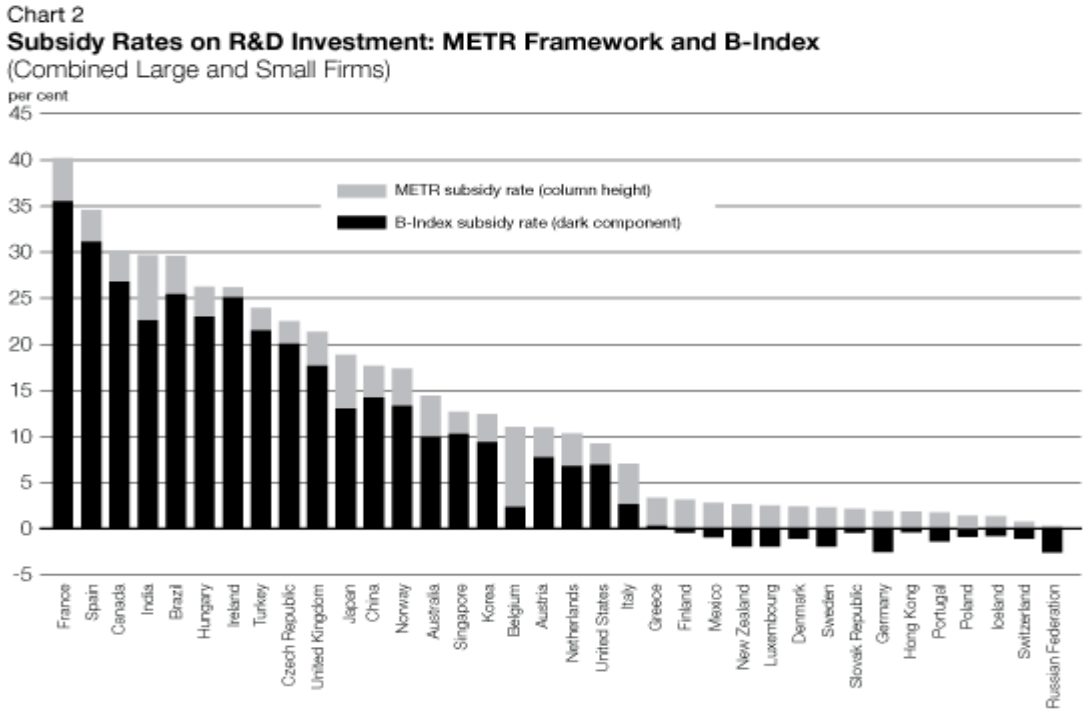
This section therefore discusses the main tax indicator frameworks that are applied in the literature to assess tax assistance to investment in R&D: the B-index, the user cost of capital/marginal effective tax rates framework and the average effective tax rates framework. With regard to the analysis of them, the main assumptions and the caveats are discussed. Figure 4 shows an application of these frameworks, ranking OECD and non OECD countries according to the B-index (rate of tax subsidy on R&D investment) for SMEs and large firms. Figure 5 shows both the B-index and METR subsidy rate for large and small firms combined.

Figure 4. Rate of tax subsidies for USD 1 of R&D investment, large firms and SMEs, 2006-2007



Source: OECD Science, Technology and Industry, Scoreboard 2007. Note that in Figure 2 the index does not account R&D incentives provided at the provincial/state level in case of federation system, such as Canada or U.S.

Figure 5. Subsidy Rates on R&D investment: METR framework and B-index



Source: Department of Finance - Canada, publication on "Tax expenditure and evaluation 2009". More details about this study can be found at the following web site: http://www.fin.gc.ca/taxexp-depfisc/2009/taxexp0902-eng.asp#part2 .

2.2.1. The B-index

The B-index is defined as the present value of before-tax income necessary to cover the current and capital cost of R&D investment and to pay the corporate income tax on the return of the investment, so that it becomes profitable to perform research activities. Algebraically, the B-index is equal to the after-tax cost of an expenditure of current unit on R&D divided by one minus the corporate income tax rate:

$$B-index \quad = \quad \frac{(1-A)}{(1-\tau)}$$

$A = xt + yzt + c(1- \tau)$

Where:
x = proportion of current R&D expense;
y = proportion of capital R&D expense;
z = present value of tax depreciation allowances;
c = tax credit.

The after-tax cost is the net cost of current and physical capital costs in undertaking R&D (excluding financing costs), taking into account all the available tax incentives, where "A" is the net present discounted value of depreciation allowances, tax credits and special allowances available for R&D assets and "τ" is the statutory corporate income tax (CIT) rate. It's worth noting that it does not account for

deductions allowed for interest payments on loans. The amount of tax subsidies to R&D is then calculated as 1 minus the B-index – lower B-index values indicate more favourable tax regimes, or:

$$Rate\ of\ tax\ subsidies \quad = \quad \frac{A-\tau}{(1-\tau)}$$

The B-index model can include many components of the R&D cost structure and applicable tax provisions (Warda (2005)):

- Current R&D expenditure, including wages and salaries of R&D personnel and the cost of materials used in the R&D process,
- Capital expenditures (the cost of machinery and equipment, facilities and buildings) incurred in R&D investment that can be immediately expensed,
- Capital expenditures that have to be depreciated, usually over the useful life of the capital input,
- Additional tax allowances on R&D expenditure: these provisions allow firms conducting R&D to deduct more from their taxable income then they actually spend on R&D,
- Tax credits that are applied against income tax payable,
- Does not capture the considerations related to depreciation of the output of the R&D.

Immediate expensing as the benchmark

In case the cost of investment is immediately expensed and there are no additional R&D tax incentives, the value of "A" will be equal to the statutory CIT rate "τ", implying a value of the B-index equal to 1 and therefore 1-B will equal 0. At first sight, this seems to imply that the tax system does not provide generous R&D tax provisions as the value of the tax subsidies equals 0. However, this is not correct as the benchmark of the B-index refers to immediate expensing which implies a favourable tax treatment compared to the tax treatment of other investments that have to be depreciated over time.

On the other hand, the corporate tax literature shows that immediate expensing, as for instance implemented under a corporate cash-flow tax, is optimal because it implies that the normal rate of return on investment is not taxed under the corporate income tax. The firm's marginal investment decision will therefore not be distorted. As a result, having immediate expensing as the benchmark in the B-index is therefore not as strange as it might look at first sight. However, the B-index ignores financing: immediate expensing and tax deductions for the cost of debt constitute an overall tax incentive for R&D.

Notice that in the case of R&D investment, immediate expensing of the R&D investment inputs does not necessarily imply that the costs of these inputs would have to be immediately deductible when these costs are incurred. Because firms might invest over a number of years before the R&D investment leads to an intangible that will increase profits, the immediate expensing of the inputs could be postponed until the intangible starts being used and starts generating profits.

Shortcomings of the B-Index

The B-index is a tool for comparing the generosity of the tax treatment of R&D in different countries. However, its computation requires some simplifying assumptions. The main shortcomings are summarized below:

- The B-index assumes that the return on R&D investment is taxed at the statutory CIT rate, for instance ignoring the mobile nature of IP (e.g. patents) and tax planning mechanisms to avoid taxes; this argument will be further developed below. In fact, some countries may offer no R&D tax incentives but compensate for this by taxing investment income very lightly. By using the domestic CIT rate, the B-index considers a closed economy case and ends up over-estimating the tax burden on R&D activities as the tax gains as a result of cross border tax planning are not considered.

- In the B-index, the effective impact of R&D tax allowances (proportion of the current and capital R&D expenses) on the after-tax cost of R&D is influenced by the level of the CIT rate. The level of the statutory corporate income tax rate affects the value of the accelerated deductions and the amount of taxes paid on income generated by successful R&D. The higher the tax rate the lower the after-tax cost of R&D. This might sometimes give the impression that having a high corporate income tax rate is beneficial to the firm. In fact, if tax depreciation allowances exceed 100 per cent of the total R&D expenditure, an increase in the CIT rate will reduce the B-index, indicating a more favourable treatment. For countries with less generous R&D tax treatment, the B-index is positively related to the CIT rate such that an increase in the CIT rate yields a lower positive effect in terms of a reduction of after-tax costs compared to the negative effect due to the tax burden on R&D income. The B-index considers investment at the margin and does not reflect the tax treatment of infra-marginal investment and profits.

- The framework assumes that all investment in R&D should be expensed and does not consider the tax treatment of the cost of financing as the tax deductions for debt financing are not included.

- The framework assumes that there is no tax exhaustion; i.e. that the "representative" firm has taxable profits that are large enough to claim the total amount of R&D tax benefits and credits that are available in the current year. The approach does not allow for loss carry forward or carry backward provisions in case R&D tax provisions cannot be claimed in the current year.

- The B-index ignores the differences between tax and economic depreciation of capital costs; the economic depreciation of the capital cost is not included in the framework. Extending the index to include tax depreciation allowances that differ from immediate expensing in the variable 'A' would only partly solve the problem, (as the tax depreciation would not be seen in relation to the economic depreciation of the asset) as differences between true tax and economic depreciation would not be assessed in relation to the true tax treatment of finance.

- In case of incremental R&D tax credits, the B-index assumes that the marginal investment benefits from the R&D tax credit. This would not necessarily be the case if the firm is not increasing its total amount of R&D compared to the R&D in past years.

- The B-index cannot be used to assess the efficiency of the tax system; the index cannot be used to study the degree to which total investment and the composition of investment is distorted by the tax system.

- Positive values of "1 minus the B-index" can be easily interpreted as a result of the immediate expensing benchmark. However, negative values cannot. A negative value can imply that tax depreciation allowances are more generous than the economic depreciation of the intangible but the number could also imply the opposite.

- The B-index focuses only on firms that can finance their investment on the worldwide capital market – only the discount rate and the corporate level taxes and provisions are incorporated. For

other firms relying on local sources of finance, capital income taxes at the personal shareholder level will play a role. These taxes cannot be included in the B-index.

- The B-index focuses only on capital income tax incentives and not on the labour cost tax incentives, which is especially important in the case of investment in R&D.

Overall evaluation of the B-index

Although the B-index is widely used, as it provides an indication of the degree of tax assistance in undertaking current and capital expenses, the index excludes many important economic and tax variables (Adéa, Lester and Warda (2008)). The absence of the economic depreciation rate of capital costs, the assumption of immediate expensing and the fact that the index cannot consider the impact of the deductibility of interest payments, for instance, implies that the index oversimplifies the assessment of tax-induced benefits in undertaking R&D activities. By ignoring tax and economic depreciation and financing, the B-index can't be used to assess neutrality or whether the tax system distorts R&D activities. The B-index should therefore not be used to evaluate and design R&D tax policy as it simplifies the tax treatment and returns on R&D.

Alternative indicators should therefore be used to measure the generosity of the available R&D tax provisions across countries and time. The following sections will discuss alternative tax burden indicators: the marginal effective tax rate framework that builds on the user cost of capital concept and the average effective tax rate framework.

2.2.2. User cost of capital/METR approaches for tangible capital

The methodology that will be discussed in this section follows the approach developed by King and Fullerton (1984). They invoke a standard investment rule – that the marginal discounted after-tax cash flows of the marginal investment project must equal its marginal after-tax cost – to derive the pre-tax return on investment in the project. A tax wedge can then calculated as the difference between this return and the post-tax real marginal rate of return required on this same investment project. In effect, the King-Fullerton (K-F) method uses the cost of capital concept to form an index of tax influences on investment incentives. In particular, it provides a measure of how the tax system scales up (or down) the pre-tax rate of return that must be earned on investment project in order for it to yield a given after-tax return to households (Gordon and Tchilinguirian, (OECD 1998)).

The strengths of the King and Fullerton method are considerable. It provides a way of indexing the incentive effects of a large number of tax and subsidy instruments in a manner that is solidly based in neo-classical economic theory (i.e. assuming perfectly competitive markets and rational economic agents). In particular, because of the method's close attention to the timing of benefits and costs, such as tax versus economic depreciation and after tax-cost of finance, it is consistent with investment theory. The method also integrates the tax implications of inflation, as well as personal taxes through the cost of funds (discount rate).

The following paragraphs show the value of the cost of capital and marginal effective tax rates in the case of equity and debt-financed investment. The analysis includes only taxes at the corporate level, but taxes at the personal level can be included in a straightforward way. No distinction is made between newly issued equity and retained earnings because only taxes at the corporate level are included.

The following variables will be used: the variable Y denotes the firm's output (production), K is the capital stock, δ is the economic depreciation rate of capital, A shows the present value of tax depreciation

allowances, τ is the statutory CIT rate, r is the world market interest rate and π is the inflation rate. $\frac{\Delta Y}{\Delta K}$ is the firm's pre-tax cash-flow resulting from an additional unit of capital, *gross of depreciation* which equals the sum of the cost of capital and the return to pay for the economic depreciation of the asset.

The general equations, from which the cost of capital p follows immediately, are as follows:

Equity: $$\frac{\Delta Y}{\Delta K} = p + \delta = \frac{(1-A)(r+\delta)}{(1-\tau)}$$

Debt: $$\frac{\Delta Y}{\Delta K} = p + \delta = \left[\frac{(1-A)}{(1-\tau)}\right]\left[(r+\delta) - \tau(r+\pi)\right]$$

The marginal effective tax rates are equal to $METR = \frac{p-r}{p}$, which implies that:

Equity: $$METR = \frac{(\tau - A)(r+\delta)}{(1-A)r + (\tau - A)\delta}$$

Debt: $$METR = \frac{(\tau - A)(r+\delta) - \tau(r+\pi)(1-A)}{(1-A)r + (\tau - A)\delta - \tau(r+\pi)(1-A)}$$

Note that the R&D tax provisions, including the available R&D tax credits, will be included and modelled in the variable 'A'.

In order to interpret marginal effective tax rates, it is useful to focus on a number of specific cases: the no-tax case, the case when tax depreciation allowances offset the economic depreciation of the asset and the immediate expensing case.

The "no-tax"-case

In the absence of taxes, the representative firm will invest until the cost of capital equals the world market interest rate: $p = r$. The total cash-flow then pays for the depreciation of the asset and for the required interest rate. The METR then obviously equals 0.

The "neutral depreciation allowances"-case

In case tax depreciation allowances follow the economic depreciation of the asset, the equations simplify to:

Equity: $$p = \frac{r}{(1-\tau)} \quad \Rightarrow \quad METR = \tau$$

Debt: $$p = r - \frac{\tau\pi}{(1-\tau)} \quad \Rightarrow \quad METR = \frac{-\tau\pi}{(1-\tau)p} < 0$$

The economic depreciation rate δ does not appear in these equations, implying that the return that the firm receives for the depreciation of the asset just pays for the economic depreciation of the asset. Put differently, the tax depreciation allowances entirely offset the taxable return that the firm receives to pay

for the depreciation of the asset. As a result, the cost of capital – the minimum required return the investment must earn in order to be undertaken – is independent of the asset's economic depreciation rate.

However, in case of equity financing, the cost of capital does depend on the CIT rate. An increase in the CIT rate then implies that the minimum required return that the marginal investment has to yield will increase. In case of debt financing, the cost of capital equals the interest rate net of a term that measures the impact of the fact that the *nominal* interest payments are deductible from the corporate tax base. An increase in the CIT rate and/or inflation rate then implies that the cost of capital will decrease further below the world market interest rate.

In case the tax depreciation allowances do not follow the economic depreciation of the asset, the cost of capital will depend on the value of the economic and tax deprecation rate, as shown in the general equations presented above. In that case, the firm's decision to invest in particular assets will be distorted by the tax system. The less generous the tax depreciation allowances compared to the economic depreciation of the asset, the lower the incentive to invest in that particular asset.

"Immediate expensing"-case

In case of immediate expensing (and in the absence of other tax provisions), the cost of capital of equity-financed investment equals the world market interest rate:

$$\textbf{Equity}: \quad p = r \quad \Rightarrow \quad METR = 0$$

$$\textbf{Debt}: \quad p = r - \tau(r+\pi) < r \quad \Rightarrow \quad METR = \frac{-\tau(r+\pi)}{p} < 0$$

So in case of immediate expensing of equity-financed investment, one obtains the same result as in the absence of taxes. Hence, the tax system does not distort the firm's marginal investment decision. However having immediate expensing and interest deductibility implies a double deduction which implies an effective subsidy of debt-financed investment.

Shortcomings of the user cost of capital / METR model

The cost of capital and METR framework have enjoyed considerable support as summary statistics of the combined interaction of a range of tax parameters linked to investment decisions (in particular, in tangible/physical capital), and as indicators of how tax provisions compare over time, across industries and across countries. The cost of capital / METR framework does not face some of the main shortcomings of the B-index. However, also the METR model has a number of shortcomings, which suggests that METR analysis can be helpful if not pushed beyond its limits. The main shortcomings of the cost of capital / METR approach are:

- METR statistics are derived from a static partial equilibrium framework, which does not allow assessing investment and capital stock responses to tax changes, factor substitution possibilities, timing issues, distributional and incidence effects, tax-planning responses, etc.

- The "representative" firm that is usually modelled is assumed to operate in perfectly competitive markets and takes output as given. The model ignores that most firms enjoy a degree of monopoly power.

- The tax treatment of infra-marginal investment and profits is not considered.

- The METR framework – based on neo-classical investment theory – assumes that capital is infinitely divisible and that the marginal product of capital declines as the size of the overall capital stock increases. As a result, equilibrium where marginal benefits equal marginal costs will be reached.

- The firm's managers maximize shareholder equity and funds are not wasted.

- Capital investments are reversible in full and without cost. This characterization is clearly inappropriate for most types of capital. Capital will often be task or industry specific, and where it is not, the costs of removing it from a given installation and transferring it to another may be significant.

- The model's results will depend on the choice of the financial market arbitrage assumption that is employed. The cost of capital equations included in this note assume for instance that both equity and debt financed investment has to yield a return equal to the world market interest rate.

- The firm's financial structures and the financial intermediation process are modelled in a rather rudimentary way. Thus, for example, firms have a fixed financial structure and cannot alter this structure in response to shifting tax incentives. Also the types of financial instruments considered are limited.

- The method relies on statutory rates and not on the tax rates that firms and households actually face once avoidance and evasion possibilities are accounted for.

- The framework assumes that there is no tax exhaustion or that governments provide firms with full re-fundability of negative tax liabilities.

- The model often employs static expectations and assumes perfect certainty. This assumption is especially problematic because, in reality, there is uncertainty regarding the economic rate of depreciation of installed capital, due to an unknown future purchase price of capital or to a stochastic rate of physical depreciation or obsolescence. This 'capital risk' may be accounted for in theory by increasing the economic rate of depreciation (without an equivalent increase in the tax depreciation rate). However, in practice, it is difficult to measure the risk premium associated with capital risk.

2.2.3 The METR model applied to intangible investments

This section discusses the use of the cost of capital / METR framework if applied to intangible investments. The analysis will focus first on the approach usually followed in the METR literature. Focusing on the cost side, the economic depreciation rate that has to be used in the cost of capital / METR framework will be discussed in light of the different investment stages discussed in Figure 1. The implications for the METR framework and modelling will be stressed. This analysis will lead to two complementary ways to model and interpret intangible investment in the METR framework. Afterwards, the impact of theuse of R&D inputs in the investment process will be discussed. Next, the analysis will focus on the income side of the investment. It will be argued that the effective corporate tax paid on the return on intangible investment is lower than the statutory CIT rate, especially in the case of intellectual property.

R&D investments in the standard METR literature

The METR approach has been widely employed to assess the impact of taxes on the incentive to invest in physical or tangible capital and to compare tax incentives across jurisdictions using a single and sensible summary measure that accounts differences in statutory tax rates and differences in tax bases due to special write–offs, credits, and allowances and other differences in other taxes on capital (McKenzie (2005)).

The common literature applies the METR model to analyse the effectiveness of tax incentives on R&D investments using the same approach which is applied to investment in physical capital. Note that in case of an investment by a firm in the automotive sector, for instance, the METR model can be used to assess the minimum pre-tax rate of return that the investment has to yield in order to cover the cost of the production of cars, including the depreciation of the assets, and to pay the investor the required return on the funds invested, taking into account all relevant economic and tax factors. This approach takes into account the economic depreciation of capital inputs, such as the depreciation rate of land, equipment and machinery.

When the same user cost of capital framework derived for tangible/ physical investment is used to model R&D investment, the only adjustment that is made compared to the case of tangible investments is that a higher depreciation rate is applied in order to approximate the economic depreciation of the R&D inputs. In choosing an appropriate economic depreciation rate for R&D input, studies in the literature ('traditional studies') typically use an economic depreciation rate obtained from statistics for scientific equipment while an economic depreciation of 15% is used for R&D current expenditure. Researchers have had difficulty measuring the rate of depreciation for R&D given its intangible nature, but 15% is commonly used, as argued by Griliches (1998). Other empirical work suggests that a higher rate would be appropriate (see for example Hall (2007)). By assuming a higher weighted average depreciation rate, the literature considers the rapid obsolescence of knowledge and takes into account that IP depreciates at a faster pace than tangible investments and capital. When measuring the marginal tax incentives on innovation capital (acquired through research and development), studies often apply the economic depreciation rates for R&D investment that have been developed in Goto and Suzuli (1989) and in Joly (1993) (see for instance Gordon and Tchilinguirian, (OECD 1998)). Joly notes that in the US, the rate of economic depreciation (called rates of obsolesce) for R&D is very high (in the vicinity of 25%), while Goto and Suzuki find rates for R&D performed by Japanese manufacturers between 25% for short-lived projects and 6% for long-lived projects. This higher depreciation rate also reflects that some investment inputs can only be used in R&D activities (e.g. highly specific equipment) and not for other types of investments, thereby violating, to some extent the reversibility assumption.

In adopting the METR approach to R&D capital, other articles focus more on the two-stage process underlying the creation of intangible R&D capital. Kenneth J. McKenzie (2005) defines R&D capital – being knowledge and information - as a "non-marketed" input into the production process. He underlines the intangible nature of R&D, which differs from physical capital because it is not purchased on the market but is rather produced within the firm using intermediate "marketed" inputs such as labour, materials and equipment. The resulting stock of intangible R&D capital produced within the firm then enters into the firm's production or product development process. McKenzie (2005) argues that this treatment of R&D is consistent with the fact that tax incentives are available for the expenditures on intermediate inputs that are used in the creation of R&D capital and not for the intangible capital itself.

His methodology consists in calculating various METRs for each of the R&D inputs and in aggregating these different METRs into the ETRRDC summary measure (ETRRDC stands for "the effective tax rate on marginal R&D costs"). The idea is that the tax treatment varies across input expenditures and these taxes or subsidies imposed on these inputs collectively affect the marginal cost of

producing an incremental unit of intangible R&D capital within the firm. For this reason the ETRRDC can be thought of as the excise tax rate implicitly imposed on the production of an incremental unit of intangible R&D capital that arises from the various taxes imposed on the intermediate inputs (McKenzie (2005)).

In summary, the first 'traditional' approach mentioned above models all R&D investment inputs into "A", which becomes a weighted average value of the R&D inputs. McKenzie on the other hand focuses on each input entering into the R&D project separately and calculates a separate METR for each input. He then derives an average METR for R&D investment by weighting the marginal tax burden on each input.

Both approaches – either modelling R&D as tangible investment but imposing a higher depreciation rate or by decomposing R&D process into the tax burden on the different investment components and aggregating the different input METRs by a R&D production function – look at the investment process in a similar way.

On the one hand, one might argue that the METR framework applied to intangibles considers the creation of knowledge as the final output of the production process. In terms of Figure 1, this means that the METR framework models (only) stage I. However IP (or more general knowledge), as for instance patents, cannot be considered to be the final production outcome. IP and knowledge will be used as an input, among equipment and other types of capital, in the next stage of the production process in which these inputs (assets) are used to create and produce products and services of higher quality (that are sold on the market) than would be the case in the absence of the use of the IP. Note that it in this second stage, the amortization of the intangible assets will have to be considered.

On the other hand, the traditional approach followed in the tax literature could also be interpreted as if the investment of R&D inputs lead to the production of products and services of higher quality (as in the example of the car output presented above). The creation of the IP is then implicitly modelled and considered in the investment process. In terms of Figure 1, this implies that the METR framework models the R&D inputs in stage I which lead to the production of higher quality products and services that can be sold at the end of stage II, without explicitly identifying and modelling the IP asset.

An Alternative way to analyse the use of the METR model to intangible investment

An alternative approach to apply the METR model to intangible investment would be to explicitly divide the innovation process in the two stages presented in Figure 1:

- Stage I: the creation of the intangible: the inputs are labour and capital, including R&D inputs; the output is the increase in knowledge or a patent (IP);

- Stage II: the use of the intangible: the intangible asset is an input in the production of products and services. The intangible may be obtained by purchasing or licensing it or by self-developing the intangible. In the latter case, the output of the first phase (the creation of the IP) becomes the input in the second production stage.

These considerations will be further developed below, focusing also on the depreciation rate that has to be applied. At the end of the analysis, we will discuss both the traditional approach followed in the tax literature and we will suggest a complementary approach to model investment in intangible assets applying the METR framework.

The intangible investment's depreciation rate in stage 1 and 2 of the innovation process: insights on the link between the value of the intangible and the economic depreciation rate

The most difficult issue when modelling intangible investments in the user cost of capital/METR framework (ignoring tax planning considerations) is the choice of an appropriate depreciation rate for R&D investments. The analysis in this section will use the investment and innovation stages described in Figure 1 in order to analyse this choice.

R&D investments and intangibles depreciate mainly for four reasons: decrease in value due to wear and tear of the R&D inputs, the probability of failure of the investment activities, obsolescence caused by newer innovations by other firms and the rising probability of diffusion of the technology over time because corporate secrets might leak, innovations might be illegally copied, the development of generic replicas will increase with the age of the technology and patents will eventually expire (see Adéa, Lester and Warda (2008)).

- ***Investment stage I***

In investment stage I, the firm uses R&D inputs to create an intangible asset. The (endogenous) cost of capital of the marginal investment in R&D can then be interpreted as the minimum required increase in royalty payments that have to be received if the intangible is licensed once it has been produced. The cost of capital – in fact, the present value of the sum of the minimum required rates of return over the useful life of the intangible – could also reflect the marginal increase in the value of the intangible if it will be sold or afterwards used as an input in stage II of the investment process.

The example which will de analysed in the next paragraphs provides useful insights with respect to the depreciation rate to be applied if the investment in stage I would be modelled in the user cost of capital/METR framework. The example will point out the complexities in choosing an appropriate depreciation rate. This is mainly because the change in value of the R&D investment inputs is linked to the possible change in value of the intangible that the firm is investing in.

Assume that a pharmaceutical company has built a new laboratory for the development of a new medicine that treats a particular disease; assume also that the laboratory and the firm's other R&D inputs can only be used for that particular purpose. Now assume that a competitor finds the cure for this disease first and takes a patent on the new medicine. In that case, the expected value of the pharmaceutical firm's intangible drops to zero. Also the value of the R&D inputs suddenly drops to zero because these inputs cannot be used in developing any other medicine and can therefore not be sold either (by assumption). All R&D inputs – including labour costs, material inputs and the laboratory – then should be classified as sunk costs.

In this case, the METR model should apply a depreciation rate which ranges between the value that reflects the usual wear and tear of the R&D inputs and the full loss in value of these inputs – under the assumption that these inputs cannot be used as input in another investment decision and cannot be sold either. In fact, the depreciation rate that will be applied in the METR model should be calculated given the probabilities that these events occur. In practice, of course, some of the R&D inputs might be used alternatively. All of these factors should then be considered in calculating a representative depreciation rate for R&D inputs in the user cost of capital/METR framework. This depreciation rate will very likely not be constant over time, as the probability that a competitor finds a cure first might increase over time. The depreciation rate will also be case/intangible specific, depending on the probability that there will be another firm or research centre that is investing in the development of a similar intangible and that this first developed intangible makes the firm's own intangible obsolete.

Note that the tax system will create a disincentive to invest in R&D if the tax depreciation rate that is used in the METR model would reflect only the wear and tear of the R&D inputs. As the economic depreciation is in expected terms higher than the wear and tear of the inputs, the tax system has to foresee tax depreciation allowances that approximate this actual economic depreciation rate in order to be neutral regarding the choice of investment projects.

- ***Investment stage II***

Once the intangible has been successfully produced and, for instance, a patent has been taken, the intangible will become the input in the production of new products, services or processes. This investment and innovation process is modelled in stage II, as shown in Figure 1. The return on this investment then equals the increase in profits – because of the increased quality of products, services or processes – that the firm will earn as a result of the use of the intangible.

This investment stage II, however, cannot be modelled in a user cost of capital/METR framework as it is usually not possible to marginally increase the intangible input to create more profits. This will be explained by using the same example as before.

Assume that a firm has developed the cure for a particular disease and has taken a patent to protect its medicine such that it can start producing and selling the new medicine. The intangible is clearly the investment's input and the sale of the medicine is the return on investment. The cost of capital then represents the minimum amount of net profits that the firm has to earn by selling medicine every year in order for the intangible investment to be profitable. However, in this case, the firm will not be able to equalize marginal costs and benefits. The intangible input is a chemical formula which has been created before. It can either be used or not be used in the firm's investment process. The decision to produce medicine by using the intangible is clearly a discrete investment decision. Note that the firm could also decide to use the intangible itself or to sell it to another firm, for instance. These types of investment decisions cannot be modelled in a neo-classical framework that assumes that the marginal product of capital declines as the size of the capital stock increases and which assumes that capital is perfectly divisible. The use of the intangible is not perfectly divisible; the intangible can either be used or not be used in the investment process.

Note that this does not hold for investment in stage I. In this stage, the firm can decide to marginally increase the R&D inputs. These inputs will increase the probability that the development of the intangible will turn out to be successful and lead to a patent. Decreasing returns to scale could indeed be assumed once a minimum amount of R&D resources have been invested.

Note also that in case of investments in trademarks, it will be possible to consider a marginal increase in intangible input in stage II. A firm might, for instance, decide to spend an additional currency unit in advertising to strengthen its brand name. A slightly stronger brand name as input might then give rise to increased profits in stage II. This stage II investment might then require that the R&D inputs such as the firm's marketing expenses are increased in stage I. This shows clearly that both investment stages are linked.

However, another modelling problem might have to be faced in case of investments in trademarks. In this case, one might argue that the decreasing marginal productivity of capital assumption underlying the METR model does not necessarily hold. One might argue that the return on marketing inputs increases with the amount of marketing that is undertaken, at least to a certain extent. This would then again imply that the investment cannot be modelled in the METR model.

- ***Modelling investments in stages I and II jointly***

The examples above show clearly that investment stages I and II are linked: the R&D inputs lead to an intangible in stage I which is used as input in order to increase profits in stage II. A solution to the infeasibility of modelling stage II separately in the METR framework would then be to model the investment stages I and II jointly. Combining both investment stages implies that we are focusing on a firm which is investing R&D inputs in stage I of the investment process with the aim to increase future profits as a result of better products, services or processes in stage II, without explicitly considering the creation of the intangible asset in the investment model. The investment's cost of capital then reflects the minimum required net increase in future profits 'p' – for instance because of an increased quality of its produced products – in stage II.

This approach is clearly possible in case of an investment in a self-developed intangible. At first sight, this solution seems less straightforward if the firm uses a purchased intangible as input in stage II because it has been developed by another firm. Modelling the investment by using a purchased intangible would then require that the entire chain of investments across firms is considered. The investment model would focus first on the firm that produces the intangible in stage I and afterwards on the other firm that buys and implements the intangible such that it can create better products, services and processes in stage II. The approach to focus on the chain of investments, irrespective of which firm has undertaken which type of investment, would then allow the modelling of purchased intangibles in the METR framework.

In case investment stages I and II are considered jointly, what is the depreciation rate that has to be considered in the METR model? Before the patent has been obtained, the backward looking approach implies that the value of the intangible depends on the historical R&D input costs. The depreciation rate of the intangible is then linked to the depreciation of the R&D inputs as was the case in stage I. Once the patent has been obtained or a stock of knowledge is reached, its value equals the present value of the increase in profits as a result of innovative production processes and increased efficiency. In that case, the depreciation rate represents the expected loss in value because of obsolescence caused by newer innovations by other firms and the rising probability of diffusion of the technology over time because corporate secrets might leak, innovations might be illegally copied, the development of generic replicas will increase with the age of the technology and patents will eventually expire.

The issues are more complicated when determining the depreciation rate before the patent has been obtained under the forward looking approach. Although the issues are complicated – further analysis regarding these topics might be required – this analysis does lead to an alternative way of looking at stage I and II in the METR framework. This approach will be shown with an example.

Assume that another firm or a research centre has developed the intangible first and takes a patent. The firm's invested R&D inputs then become sunk costs. These costs will have to be considered in the firm's depreciation rate 'δ'. However, in order for the firm to realize its return on investment – i.e. increasing the quality of its output – the firm will now have to buy the intangible from the firm that holds the patent. The cost of the required purchase of the intangible reflects the loss in value of the intangible that the firm was creating itself. The cost of the purchase of the intangible, including the probability that this event might occur, will have to be included in the investment's depreciation rate 'δ' as well.

Another example might be useful in clarifying the argument. Imagine that during the investment phase I depicted in Figure 1 the firm is developing two intangibles simultaneously. It is the combination of both intangibles that will create additional profits at the end of stage II. Assume also that while the firm is developing these intangibles, one of the intangibles becomes obsolete because a competitor is first in claiming a patent. The firm in that case might be obliged to buy the patent from its competitor in order to safeguard its future increase in profits. This additional cost will have to be considered in the METR

framework as well. The expected cost, which includes the probability that this event occurs and the expected price that would have to be paid to purchase the patent, reflects the loss in value of the firm's self-developed intangible. This loss would then have to be accounted for in the depreciation rate that is applied in the METR framework.

In fact, the cost of the purchased intangible only approximates the loss in value of the intangible that the firm was creating itself. The value of the intangible equals the present value of the increase in profits that the firm will earn as a result of the intangible in the future because of higher quality products and because the intangible can be licensed. The fact that the firm decides to purchase the intangible from another firm in order to continue its investment process implies that the cost of the purchased intangible is below the present value of the increased profits as a result of the use of the intangible (reflecting the value of the intangible for the firm). Moreover, the firm can now no longer licence the intangible, implying that the price of the purchased intangible will be a lower bound on the value of the intangible if the firm would have been able to obtain a patent itself. On the other hand, however, the value of the intangible that the firm was self-developing is below the present value of the increased profits because the firm was not able to finalize the development successfully.

In case of intangibles, the variable 'δ' in the cost of capital / METR framework then no longer only reflects the wear and tear of the R&D inputs – possibly reflecting the total decrease in the value of these inputs, as explained above – but also includes a return to pay for the possible purchase of the intangible in case the firm develops that intangible not on time or is not able to implement it successfully and it therefore has to buy the intangible from another firm or research centre.

This perspective is in accordance with the general interpretation of the depreciation rate in the user cost of capital and METR framework. The depreciation rate reflects the return that the firm must earn to pay for the depreciation of the assets such that the value of the capital will remain constant. The depreciation rate will pay for the replacement of the obsolete part of the investment such that the stream of profits generated by the investment remains constant. The purchase of the patent from the firm that has produced the intangible first fits within this interpretation. The firm needs a return to pay for the purchase of the intangible such that its profits will remain constant.

Modelling intangibles in a METR framework then poses many valuation problems, especially because the value of the intangible is difficult to quantify if the firm is developing it within the firm itself (or within the same group of firms). This mainly is the result of the fact that there are few comparable transactions in the IP market that can be used to determine a value for the IP. A proper valuation of the intangible is however required in order to quantify the cost of having to buy the intangible on the market if its value is lost. Deriving an appropriate depreciation rate seems in that case very difficult.

However, this valuation problem does not exist in case the intangible input has been purchased by the firm in stage II, as the value has been monetized through the market transaction. The price that has been paid can then be used to determine an appropriate depreciation rate in the investment process.

- ***Different approaches to model the tax burden on IP***

Investment in intangibles is a risky activity as it is not sure whether the investment will lead to the creation of a patent (for instance). Modelling uncertainty in the cost of capital framework is not evident. Two complementary approaches to apply the METR framework seem possible. The difference in these approaches lies in the way they model risk.

The first approach follows the usual approach discussed and modelled in the tax literature. In this approach, the investment of R&D inputs leads to the production of products and services of higher quality. Uncertainty in this approach takes the following form:

- With probability π, the firm successfully produces the new product
- With probability $(1-\pi)$, the firm will not produce at all because the firm was not able to create an intangible (the patent), for instance because a competitor was first in the development.

The cost of capital 'p' then reflects the minimum required *expected* return on investment, considering that the investment can be either successful or not (implying that the firm will not produce any product with probability $(1-\pi)$). The variable 'δ' reflects the depreciation of the R&D inputs, which can range from wear and tear to the full depreciation in case the firm does not produce.

In the second way of modelling intangible investment in the METR framework, the firm will invest and will produce the new product. There is no uncertainty regarding the production of the new product, as opposed to the first approach. However, this second approach does consider uncertainty regarding the inputs:

- With probability $\bar{\pi}$ the firm will create the patent itself; the input to the investment and production process are then the R&D inputs
- With probability $(1-\bar{\pi})$: the firm will not be successful in self-developing the patent and will therefore have to buy the patent on the market; in that case the input equals the R&D inputs + the purchase price of the patent

The cost of capital 'p' then reflects the minimum required return in producing a product or service that uses the IP as input (no uncertainty here). The variable 'δ' reflects the expected return to pay for the inputs in the creation of the output, it ranges between:

- the depreciation as a result of the wear and tear of the R&D inputs (with probability $\bar{\pi}$)
- and the depreciation of the inputs in case the IP has not been successfully developed (with a maximum value of the total value of the R&D inputs) + the purchase price of the IP from the firm that did create the IP (with probability $(1-\bar{\pi})$).

This second approach has a number of advantages:

- it allows to focus on the firm that is investing in a patent but is not successful. This approach includes the loss in IP value / depreciation of the IP, approximated by the price that the firm has to pay for the intangible on the market (replacement cost). This approach therefore allows to include the expected loss in value if the IP was not successfully self-developed.
- In case $\bar{\pi} \to 1$, this second approach allows focusing on Stage II of the investment process that models the use of purchased IP.

The main problem regarding this second approach is that, when calculating the cost of capital, it is unclear what the exact value of δ is that has to be included in the calculation. In this respect, the first approach is easier to model as the uncertainty is part of the endogenous 'p'. A possible solution would be to fix the value of 'p' and make the δ endogenous in the second METR approach.

Note that both methods face an additional complexity as both π and $\bar{\pi}$ are increasing in the amount of R&D inputs (other factors might have an impact as well), as a result of the fact that:

$$\pi = \pi(\text{the amount of R\&D } inputs)$$

with:

$$\pi' > 0 \qquad \pi'' < 0 \quad or \quad \pi'' > 0$$

This endogeneity will then have an impact on the calculation of the marginal investment unit.

2.2.4. The AETR model.

Sections 2.2.2 and 2.2.3 discussed marginal effective tax rates (METRs) as the alternative for the B-index in measuring the tax burden on investment in intangibles and the generosity of R&D tax provisions. In summary, the analysis pointed out that the traditional method of measuring the impact of corporate income and other taxes on the level of capital investment is through the user cost of capital – defined as the pre-tax real required rate of return on an investment project. The firm will invest up to the point at which the marginal product of capital is just equal to the cost of capital – so that, at the margin, the project just breaks even. As investment increases, the marginal product is assumed to decline, resulting in a unique profit-maximising level of investment. The impact of tax on the cost of capital is measured by the METR. A higher METR increases the cost of capital, and therefore discourages investment in the capital stock.

However, corporate tax systems also have an influence on the firm's discrete investment choices. For example, if a firm wants to enter the European market, it could locate production in one of a number of different European countries. Given the structure of its costs, it will probably not locate in all countries. Where an investor faces a choice between mutually exclusive projects that are expected to earn more than the minimum required rate of return, the choice of which project to undertake depends on the level of the post-tax economic rent that would be earned from each project. The firm might then choose that location (or locations) offering the highest post-tax profit. The impact of tax in this case is measured by the proportion of the pre-tax economic rent paid in tax – the average effective tax rate (Devereux and Griffith (1998), Devereux and Griffith (2003)). Conditional on this location choice, the scale of the investment will be determined by the cost of capital and the METR.

Investment in intangibles are clearly discrete investment choices in order to earn economic rents. Devereux and Griffith (1998) provide the example of a firm that can invest in R&D to make a production facility more automated compared with a relatively labour-intensive production process in the absence of the successful development (or purchase) of the intangible. The firm will follow the investment strategy that yields the highest post-tax level of economic rents, which depends on the average effective tax rate levied on the investment's return. Given the choice of the investment strategy, the exact amount of R&D investment will then depend on the marginal effective tax rate, as discussed in prior sections.

In addition to calculating the user of cost of capital and METRs, future work might therefore also focus on the calculation of AETRs on the return of intangible investments. The analysis could calculate forward-looking average effective tax rates on a prospective investment in intangibles, similarly to the METR approach discussed in the prior sections. Alternatively, backward-looking average effective tax rates measure the average tax rate on income derived from previously acquired (i.e. existing/installed) capital of firms. Such frameworks are "backward-looking" in the sense that they assess current tax liabilities on profit generated from capital accumulated in the past (at historical value). Ideally, firm-specific data would be used to calculate the effective average tax rate that firms have paid on their intangible investment. These AETRs then would also indicate the actual impact of firms' tax-planning activities on taxes paid, as will be discussed in the following section.

2.2.5. A main assumption to be re-assessed: the basic corporate income tax rate and tax burden on R&D income

Tax indicators and related expressions for capital investment generally assume that returns to R&D are taxed at the basic corporate income tax (CIT) rate. In the case of intangibles, however, this level might overstate the rate at which investment income is effectively taxed given the tax planning techniques that are commonly and increasingly used by businesses to minimize their tax burden. The intangible might for instance be shifted to another country such that the returns on the investment will not necessarily be taxed (at high rates) in the country that has provided the R&D tax credits.

As intangibles are mobile and their valuation poses many practical problems, they become a major element in firms' tax-planning activities. This is especially the case for commonly controlled taxpayers. Businesses that are part of the same group, for instance, and that operate in the international market and are located in different countries, often try to find opportunities for income shifting by changing the location of their intellectual property.

Because businesses face tax-induced incentives to shift their domestic profits offshore, through transfer pricing and other tax motivated financial tax-planning techniques, the use of the nominal CIT rate in the METR equations will overstate the effective taxes paid by businesses. In fact, in the absence of targeted tax regulations as CFC rules, thin capitalization rules or other provision aimed at protecting the domestic income tax base, the effective CIT rate paid might be considerably below the statutory CIT rate. However, in practice, it will be difficult to choose an effective CIT rate that could be applied in the user cost of capital / METR framework and which reflects the tax savings as a result of the tax-planning that firms are engaged in.

Moreover, for identifying a representative CIT rate to include in the model, it is fundamental to consider that some countries have introduced favourable treatment targeted to R&D income, for example by exempting royalties or by levying a reduced CIT rate on the stream of income obtained from the use of self-developed or licensed IP (on patent remuneration embedded in the sales prices). This consideration is important because it otherwise would lead to an overestimation of the tax burden on R&D investment.

2.3. Tax and innovation policy considerations

With R&D recognized as key to expanding production possibilities and efficiencies, policy makers interested in pursuing pro-growth strategies often look to R&D tax incentives as an attractive policy instrument. Increasing use of R&D tax incentives heightens interest in evaluating their effects.

The efficient design of R&D tax provisions has become even more important in light of the global financial and economic crisis. Innovation might provide firms a competitive advantage and will be an important factor in the long-run recovery strategy of OECD member countries. Moreover, R&D tax provisions may be very costly in terms of tax revenue foregone. In light of the increased need to raise taxes and finance increased public deficits, an evaluation of the effects of the R&D tax provisions and adjusting their design has therefore become crucial.

2.3.1. Evaluation of R&D Tax Incentives

This section considers three levels of tax incentive evaluation and some approaches that may be taken to assess a given R&D tax incentive (or basket of R&D tax incentives). Following the review of assessment frameworks, the standard assumption of taxation of returns on R&D at the basic CIT rate is questioned.

2.3.1.1. Effectiveness of R&D tax incentives

To assess whether R&D tax incentives are effective in increasing private R&D spending, two approaches may be used that do not require detailed information on effective tax rates on R&D. One approach is to carry out case study analysis, involving the development and analysis of responses to questions posed to senior management of firms involved in making R&D activity decisions. A second approach is empirical estimation of an *ad hoc* R&D demand equation (not based on a model of investment behaviour).

Under the case study approach, questions are posed to senior management of firms to determine whether R&D expenditures responded positively to the introduction of an R&D tax incentive (see Mansfield (1986) for a discussion of case study analysis of effects of introducing an R&D investment tax credit).

A potential advantage of the case study approach is that managers can control for other explanatory factors when assessing whether R&D tax incentives motivated R&D spending. On the downside, managers may give a biased assessment for subjective or perceptual reasons.4 Given the relatively high costs of carrying out detailed case studies involving interviews with managers, the sample size of a case study investigation of tax incentive effects tends to be relatively small, raising uncertainty over how representative the case study results are.

Another approach to assess the effectiveness of R&D tax incentives is to estimate an *ad hoc* R&D demand function that relates R&D spending to a list of explanatory variables including a 'dummy variable' capturing the availability or not of an R&D tax incentive. The sign of the estimated coefficient for this variable indicates whether R&D expenditure responds positively to the availability of tax incentive relief, while the estimated value of the coefficient provides an estimate of the amount of R&D expenditure induced by the introduction of the R&D tax incentive (e.g. R&D tax credit). Reliance on firm-level data is preferable to the use of aggregate data.

2.3.1.2. Cost-effectiveness of R&D tax incentives

A key evaluation question is whether the estimated additional amount of R&D investment undertaken by firms directly as a result of an R&D tax incentive, more than offsets the corresponding amount of foregone tax revenue (tax expenditure).5 Consider the following cost-effectiveness measure:

Cost effectiveness = additional R&D/foregone tax revenue

Where the cost effectiveness indicator is assessed to be zero, implying no additional R&D expenditure, this means that each currency unit of tax relief provided (foregone tax revenue) is offset by a one currency unit reduction in privately funded R&D. Where the indicator is assessed to be unity, then each currency unit of tax relief provided results in one additional unit of R&D expenditure and no crowding out of privately funded R&D. Values between zero and one imply partial crowding out, while values exceeding one imply that R&D spending increases by more than the tax subsidy.

Estimates of the additional amount of R&D investment directly resulting from an R&D tax incentive typically draw on empirical results from estimation of a structural R&D demand equation that relates R&D expenditure to a number of explanatory variables including the tax-adjusted user cost of capital. In particular, the additional R&D resulting from a tax incentive is calculated using empirical estimates of the elasticity of R&D with respect to its price ('user cost') – that is, the percentage change in R&D caused by a 1 per cent change in the price of R&D – combined with measures of the percentage change in the price (user cost) of R&D resulting from the R&D tax incentive.

Most econometric work attempts to explain the relationship between R&D investment (expenditures on R&D) – in particular, investment in physical capital of various types (equipment, plant, buildings) used in R&D – as a function of the weighted average price (user cost) of these capital types.

Estimates of the amount of tax revenue foregone as a result of a given R&D tax incentive may be estimated using a corporate income tax micro-simulation model, based on taxpayer-level information gathered from stratified samples of corporate income tax returns. A main advantage of such models is that they factor in the interactions of tax variables, carryover provisions, and distinguish taxable firms from those in a tax-loss position. This approach is preferable to one that simply adds up the value of R&D tax allowances and tax credits claimed, without capturing interactions and carryover provisions.

2.3.1.3. Cost-benefit assessment of R&D tax incentives

As reviewed above, an assessment of the cost-effectiveness of a given R&D tax incentive is limited to a comparison of the benefit of additional R&D directly related to the incentive, against the cost of foregone tax revenues. A cost-benefit assessment would attempt to capture other benefit and cost factors, assessed from a public (societal) perspective. As the name implies, a cost-benefit assessment compares (societal) costs and benefits, taking into account not only current but also predicted future benefit/cost amounts:

$$CB = \frac{\sum_{s=1}^{\infty} \frac{B_s}{(1+r_s)^{s-1}}}{\sum_{s=1}^{\infty} \frac{C_s}{(1+r_s)^{s-1}}} \tag{13}$$

The numerator of the cost-benefit ratio measures the sum of the present discounted value of expected current and future period benefits, and the denominator measures the sum of the present discounted value of expected current and future costs.

In principle, benefits to factor into a full cost-benefit assessment of an R&D tax incentive would include:

- increased producer surplus accompanying an expanded R&D capital stock;
- net spillover effects (knowledge/profit spillovers).

As regards the costs to be factored into a full cost-benefit assessment, main components are:

- foregone tax revenues, assessed taking into account the opportunity cost of public funds;
- compliance costs of R&D performing firms applying for R&D tax incentives;
- tax administration costs of governmental bodies administering the R&D programme.

In measuring producer surplus, the analysis takes into account not only the estimated additional amount of R&D resulting directly from the tax incentive (the focus of cost-effectiveness assessment), but the return on the R&D, recognizing that returns at the margin to (subsidized) R&D may be relatively low.

2.3.1.4. Implications of possibly biased assessments of the tax burden R&D

As discussed in Section 2.2.2. standard user cost and METR measures for R&D may be mis-specified. One concern is the assumption of taxation of returns on R&D at a country's basic CIT rate. A key question to be addressed is whether empirical analyses of tax effects on R&D, and evaluations of R&D tax incentive

programs, are based on biased measures of the user cost of capital that do not factor in the implications of cross-border tax planning involving geographically mobile intangibles.

Assessments of the amount of tax relief afforded to R&D typically focus on the tax treatment of R&D expenditure, and do not factor in relief from limited taxation of returns on R&D. As reviewed above, with few exceptions, the focus in theoretical and empirical work is on tax incentives that lower the effective (net of tax) cost of purchasing or acquiring the services of inputs used to undertake R&D, primarily physical capital and labour. Consistent with this, the main tax policy indicators for R&D – the B-index and standard METR measures – assume that revenue derived from R&D is subject to tax at basic statutory corporate income tax rates. However, a more complete assessment would take into account the full range of applications of knowledge capital (including licensing) and instances where revenues derived from such applications are taxed at reduced rates.

Where knowledge capital is used in domestic production, and revenues from commercialization (sales) are included in the domestic tax base, the applicable tax rate would normally be the basic (or small business) statutory corporate income tax rate. Where knowledge capital is licensed, preferential taxation may apply. For example, a low scheduler tax rate may apply to foreign-source royalty income, as under Dutch rules. In countries that tax foreign direct dividends (e.g. the U.S.), excess foreign tax credits on high-taxed dividend income may be applied to shelter foreign royalty income from domestic tax.

Where knowledge capital is transferred to an offshore holding company, little or no income taxation of foreign royalty income may apply. Various tax-planning strategies may be routinely used by companies (MNEs) to avoid tax on royalty income on patents and other intellectual property (IP), often generated with the support of R&D tax incentives. For example, a parent company, benefiting from tax credits on R&D that results in a patent, may enter into a cost sharing agreement with a tax haven IP holding company that enables tax-free receipt of royalty income earned on licenses of the patent with operating affiliates in different countries.

A full assessment would also require consideration of the possible application of anti-avoidance rules – including anti-deferral (controlled foreign company-type) rules and transfer pricing rules – and how effective these rules are in countering tax avoidance. This level of detail implies a complex set of considerations. Yet attempts to sort out the implications of tax-planning and counter-measures are important, in order to establish the accuracy of the standard assumption in empirical work and policy assessment, including efficiency and revenue implications of R&D tax policy. In assessing overall tax relief provided, it is important to consider the tax treatment of R&D expenditures *and* income derived from R&D, and the balance of tax relief targeted at cost versus income.

2.3.2. Evaluation of the impact of R&D tax credits on innovation

Many OECD countries implement generous R&D tax credits. To a large extent, the R&D tax credits explain the high rates of tax subsidies for USD 1 of R&D investment that were shown in Figure 3. Their design is therefore of particular interest.

CTP/TPS and the Economics Directorate have analyzed the impact of R&D tax credits – as well as the impact of other taxes and tax provisions – on economic growth. The tax and economic growth study (OECD (2008)) has analyzed the impact of R&D tax credits on total factor productivity, which measures how efficiently industries use their factors of input. The econometric analysis has shown that R&D tax credits do increase productivity in OECD countries and that they therefore stimulate economic growth. However, their impact is found to be relatively modest.

The analysis has shown that the positive impact of R&D tax credits is larger for industries that are structurally more R&D intensive. The analysis also concluded that targeting of R&D tax credits at young and small firms will not necessarily be efficient. This result seems to imply that targeting of R&D tax credits at highly innovative firms and industries might be a good tax policy option. Targeting, however, will increase enforcement and compliance costs. Governments might therefore have to trade-off the benefits of targeting with the corresponding costs.

R&D tax credits might be good for growth in the presence of large positive external effects, especially in highly innovative industries (e.g. health industry). An important question which remains, however, is whether R&D tax credits are better for economic growth than a standard CIT rate reduction (in a tax revenue neutral setting).

It is also important to note that high R&D tax credits in one member country might attract other country's R&D activity. This phenomenon might have influenced the empirical results of the Tax and Economic Growth study. R&D tax credits might indeed be good for growth in one particular country but not necessarily – or not to the same extent – for the OECD as a whole. This concern is confirmed by the work by Wilson (2007) who analyzes the impact of R&D tax incentives among U.S. states. He finds that generous R&D tax credits increase R&D spending within the state, but that nearly all of the increased spending draws in R&D from other U.S. states. A state's (or country's) generous R&D tax provisions therefore impose an externality on R&D activity in other states (and countries). For the OECD as a whole (or for regions as for instance the EU), this result then seems to indicate that R&D tax provisions reduce total tax revenues without strongly increasing the total amount of R&D that is undertaken. However, Wilson (2007) also confirms that R&D spending is very mobile; a country that does not implement generous R&D tax provisions may lose much of its R&D activities.

Moreover, the case for R&D subsidies is not clear cut and may be questioned on a number of grounds, including practical experience showing that R&D subsidy programs tend to impose a significant administrative burden on government, for instance in identifying qualifying R&D activity, depending on the efficiency of the bodies administering the program (e.g. tax administration) and the design of the subsidy instrument (e.g. R&D tax credit).

2.3.3. R&D tax credit issues

Many countries provide R&D tax credits for investment in R&D. These credits are either volume-based, meaning that an R&D tax credit is available for the total amount of R&D that the firm undertakes in a given fiscal year. Although being easier to administer, many countries consider this type of credit as being too advantageous as they do not want to provide tax incentives for R&D that would have taken place anyway.

Countries therefore often provide R&D tax credits only for an increment in R&D (e.g. R&D in excess of the average R&D expenditure incurred in prior three years). The only companies that benefit from such a system are those that have committed to accelerating their rate of R&D spending over time. Such system does not take account of typical business cycles. Another problem with this approach is that it is for tax administrations very difficult to determine the exact incremental amount of R&D. Moreover, the R&D tax credit system provides firms with an incentive to change their R&D pattern over time in order to maximize the incremental amounts of R&D. A sequence of high R&D in the first years, being followed by low R&D and then again high R&D investment in the following fiscal years could maximize the total amount of R&D tax credits that could be claimed. Increment-based schemes encourage firms to have a cycling R&D behaviour to maximize the benefits of tax incentives (Hollander, Haurie and L'Ecuyer, (1987) and Lemaire, (1996)) and they are limited in their effects as any increase in R&D in a given year reduces the possibility to claim tax credits in future years (at least when the reference base is a moving base).

Governments that want to tackle this type of tax arbitrage behaviour may average the R&D investments over time, although this would not solve the tax planning incentives entirely. A further problem with incremental R&D incentives is that firms may take advantage of incremental incentives by changing the firm organization through mergers or the creation of new firms.

R&D tax credits could be provided for all types of R&D. However, they may also be targeted at specific types of R&D and/or specific industries. It should be noted that there are administrative difficulties in identifying R&D expenditures and their eligibility for both volume based and incremental R&D tax credits. The question also rises whether R&D tax credits work better than direct R&D subsidies or whether credits and subsidies are complementary in terms of efficiency and tax administration.

R&D tax credits may be a relatively attractive incentive mechanism, compared to enriched tax allowances or deductions for qualifying current and capital R&D costs, in that the amount of relief provided is not fixed to the personal or corporate income tax rate. Under a progressive corporate tax rate structure, large profitable firms receive more tax relief than small profitable firms, for a given amount of qualifying R&D expenditure. Volume-based offer certain advantages relative to incremental tax credits, despite general larger windfall gains associated with the former. At the same time, even with incremental credits, much of the subsidy may be to R&D that would have been undertaken in the absence of tax relief. Refundable (non-wastable) R&D tax credit programs may be introduced to assist non-taxable firms but should be designed and administered with considerable care.

2.3.4. R&D tax policy design issues

R&D tax provisions are targeted at R&D investments (stage 1 of Figure 1). However, only some investment in R&D will give rise to the creation of intangibles; not all R&D investment will turn out to be successful. The question then is whether governments can target R&D tax provisions at the projects that will turn out to be successful. While businesses would presumably rank their projects in terms of the expected private rate of return, it may be socially optimal to invest in projects that do not make sense from a private rate of return perspective, but they have a high social rate of return, such as positive externalities. However, one might also question whether R&D tax provisions provide incentives to invest in R&D projects that have a small probability of becoming successful. If so, one could conclude that R&D tax provisions are too generous by providing tax support also to projects of low quality. Substantial R&D subsidies, if not justifiable in an economic grounds, can lead to undertake an investment which earns a before tax rate so low that, in absence of tax incentive, would never take place (McKenzie (2005)).

While the statutory corporate tax rate applies generally to large corporations, small firms in some countries may pay a reduced corporate tax rate. About half of OECD countries have some form of reduced rate targeted at either small firms, certain business activities or firms operating in certain regions. In this context, R&D credits seem to be a better tax incentive mechanism compared to enriched tax allowances or deductions for qualifying current and capital R&D costs, in that the amount of relief provided is not fixed to the (personal or corporate) income tax rate. Moreover R&D tax credits might be made refundable while it's more difficult and costly to implement generous loss-carry forward provisions linked to the tax losses as a result of immediate expensing.

Governments that want to stimulate economic growth might not only want to provide incentives for the creation of intangibles but might also want to ensure that the newly created intangibles end up being embodied in newly produced goods and services. By providing tax reliefs for R&D expenditure, the tax system only stimulates the production of intangibles but not necessarily the use and the adoption of these intangibles. In fact, profits will increase and the economy will grow the strongest, not particularly when knowledge or IP is created, but especially when technological change are implemented and results in new

products, new capital equipment and new production methods. Currently, most governments only provide tax support to the creation of intangibles and not for the use of the IP.

The question of course arises why countries would want to provide tax support for the use of intangibles in production (by providing accelerated depreciation allowances, additional tax credits linked to, for instance, royalty payments on purchases or licenses of intangibles, etc.). Are there market imperfections or positive external effects that explain why governments would want to provide support through the tax system for the use of intangibles in creating new products, services or processes? It is worth noting that an important source of innovation and growth is the dissemination and effective use of the new knowledge throughout the economy, whether it has been created locally or imported from abroad; however, R&D incentives may have some difficulties to address this third aspect.

First, one might argue that the adaptation of new technology leading to the creation of new products faces positive external effects which are not internalized by the firm. For instance, the use of a particular new technology that leads to the creation of a new product might in itself give rise to the creation of new markets and therefore to economic growth. Second, the adaptation of new technologies might require investments without guarantee of success. The use of intangibles might therefore be considered to be an innovative activity in itself. Moreover, other firms might copy the newly developed products quickly, thereby reducing the return on the firm's innovative investment. Fourth, once a firm has registered a patent, the firm becomes a kind of monopolist. The firm will therefore have an incentive to charge royalties above the price in a competitive market in order to maximize its profits. While legal protection defends the rights of the inventors, it might subsidise monopolistic surpluses. Some may argue that the availability of R&D tax provisions on the licensee side might address this distortion. However, more direct market regulation might be more appropriate.

It may be argued that the use and the commercialization of intangible assets or IP should be subsidized to enhance the dissemination and the deployments of knowledge in terms of increasing investment, productivity and economic growth (these are intended externalities). For instance, when a company buys a new technology available abroad from a non resident company and starts exploiting it, it will give rise to new investment within the country, train workers and realize benefits from the spread of knowledge and innovative activities. These spillovers effect may be considered as a necessary condition for subsidising the use of IP.

While sound in theory, the spillover benefit argument is difficult to implement in practice. A number of complexities and uncertainties are met. A central question is how to determine the optimal tax treatment of R&D to address spillover effects. In examining this issue, Dahlby (2005) presents a framework which identifies three main considerations to be taken into account by policy makers when deciding or evaluating tax subsidies for R&D:

- the tax sensitivity of R&D
- the external (or social) rate of return
- the marginal cost of public funds.

One of the biggest costs of providing subsidies is the distortions caused by the taxes used to finance the subsidy. However, given the high social rate of return on R&D found in typical empirical study, administration and compliance costs may not be great enough to result in a welfare loss from an R&D subsidy.

While Dahlby is able to derive a formula for the optimal net tax rate on R&D activity that addresses spillover benefits, making the framework operational is difficult given considerable uncertainty (i.e. a wide range of estimates) over the magnitudes of each of the above-noted factors.

Finally, self-developing, licensing or purchasing IP might be very costly. Firms that do not have sufficient funds might then be constrained in their innovative business activities. If a firm's innovative business activities are expected to be profitable, firms which do not possess sufficient retained earnings could then finance their innovative investment by issuing new equity or by borrowing additional funds. However, this might not be possible in the presence of financial market imperfections. Especially SMEs might face constraints in financing their investments. This argument, which is also one of the main arguments why tax systems implement a reduced tax rate on the profits of SMEs, explain why countries might provide tax incentives for the use of IP in addition to its creation.

When providing generous R&D tax provisions, governments should also take into account that these provisions will not necessarily lead to an increase in taxable income in their country. Intangibles that are created might for instance be transferred abroad and/or be used in the production process in other countries. This might result in an increase in taxable income in other countries but not necessarily in the country that has provided the R&D tax provisions. Countries that face a high statutory CIT rate to finance a generous system of R&D tax provisions might be especially vulnerable to the tax-planning behaviour of firms designed to avoid home country tax on foreign royalty income.

Tax systems generally distort a firm's choice to either self-develop, to purchase or to licence IP. Most costs linked to the self-development of IP can usually be immediately expensed and firms may benefit from additional R&D tax provisions. However, the purchase of IP implies that the price has to be capitalized and depreciated over time. There are no tax incentives for licensees as royalty payments are normally tax-deductible costs. Note that businesses usually prefer immediate expensing although the depreciation of assets might be more beneficial in the presence of losses and limited loss carry-forward provisions.

The different tax treatment of self-developed and purchased IP could also imply that research centres that are specialized in the development of intangibles face a competitive disadvantage where businesses are encouraged to self-develop instead of outsourcing (part of) the creation of their IP to domestic or foreign research centres. This implies a loss in efficiency because businesses do not use their resources – for instance their human capital – in the most productive way, while research centres that face more synergies might not be used up to their full potential. By providing incentives to self-develop IP, businesses might not end up possessing the most efficient technology and the highest quality IP possible.

No special tax incentives are available for licensees where tax relief is limited to deductions for royalty payments from taxable income similar to other production costs. However, in order to stimulate the exploitation of intangibles, increased allowances for the cost of royalty payments might stimulate innovative activities as well. Instead of providing incentives to the effective users of IP, countries have preferred to lower the taxes on royalty income, possibly sacrificing economic growth. The focus on reducing the tax rate on royalty payments may be driven not only to encourage and attract innovative investments within the country, but also by the concern that intangible property and the corresponding taxable income would otherwise be shifted out of the country. However, these kinds of tax reductions do not create real economic spillovers. A possible alternative policy would be to provide incentives for the use of IP that has to remain within the country where the business activity is carried out, thereby protecting the country's tax base indirectly.

If these policies are not effective, countries might consider implementing R&D tax provision allocation rules. These rules would provide R&D support only if these R&D tax provisions would lead to an increase in taxable income afterwards. These rules could work similarly to interest allocation rules which countries implement in order to protect their domestic tax base. Alternatively, countries might consider providing R&D tax provisions only if they lead to an increase in fixed capital assets and/or

employment. These strategies would try to prevent outcomes where firms benefit windfall gains from generous R&D tax provisions without having a fundamental impact on the country's value added and economic growth rate.

It is worth noting that the high rates of spillovers found in the literature often capture only the spillovers that remain within the national boundaries. Further, the fact that the spillover are not contained within national boundaries suggests international coordination in subsidizing R&D, not unilateral limitation.

2.3.5. Tax impediments to investment

A common criticism of corporate income tax (CIT) is that it discourages investment in physical capital and other assets relative to the no-tax case, and relative to certain 'neutral' corporate tax system designs with a different tax base (e.g. a cash-flow tax). Tax distortions to investment in physical capital under a basic CIT may be alleviated by reducing the statutory CIT rate, allowing accelerated depreciation of physical capital costs, or providing a general investment tax credit for investment expenditure. However, broad-based tax relief is generally expensive in terms of foregone tax revenues, relative to targeted tax relief. Thus policy makers may prefer a targeted approach. An example is providing accelerated depreciation and/or investment tax credits in respect of purchases of physical capital used in R&D.

Targeting CIT relief to R&D performing firms may be attractive to policy makers for a number of reasons. First, as noted, it could limit tax revenue losses. Second, targeting R&D performing firms may be an attractive pro-growth strategy, recognizing that R&D and innovation are critical to production efficiency gains and economic growth. On this basis, policy makers may be less concerned with tax relief that provides windfall gains to investors (i.e. tax relief on investment that would have been undertaken in the absence of tax relief). That is, where a main objective is to remove impediments to R&D investment, and thereby encourage R&D to levels that would be observed under a neutral tax, less concern may be given to tax relief on infra-marginal R&D, given interest in supporting this group (as opposed to non-performers). An approach of targeting R&D firms also recognizes that R&D activity is mobile. Therefore, in a world where countries compete to attract R&D performing firms, tax relief targeted at R&D may be necessary to attract and maintain existing levels of R&D activity (while recognizing that the attractiveness of a country, as a base for R&D, depends on a number of important non-tax factors (e.g. availability of skilled labour, intangible property rights) and other features of a host country's tax system.

2.3.6. Cost considerations: re-qualifying business expenses as R&D expenses

In the presence of generous R&D tax provisions, firms face a tax-induced incentive to re-qualify 'normal' expenses as R&D expenses in order to benefit from the R&D tax provisions. However, there will not be a return linked to this input. Firms are probably able to inflate their claim for R&D tax provisions because they are actually undertaking some genuine R&D. The requalification of these other expenses – i.e. the excessive use of R&D tax provisions – should then be considered when calculating the effective tax burden on R&D investment in the METR framework. If a marginal investment in R&D implies that an additional unit of non-R&D expenses can be qualified as R&D expenses, the additional use of R&D tax provisions will have to be considered in the METR model. This double use of R&D tax provisions for one unit of genuine R&D investment will then effectively reduce the tax burden on intangible investments.

2.3.7. Profit vs. Expenditure Based Tax Relief

As noted above, tax relief for R&D typically focuses on tax incentives that lower the net cost of R&D expenditure, and ignore tax-planning aimed at minimizing tax on income from the use of knowledge

capital, created in an increasing number of OECD countries with significant tax incentive support. A more detailed and accurate assessment would factor in the tax treatment of returns on R&D taking into account commonly used tax-planning strategies.

Factoring in limited taxation of returns on mobile intangibles is necessary to address behavioural effects. A policy of offering tax incentives for R&D expenditure, while taxing at a relatively high rate the returns on knowledge capital used in or licensed from the home country would be expected to encourage:

- domestic R&D expenditure, subsidized by R&D tax incentives; and
- transfers of knowledge capital offshore, so that returns on development activity and commercial applications can be received tax free.

Tax policy may be questioned where it provides generous tax support for R&D expenditures, imposes relatively high rates of tax on royalty income received directly, and at the same time waives current taxation of royalty income received by offshore IP holding companies. While policy assessment should factor in spillover benefits of domestic R&D, the tax base implications of such an outcome lead one to consider alternative policy options.

A reduced domestic tax rate on foreign royalty income – involving a targeted rate reduction or a general CIT rate reduction taxing all business income at a reduced rate – may discourage the migration of intangibles offshore while at the same time encourage domestic R&D. Revenue losses could be financed in part by a less generous set of tax incentives for R&D expenditure. However, targeting foreign royalty income may raise concerns, while reducing the basic CIT rate tends to be expensive in terms of foregone tax revenue. It may be that tax revenue gained by reducing or even eliminating tax incentives on R&D expenditure would cover revenue losses of only a small cut in the basic CIT rate (e.g. 1 percentage point). Where royalty income can be received tax-free offshore, migration would continue to be attractive to business. This suggests that to effectively discourage the migration offshore of intangibles, steps may be required that apply and enable robust enforcement of controlled foreign company rules that tax passive foreign royalty income on a current basis.

2.3.8. Methods that countries implement in an attempt to tax the return on IP

Many low-tax countries have introduced R&D tax provisions as well. This seems surprising, as these countries levy low CIT rates. One of the possible aims of these strategies, in addition to a genuine objective of stimulating innovation, might also be to attract tax bases from other countries. IP holding companies that actually invest in R&D in the low-tax country (benefiting from the R&D tax provisions) might then convince the tax administration in the country of residence that the IP has created jointly under a cost sharing agreement. This might allow MNEs to shift profits from high to low-tax countries.

These examples suggest a necessary role for anti-avoidance measures to protect a country's domestic tax base and nullify tax planning strategies. The application of transfer pricing rules is an obvious example. Another strategy would be for countries to disallow the tax deductibility of royalty payments for IP rights held by a subsidiary offshore in a tax haven country. This section will focus only on Controlled Foreign Company (CFC) rules.

CFC rules operate by levying taxes on a accrual, as opposed to deferred basis, at the level of the parent company on passive income earned by a foreign subsidiary – typically resident in no-low tax jurisdictions - that is controlled by the parent company, with home country tax payable even if foreign income is not repatriated when it is earned. These rules therefore prevent deferral of residence country's

taxes until profits are repatriated. Put differently, these rules allow residence countries to tax the foreign earned income of their MNEs as if it is earned within the residence country.

CFC rules are typically only applied when certain conditions are met. These criteria vary across the countries that implement CFC rules. CFC regulation applies if the parent owns at least a particular amount of shares of the subsidiary (ownership threshold). Most countries have restricted their CFC legislation to subsidiaries that are located in tax havens, although some countries apply a more global approach under which CFC rules can also be applied on subsidiaries located in high-tax countries. Countries might be designated as a tax haven by comparing the taxes that are levied in the host country with the taxes that would be levied in the residence country.

Some countries employ an "entity" approach which exempts certain CFCs that are engaged primarily in genuine business activities or that reside in a particular foreign listed countries (included in a "grey list"). Other systems follow a transactional approach, where only certain types of 'tainted' income (as opposed to active business income) earned by the subsidiary is taxed under the CFC rules of the parent country's tax system. Tainted income usually consists of passive income such as dividends, interest, rents, capital gains and also royalties (Arnold and McIntyre (2002)).

Note that some countries, e.g. New Zealand, are currently reforming their rules for taxing controlled foreign companies to improve the competitiveness of their tax system and to encourage businesses with international operations to remain, establish and expand within the country.

3. Greening of the economy

Environmental issues pose significant challenges for governments. Some, such as climate change, will necessitate a significant reorientation of the modern industrial economy, with innovation being critical to addressing environmental challenges efficiently, at the lowest possible cost. The development of incremental and breakthrough innovations related to climate change, for example, can halve the expected cost of action (OECD (2009)).

In this realm, two types of market failure may be identified. Environmental degradation produces negative externalities in society, as the cost borne by the polluter is less (even zero) than the cost borne by society, resulting in a level of pollution above what is socially optimal. At the same time, when a firm is encouraged (e.g. by an environment tax) to introduce innovative technology for abatement, the returns to innovation cannot always been completely internalised and captured by the innovator, producing positive externalities that result in a level of innovation below that of the social optimum.

Governments have struggled with how best to address these issues. On the one hand, measures to address the negative externality of pollution seek to place a value on the environment, thereby encouraging firms to consider the damage done to the environment. In doing so, agents undertake more environmentally friendly activities and a more social optimal level of pollution may be attained. Pollution abatement may involve adopting technology that exists elsewhere, through a purchase or licensing agreement, possibly reorienting production processes.

The type of instrument is also important. It is widely accepted that the use of economic instruments, in particular environmentally-related taxes and tradable permits, is generally preferable to regulation, as a means to address environmental degradation, such as excessive CO_2 emissions. More rigid measures, such as technology-prescriptive regulations, limit the availability of options for firms to address environmental pressures, while market-based instruments, such as carbon taxes or tradable permits, can provide a greater range of potential options for individual agents.

In addition to the range of options that market-based instrument can provide to firms, there are also incentives for innovation and abatement. By creating a tax or a price on emissions (or some other similar constraint) to which agents are subject, the effect is to induce abatement and innovation by firms seeking to reduce their new cost burden. A Pigouvian tax equal to the negative externality is deemed to correct the market outcome and its objective is to shift the marginal private cost up by the amount of the tax (which approximates the social cost of the polluted market activity). A carbon tax, for example, can act like a level oil price increase, inducing firms to develop new fuel-efficient products or purchase new equipment to recalibrate their processes and economise on fuel consumption. With this regard, a pigouvian tax has the effect to increase the private rate of return of investments in clean technologies.

On the other hand, governments have also tried to encourage environmental performance from the other direction. By providing R&D subsidies and tax credits, the cost of undertaking innovative activities is reduced, thereby increasing the expected rate of return to firms and expanding the quantity of research and development undertaken. From the environmental perspective, it is hoped that extensions of the innovation frontier will induce firms to innovate and adopt these technologies, and reduce their environmental impact.

Measures to address international competitiveness concerns over the broad use of environmental taxes, for instance, channelling some portion of environmental tax revenues back to affected companies, should be carefully designed so as to not offset the intended abatement incentive effect of the instruments. While political economy issues cannot be ignored, it should be recognized that such compensation measures are generally very difficult to efficiently administer (for instance giving money back to industries on prior production).

Providing tax relief through R&D tax incentives for subsidizing abatement and expenditures on environmentally-clean technologies may address market failure where inadequate recognition is given by R&D performers of positive spillover effects. However tax assistance for such expenditure can introduce distortions against alternative abatement approaches that may be more efficient (e.g. the use of cleaner fuel as opposed to investment in carbon "scrubbers"). Moreover it could be argued that subsidising green innovation through R&D incentives is less efficient than charging a tax equal to the external costs from the polluted activities: while tax expenditures have a hidden cost as they must be financed by distortive taxes, a Pigouvian tax does not create distortions but brings to increase tax revenue and to recycle government revenue from green tax.

Using environmental or innovation policy brings about different results, however. Environmental policy, especially using market-based instruments, aimed at the problem of environmental challenges brings about both adoption and innovation. R&D tax credits and allowances on expenditures, by reducing the cost of undertaking R&D activities, encourages innovation but does little to address adoption. Without a profit motivation to invest in new technologies, adoption of environmental technologies is limited along with the impact on the environment. OECD (2009) estimates of climate change suggest that R&D policies alone will not induce enough innovation to stabilise carbon concentrations in the atmosphere, even at implausibly high levels, as the incentive to adopt is limited.

All this suggests that the most important factor in greening the economy is the presence of policy instruments that provide incentives to innovate and incentives to adopt the innovations. R&D subsidies targeted towards environmental objectives can play an important role, especially for basic research or for research into high-risk projects, which are long term activities with highly uncertain return (such as the search for nuclear fusion as an alternative energy). However, R&D subsidies as the primary instruments to green the economy are likely to be significantly less cost-effective than other measures, even if significant levels of R&D activities are induced.

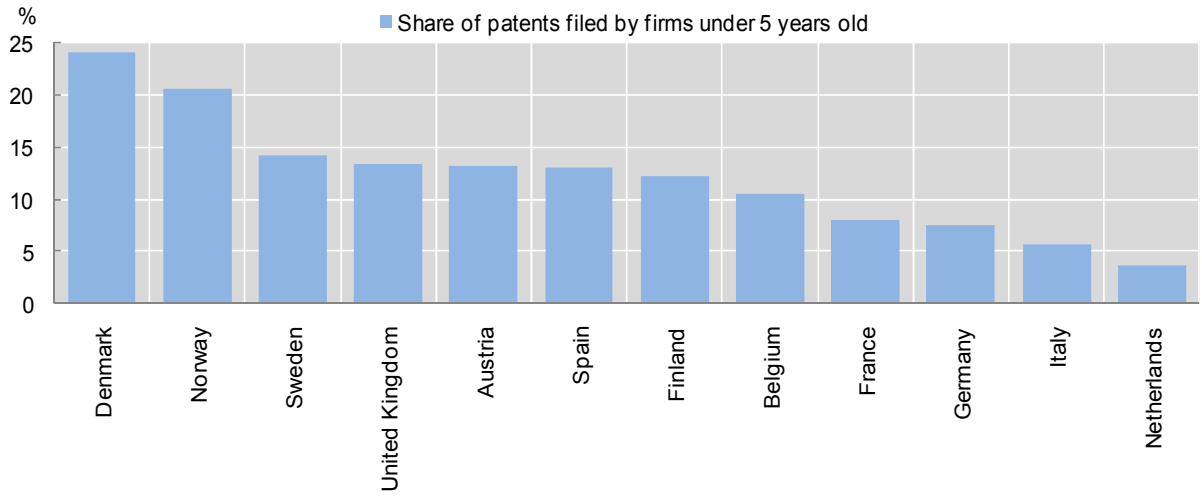
4. The impact of the tax system on business creation and risk taking

This section considers the impact of the tax system on risk-taking by new and existing innovative businesses. Despite claims that innovative new and small firms are the driver of innovation and growth compared to large firms, the evidence is mixed. It appears that only a small group of them within the total small firm population is highly innovative and makes a major contribution to innovation. While it is clearly true that many small firms do not want to grow and undertake innovative activities (e.g. the local corner shop), other small firms might face obstacles, such as lack of external funds, that could partly faced through the tax system. For instance, the tax system might may play a role and have an impact on financing of the innovative business's investments. This section discusses possible effects of the tax system on the constraints faced by small and medium-sized firms and discusses possible pro-innovative tax policies.

The innovative process can be led by the creation of new firms or the restructuring and reshaping of existing businesses. Figure 6 shows that a high number of patents is filed by young firms. Innovative start-ups are highly risky and dynamic and have limited access to the capital market. They are typically high growth firms that retain and reinvest their profits. Moreover, small firms and start-ups typically do not create innovative activities by themselves, but are highly dependent on interactions with other firms, with universities and research institutions. For this reason, it may be argued that the tax system should not discourage these innovative cooperative processes and joint projects. The following section summarizes and interprets the results drawing from a tax policy study on taxation of SMEs (OECD (2009)) in order to assess whether the current tax framework triggers innovative activities.

Figure 6: Patent applications filed by young firms, 2005

As a percentage of patents filed by firms at the European Patent Office (EPO)



Source: OECD, HAN database, October 2009 and Bureau Van Dijk Electronic Publishing, August 2008.

4.1. Business creation

Tax systems should not discourage employees to become entrepreneurs and create their own businesses to undertake investments in innovative activities.

The recent OECD policy study on taxation of SMEs mentioned above has demonstrated the potential for tax to influence the decisions over whether to move from dependent employment to establish one's own business, other than the decision to structure an SME in incorporated or unincorporated form.

The creation of a company, typically a SME, is influenced by several considerations on personal and corporate income taxation together with social security contributions (SSC). The analysis examines possible tax distortions and presents results for four OECD countries: New Zealand, Norway, Sweden and the UK.

The analysis of possible tax distortions conducted in this study is based on calculating and comparing "all-in" Average Statutory Tax Rates (corporate and personal income tax, plus social security contributions (SSC)) for a hypothetical individual taxpayer who provides both labour and capital inputs to derive income in one of three ways: as a dependent employee; as a single owner/worker of an unincorporated business; and as a single owner/worker of an incorporated business. If in business, the individual is assumed to have no employees. The calculations assume that the individual is single with no dependents. The taxpayer is assumed to have no other sources of taxable income.. It's worth noting that the discussion contained in the tax policy study (and the following conclusions) relies on the "all-in" Average Statutory Tax Rates (ASTRs): this index has to be managed with caution in an innovation context as it is likely highly sensitive, not only to the choice of the legal form and the type of financing debt/equity, but also to the timing and flows of income from R&D assets (and treatment of incentives and losses).

The tax burden of the hypothetical taxpayer will vary depending on three key factors that need to be controlled for: the amount of income earned; the relative contributions of labour and capital inputs in deriving the income (which may vary significantly by type of business activity, and may be able to be manipulated), and dividend distribution policy. To take account these factors, ASTRs are provided for fixed income levels, differing levels of capital income (as a proportion of total income), and differing dividend distribution policies; the fixed income levels are set equal to a multiple of average wage earnings in the relevant country, so as to provide comparability across these countries.

While the case studies are country specific and based on a number of assumptions, the illustrative results demonstrate the potential for tax to influence both decisions over whether to create an SME, and how to structure one, and also how these decisions depend on capital versus labour intensity. In two of the four case studies (Sweden and the U.K.) a tax distortion is found towards formation of an SME at most capital income proportions, irrespective of dividend distribution policy. For the other two (New Zealand and Norway), the potential distortion varies with both distribution policy and capital intensity. However, a tax incentive to form an incorporated SME is found in both countries where a significant fraction of corporate profits is retained, and where the business is not highly capital intensive.

As regards the SME business structure decision, the case studies show a general bias towards incorporation with full retention of profits. This is largely because incorporation tends to reduce SSC, and avoids possible additional taxation of capital income on distribution. Even with some distribution of profits, the incorporated form is still generally favoured in the UK, New Zealand and Norway. Sweden is the clear exception, where the ability to both retain unincorporated business income within the business, as well as have distributed income split into both capital and labour components, make the unincorporated form attractive from a tax perspective.

More broadly, the case studies also show that the capital income proportion can substantially influence the ASTR faced by an SME. In general, for the UK, Sweden and Norway, ASTRs fall as the capital income proportion increases, while in New Zealand there is a range of capital income proportions over which the ASTR is minimised. This raises two policy considerations for tax policy makers to be aware of, in addition to the possible distortions to business creation and structure decisions. First,

taxpayers may have an incentive to artificially re-characterise (generally to increase) their true capital income proportions to minimise tax liability. While the nature of a business will determine broadly the capital/labour income ratio, there is likely to be a margin around the "true" capital/labour income ratio that can be exploited. This could be achieved by, for example, the owner/worker paying him/herself a below/above-market wage for their labour input. Audit activity would be expected to prevent gross re-characterisation away from true ratios, but may not detect small alterations.

The second policy consideration is that, where taxpayers are unable (or unwilling) to re-characterise income, they may have an incentive to shift production structures (e.g. capital/labour mix) towards factor combinations that are tax favoured but possibly not production efficient.

4.2. How companies deal with growth and risk taking

4.2.1. The choice of the legal form

Once the decision to create a business has been taken, entrepreneurs will have to choose between creating an unincorporated versus incorporated business. In the case of a sole proprietorship – that is an unincorporated business with or without employees owned by one individual – business income, which consists of labour as well as capital income, is normally subject to the progressive personal income tax and self-employed social security contributions on a current basis. Where two or more individuals invest in a business through an unincorporated partnership, generally the same taxes apply, with business profits (and losses) allocated to the business partners to be subject to tax at the individual level (personal income tax and social security contributions) without business-level taxation. Such 'flow-through' entities avoiding business-level taxation may include general partnerships, limited partnerships, and possibly other partnership structures. This contrasts with the current taxation of profits of an incorporated business according to corporate income tax rules – involving the possible use of graduated (tiered) corporate tax rate structures – with typically additional personal (shareholder) taxation on a current or deferred basis, depending on the distribution / retention policy of the firm. This will have an impact on whether the personal shareholder will have to pay dividend taxes or capital gains taxes, if any. Managers-owners of a closely-held corporation will also earn labour income which is taxed under the personal income tax and employee and employer social security contribution system.

The decision to incorporate or not depends not only on taxes. A sole proprietor may be held personally liable for business-related obligations, including debt-obligations to creditors, and business tax liabilities. This means that personal assets (e.g. investor's personal residence) may be seized to meet these liabilities. Owners of an incorporated business, however, enjoy limited liability. Note also that with a general partnership, each individual partner may be personally liable for business liabilities. With a limited partnership, personal assets of investors providing capital but not management advice ('limited partners') may not be regarded as business assets (not at risk), so that the maximum capital that a limited partner may lose is the amount of capital he/she has invested in the business.

Small firms (measured by turnover, assets, total employment) with generally lower profits than large firms, tend to be disproportionately impacted by fixed costs. A commonly cited example concerns tax compliance costs – that is, costs involved with recording transactions, maintaining financial and tax accounts, calculating tax liabilities, making tax payments to government, and undertaking other compliance requirements under a self-assessment system. Since compliance costs have a fixed (common) component for all taxpayers, they impose a relatively higher burden on SMEs than larger firms measured as a percentage of turnover or profit.

As regards the SME business structure decision, the recent study on the taxation of SMEs (OECD (2009)) mentioned above shows a general bias towards incorporation with full retention of profits, which is

generally the case for highly innovative firms. For firms reinvesting their earnings, the taxation of corporate profits at a low rate compared with high PIT rates and self-employed SSC on personal business income in the case of an unincorporated business, combined with the ability to defer shareholder taxation of profits, tends to increase the relative attractiveness to profitable SMEs of incorporation as a choice of business form. This is especially the case if small business CIT rates apply and where the manager-owner of the corporation can shift part of its highly-taxed labour income into lower taxed capital income. In fact, the attractiveness of the corporate form will typically increase with this amount of (labour versus capital) income shifting as the combined burden of personal income taxes and especially high SSC on labour income in many countries exceeds considerably the tax burden on capital income. This conclusion holds especially for highly innovative SMEs that retain and reinvest their earnings, implying that the dividend taxes at the personal shareholder level are deferred (until the firm starts distributing dividends) and that a lower effective capital gains tax will have to be paid (as it is levied only when the capital gains are realized), if any.

4.2.2. Tax-loss treatment in SMEs

In addition to tax reasons mentioned above, the decision of entrepreneurs to form an incorporated business is also driven by the highly uncertain return on their investments and by their business's early-stage loss-position. Business losses (and taxable losses) are incurred by firms of all sizes. For small businesses with large start-up costs, and limited revenues when first entering a market, losses may be likely during initial years of the business. To the extent that most businesses start up small, the tax treatment of losses is particularly important to small companies, recognizing the more limited ability of new firms, compared to large established (mature) firms with diversified revenues, to claim tax losses. Therefore it is interesting to consider how generous the tax treatment of losses is in different systems – that is, the degree to which business losses can be deducted against other income, or are ring-fenced – and whether more generous treatment is targeted at small businesses in some countries.

At the same time, the tax treatment of losses can have a considerable impact on risk-taking. Entrepreneurs will be inclined to take more risks the higher the degree to which business losses can be deducted against other income (instead of being ring-fenced) and the higher the degree to which losses can be carried forward or backward.

The percentage of small enterprises in a tax loss-position may be significant. The data presented in the Taxation and SMEs Report (OECD (2009)) shows large numbers of businesses in a tax-loss situation (dependent in part on underlying business losses). In Greece, Ireland, Italy, New Zealand, Norway and the Slovak Republic, roughly 20 per cent of firms are in a tax-loss position, with the figure climbing to 24 per cent in Austria, and 40 per cent in the U.S. Roughly 50-60 per cent of these firms are unincorporated in these country examples.

In comparing across countries the treatment of unincorporated business losses, systems can be distinguished according to the degree to which they 'ring-fence' losses. Strict ring-fencing would deny a deduction of unincorporated business losses against other taxable income of the taxpayer in the same year (e.g. investment income, rental income, wage income, pension income), by only allowing business losses to be deductible against future business profits realized in subsequent tax years under business loss carry-forward provisions. More flexible ring-fencing provisions would allow business losses to be deductible against other types of taxable income, in addition to providing loss carry-forward and possibly also loss carry-back provisions, thereby providing greater scope for deductions for business losses (and thus greater symmetry in the treatment of business profits and business losses). Loss-offset provisions may differ considerably across countries in terms of the types of non-business income that business losses can be deducted against, and the allowed number of carry-forward (and carry-back) years.

Systems providing greater scope for business loss offsets, at the cost of foregone tax on other income, may (or may not) be designed to target the relief to genuine business losses (as opposed to losses on consumption activities), to active business owners as opposed to passive investors, and possibly to newly-established firms to address possible tax impediments to business start-ups. Systems may be differentiated according to whether ring-fencing rules apply equally to firms regardless of their size, or whether more flexible rules apply to losses of smaller firms, targeted under some measure of size, possibly with additional restrictions to steer relief where intended.

Box 4. Loss treatment - Country Examples from the Taxation and SMEs Report, OECD (2009)

The Czech Republic, Italy, Mexico and Poland all have ring-fencing rules that deny the deduction of unincorporated business losses against non-business income (the rules applied in Italy came into effect only recently, in 2006). The Czech Republic and Poland both limit business loss carry-forward to five years, while in Mexico a 10 year carry-forward applies. In each of these country examples, the rules do not differ according to firm size.

Business losses realized by individuals in the Slovak Republic may be deducted against other types of taxable income, with the exception of employment income, with unused losses carried forward for up to 5 years. Similarly for Norway, business losses may be set off against capital income, but not employment income, in this case owing to the separate taxation of wage income in the Norwegian tax system. Norway has recently moved to an indefinite loss carry-forward period (previously 10 years).

In the other (14) countries included in the study, unincorporated business losses may be deducted against non-business income, including employment income, with different approaches taken to target the loss offset relief to legitimate business activities where restrictive loss treatment could inhibit SME creation and growth. For example, business losses in Denmark may be deducted from personal income which includes employment income. Any excess of business losses over personal income can be carried forward indefinitely (whilst losses incurred before 2002 are limited to a five-year carry forward). Special rules apply to limit business loss deductions to deductions in respect of earning "legitimate" or "real" business income.

In Australia, business losses may be deducted against other taxable income in the year, provided that five criteria are each satisfied. The criteria require that the assessable income and total assets of the business activity exceed certain thresholds; the activity is a primary production or professional arts business that results in taxable income in 3 out of the previous 5 years; the taxpayer's taxable income from other sources is below a given threshold; and the loss arises in circumstances outside the taxpayer's control, or from an activity with a significant commercial purpose (e.g. a start-up expenditure) and the Commissioner of Taxation's discretion is exercised. Unused business losses may be carried forward indefinitely (no carry-back).

Similarly, in Germany, business losses may be deducted against other taxable income in the year, subject to a number of special restrictions, including limits on the deductibility of losses incurred from animal husbandry. Strict ring-fencing rules also apply to losses from forward transactions of non-financial institutions, losses from certain 'dormant' partnerships, losses in certain cases of limited liability, and to losses from certain tax deferral schemes. A capped amount of business losses may be carried back one year, with an indefinite loss carry-forward also provided, subject to capping rules.

Under passive activity loss rules in the U.S., a business owner that is a "passive" investor, not involved in a regular, continuous and substantial way in the operation of the business activity, is only allowed to deduct business losses against other "passive" income. If instead an individual "materially participates" in the activities of a business, losses may generally be deducted against non-business income. Net operating (business) losses may be carried-back two years and then forward for up to 20 years.

4.3 High-risk equity financing in innovative companies

Another argument for R&D tax incentives considers capital market imperfections resulting from information asymmetries. Perhaps the most commonly cited example is where the profitability of a business, in particular an early-stage business with highly uncertain (risky) returns on R&D, is better understood by managers of firms than by outside creditors. Asymmetric information may result in the

extension of credit to firms with 'quality' R&D investments but at excessive interest rates (in excess of what would be charged with symmetric information), or no funding (at market rates), or costly signalling, implying in each case under-investment.

Another example of information asymmetry arises where outside equity investors are unable to monitor activities of managers who may engage in consumption activities inconsistent with the maximization of firm value. In such cases, asymmetric information, leading to significant monitoring costs or demands for increased rates of return by outside investors, may lead to under-investment relative to an efficient outcome based on symmetric information. Arguments for tax incentives to correct for capital market imperfections of this type may refer to results from 'adverse selection' models.

Proponents of targeting a richer set of R&D tax incentives to SMEs may point to capital market imperfections and information asymmetries that are particularly pronounced for small firms. For example, due to their size, medium- to large-scale firms may have fewer difficulties in encouraging potential equity providers to study business plans where returns are highly uncertain. Venture capitalists, for example, may be disinterested in considering small equity deals given lower average 'due diligence' costs (possibly due to a significant fixed cost component) in reviewing larger business deals. Furthermore, large firms generally have larger hard asset pools offering more collateral to support loans, and greater access to international capital markets.

These considerations lead to assess that newly created innovative businesses with highly uncertain (risky) returns typically face difficulties in raising a sufficient amount of funds, partly due to capital market imperfections which likely have become more severe as a result of the global financial and economic crisis. Asymmetric information may result in the extension of credit to firms with 'quality' investments – projects that have an expected rate of return in excess of the market rate – but at excessive interest rates (in excess of what would be charged with symmetric information) and no or limited equity funding.

Moreover, due to the lack of clearly defined intangible asset behaviours, loan providers tend to overestimate the risk of default of loans collateralized by intangible assets. To account for this associated risk, bankers offer loans only with high discount rates on the underlying assets and underestimate the potential cash flows generated by them. The cost of capital rises and the ability to leverage intangibles diminishes, reducing the opportunities to obtain capital to finance new investments. In the long run, this distortion in the capital markets slows economic growth and erodes investor confidence in the new market economy.

These companies might also be too small or too young to secure conventional bank financing. The tax system could therefore aim at providing relief for these market imperfections by stimulating the supply of venture capital, for instance by providing up-front tax credits or tax allowances to private investors when investing directly in start-up firms or indirectly through venture capital funds.

In addition to providing support to alleviate financial market imperfections through favouring the supply of financial sources, the tax system should not create additional obstacles for start-ups in attracting funds to finance its innovative investments by taxing the return on venture capital investments unfavourably. It is often argued that a high capital gains tax rate has a negative impact on risk-taking and the funds that will be invested in start-ups. Contrarily to the common view, a high capital gains tax rate might, under certain conditions, just enhance risk-taking. This striking result will be explained in the sub-section.

4.3.1 Stimulating the supply of venture capital through the tax system

Individuals can either invest directly in start-up and highly innovative businesses or indirectly through venture capital funds in order to diversify their portfolio. In order to stimulate the supply of venture capital, countries could provide up-front tax credits or allowances when households invest, either directly or indirectly, in highly innovative businesses. Canada, for instance, provides an up-front personal income tax credit for investment in its Labour Sponsored Venture Capital Corporations (LSVCCs) program. Individuals who make venture capital investments through LSVCCs are eligible to receive a 15 per cent non-refundable federal tax credit on investments up to CAD 5 000. Most Canadian provinces provide a matching credit, implying a tax credit of 30 per cent. Other countries provide similar tax relief for direct savings in highly innovative businesses.

These tax provisions make the venture capital investments highly attractive, as it implies a low effective tax rate on the investments' return. However, this approach has disadvantages. First, these provisions reduce tax revenues considerably. Moreover, it might lead to an excessive supply of funds, as is for instance the case in Canada where recent evidence shows that the LSVCCs are underperforming. Moreover, poor governance has also been identified as an important weakness in the LSVCC model.

Charities and non-profit organizations are intermediaries and can therefore be considered to be indirect ways to invest in highly innovative businesses or projects. Charities seem to play an important role as organizations that finance innovative activities, especially in the United States. The tax system seems to play an important role in this because of the favourable tax treatment both in terms of the entities (tax exemption at the entity level) but also in terms of the contributions made by individuals and corporations as the contributions are deductible from taxable income. Also in case of charities, governments must trade-off the disadvantages of the generous tax treatment (e.g. reduction in tax revenues) with the gains (e.g. positive spill-over effects from the projects that the charity is investing in, or reduced costs for government financing certain projects that charities do not).

4.3.2. The capital gain tax rate

This section assesses the tax treatment of capital gains and losses that represents one of the main economic push factors for individuals who undertake venture capital investment. The standard model that studies the impact of the capital gains tax on risk-taking assumes that individual investors are risk averse – i.e. their marginal utility of wealth declines – and prefer a certain return on a safe asset to an uncertain return on a risky asset, at the same expected return. Another fundamental assumption of the model is that capital gains are taxed as they accrue and also capital losses are deducted as they mature at the same effective rate applied to taxable gains and against any other taxable income (employment and capital income).

The counter-intuitive result from this model is that a capital gains tax that treats capital gains and losses symmetrically may operate to increase risk taking, defined as the percentage of wealth placed in an asset with a risky and uncertain return. The tax may provide a risk subsidy and, as a result, encourages the amount of risk-taking in the economy through individual portfolio reallocation between safe and risky assets. The explanation of this result lies in the behaviour of a risk averse investor who is willing to pay a premium to avoid risk and uncertainty associated with a risky investment. The increase in the capital gains tax burden reduces the difference between the expected returns (gains and losses); it reduces the after-tax capital gain but reduces also the cost of the losses (increase of the gain of deductibility), thereby reducing the variance of the return. Therefore, an increase in the capital gain tax rate corresponds to the conditions sought by a risk averse investors. As a result, the investor will partly offset the effect of the increased capital gains tax rate by enhancing his risk-taking behaviour. This conclusion holds if (and only if) the tax treatment of gains and losses is fully symmetrical, so that there is an effective reduction in the variance.

The model implies that governments, in order to encourage risk-taking and to boost start-up companies that invest in innovation, should tax capital gains while providing symmetric treatment of losses, rather than reducing the capital gains tax rate. This suggests that governments should consider less restrictive capital loss treatment where current claim provisions result in a deferral/delayed use of losses (often not immediately deductible), which implies that losses are effectively deductible at a lower rate. Governments might therefore allow losses to be carry forward in the future with an interest adjustment, allow excess capital losses to be deducted against a broader measure of taxable income – not only against other capital gains but also, for instance, employment income – or increase the capital loss inclusion rate.

However, less restrictive capital loss treatment tends to open the door to tax-planning activities that abuse the tax system without increasing risk-taking (Box 5, point 3). A limitation of loss offset provisions might therefore be desirable, e.g. by allowing losses to be only offset against similar types of income.

Moreover, a full loss-offset is not costless to government, which becomes a silent partner in the investment as it shares the cost of losses, because it reduces tax revenues. For this reason, the decrease in tax revenues as a result of a full loss-offset should be weighed against the positive effect of the increase in risk-taking by entrepreneurs and businesses. This trade-off may differ substantially across countries.

It is also important to recognize that often capital gains are taxed effectively at a lower rate than the statutory CIT rate, for instance as a result of deferral behaviour. In this case, the effective tax rate on capital gains will be lower than the rate at which losses are deductible. This will tend to encourage excessive risk-taking. Hence, the optimal degree of risk-taking – the amount of risk-taking that follows from the standard model in case all its assumptions hold – will not be achieved if capital gains and losses are effectively not treated symmetrically either as a result of government rules or as a result of agents' tax-planning behaviour. In this case, governments might indeed have an incentive to actually ring-fence losses, for instance by only allowing deductibility against similar types of income. In an international context, governments might then implement "loss allocation rules" (similar to interest allocation rules) in order to avoid losses being deducted at higher rates than the rate at which the capital gains are effectively taxed.

Where capital gains are taxed effectively at a higher rate than the rate at which losses are deductible, a reduction in the capital gains tax rate will increase the after-tax capital gains but will also decrease the gain of the deductibility of losses. The decreasing rate will reduce risk-taking, but this effect might change if governments avoid ring-fencing of losses and implement a symmetric treatment of capital gains and losses.

In summary, a high capital gains tax or a favourable treatment of capital losses will increase risk-taking in individual portfolio but only if there is full symmetrical treatment of gains and losses, which means that gains are *effectively* taxed at the same rate than the rate at which losses are *effectively* deductible.

Box 5. Capital gains taxes (CGT) and risk-taking: Assessment of assumptions

What are the assumptions of the standard model that predict increased risk-taking through an increase in the CGT rate while providing fully symmetric treatment of capital gains and losses?

1. Taxation upon accrual;
2. Immediate deduction of losses;
3. Deductibility of losses from capital gains or other types of income;
4. Same statutory tax rate is applied to taxable gains and to deductible losses;
5. Same partial or full inclusion rate of gains and losses in the tax base;
6. Focus on individual investment and risk-taking behaviour.

What is the actual impact on risk-taking when these modelling conditions are not met? How can tax policy be designed to address the resulting distortions in investment behaviour, in such a way that risk-taking is not impeded?

1. What is the effect by changing from an accrual to a realization based system (as usually is the case in the reality)? Theoretically there seems to be limited effects on risk-taking where both taxable gains and losses are deferred. However, this kind of system creates tax planning opportunities that have an impact on the degree of symmetry. The effective tax rate on capital gains is expected to vary, depending on the specific investor situation/behaviour and deferral opportunities. Investors can reduce the effective tax rate on taxable capital gains by deferring the realization date of the assets (postponing the sale of the assets). In the presence of this kind of tax planning and in order to stimulate the same level of risk-taking, while increasing the effective rate of deductions of capital losses by claiming them immediately, the government could implement slightly less generous loss off-set rules..

2. What is the effect when losses can't immediately be offset? This will reduce risk-taking. To provide full symmetry, the government may provide a cash equivalent value of unused deductible capital losses when taxable income is insufficient to fully absorb allowable capital losses, or provide an interest adjustment to loss carry-forward claims.

3. Losses are deductible from other income, which can have either the same source or can be another type of income. What is the impact of this? The first consideration is that if losses can be offset only against the same type of capital income, risk taking will decrease because of the reduction in the deductibility of the losses. However, in the case of no limitation to the offset provisions, which implies that losses can be offset against any type of income, the government may end up stimulating consumption instead of risk taking activity. In fact, taxpayers may be encouraged to use the tax system to subsidize consumption activities which the government may not wish to support: taxpayers can obtain a tax advantage by investing in a business that has a private and consumption purpose without having a substantial economic interest, undertaking activities only with the intention to use losses to reduce other types of taxable income. It means that allowing capital losses to be set off against other types of income provides a greater and unintended scope for subsidizing consumption. Because governments wish to support only profit-oriented activities and to circumvent the possibility of abusing the system for consumption purposes, they might allow losses to be set off only against capital gains on similar and related investment.

4. What if the same statutory tax rate is not applied to taxable gains and to deductible losses? What is the impact (assuming a full loss offset) when the other income from which losses can be deducted is taxed at a progressive/higher rate? In this case, risk taking will be encouraged because the gain from the loss deduction increases. There will be a reduction in risk taking if losses are deductible at a lower tax rate. (Note that he amount of risk-taking that follows from the standard model can be considered to be the optimal amount of risk; higher degrees of risk can be considered to be "excessive" degrees of risk-taking).

5. A symmetric treatment of gains and losses requires also that gains and losses have the same partial or full inclusion rate in the tax base. A deviation from this rule will have an impact on risk-taking. As typically governments constrain loss claims, implying asymmetric treatment because losses are not deductible at the same effective rate applied to tax gains, such a system will discourage risk-taking compared to the full loss offset case.

6. The standard model focuses on individual risk-taking. But how do the results vary if a corporate investor is assumed? Businesses are usually considered to be risk-neutral. In that case, the level of the capital gains tax rate is neutral regarding risk-taking as long as there is a full-loss offset / if gains and losses are treated symmetrically. The conclusion that gains and losses should be treated symmetrically is therefore also a conclusion that holds for risk-neutral investors. If gains are effectively taxed at a lower rate than the rate at which losses can be deducted, the tax system will result in "excessive" risk-taking! What happens if losses of MNEs can be deducted in a high tax county while gains are realized in a low tax country? This will increase investment and excessive risk-taking. What if venture capital financing is done mainly by pension funds or foreign investors exempt from domestic capital gains tax? In that case, it would be unlikely that liberalizing domestic capital loss offset rules (or reducing the capital tax rate) would materially impact on the level of risky investment undertaken.

4.4 Tax measures to foster innovation through cooperation

Innovation is best seen as a collective process in which all types of firms and research establishments are involved in deliberate collaborations and other interactions – including also mergers and acquisitions – that lead to the generation, transfer and exploitation of knowledge. For instance, small firms and start-ups typically do not create innovative activities by themselves, but are highly dependent on interactions with other firms (often large ones), with universities and research institutions. Businesses that create a network might overcome the obstacles to innovation, for instance because they are too small to pay for the costs of innovation. Joining efforts between similar types of firms might be an outcome to obtain a large enough scale and synergy. Also competitiveness poles – e.g. associations of enterprises and research and training centres that share a development strategy implemented through joint projects – encourage co-operation and collaboration among key development stakeholders around related industries. These poles are an important occasion to break up with isolation and share the risk of R&D and innovation investment with other partners.

In principle, tax systems should provide neutral tax treatment. The tax system should not influence the decisions of businesses to reshape their operations in the most efficient way from an economic perspective. This means that tax systems should not create obstacles nor create incentives for firms to cooperate, to enter a partnership, to merge or acquire other firms.

In the case of cooperating firms that are involved in a joint innovative process but which remain separate entities, the tax system should foresee clear rules regarding cost/risk/loss sharing agreements – in terms of labour costs, equipment and other types of assets – for unrelated parties not only in a domestic setting but also for firms that cooperate with foreign firms. All transactions related to the transfer of the joint output, for example a patent, to each participant in the joint innovative process should not be considered a taxable event. It means that the tax system should provide tax treatment similar to that where an intangible asset was self-developed.

Neutrality should also be the objective in case of mergers and acquisitions aimed at creating more efficient innovative processes. This for instance implies that assets obtained through merger or acquisition should not be taxed if the new book value exceeds the historical value; i.e. the merger should not lead to the taxation of the increase in value of the assets until the value is actually realized (when it is sold to third party). Correspondingly, firms should be allowed to depreciate only the historical value of the acquired/obtained asset.

Moreover, the tax system should also consider that firms that benefit from particular tax reliefs – for instance reliefs available to SMEs only – do not lose these gains if they decide to cooperate with other firms, carry out activities jointly or decide to merge.

On the other hand, if cooperation increases the (social) rate of return of joint R&D investment and there is a positive externality that should be factored in lower tax burden, countries might use their tax system to stimulate cooperation between firms, research centres and/or universities. Countries could provide favourable tax credits, more generous tax loss carry-forwards or tax depreciation allowances. In the case of mergers between unrelated entities aimed to restructure innovative processes, countries could, for instance, allow firms to increase the book value of their acquired tangible and intangible assets such that they can benefit from increased tax depreciation allowances. In order to prevent abuse, these provisions might be linked to the actual increase in intellectual property as a result of the business restructuring.

5. Mobility of high-skilled workers

The tax system is one of the main drivers behind the recent increase in the international migration of information technology, workers, researchers, scientists, postdoctoral students and company transferees (OECD Policy Brief (2002) on the International mobility of the highly skilled). This section discusses the impact of the tax system on the mobility of these high-skilled workers.

Several taxes affect the labour markets (personal income, payroll, sales and excise taxes affect) as they reduce the real income earned by workers to buy goods and services. Differences between the tax system of the host country and the residence country of a worker might affect the decision to migrate on a temporary basis or to settle permanently in the host country. Host countries might therefore set up rules with the aim to increase the stock of the available human capital that embody knowledge and the consequent stimulus to innovation. The decision of workers to move temporarily or even settle abroad might be influenced by the presence or absence of a tax treaty that deals with labour income issues between the different countries involved.

Note also that high-skilled workers and researchers can be employed and paid either as employees or as self-employed (e.g. liberal professionals and consultants). This will have an impact on the overall tax burden on high-skilled workers (including personal income taxes, SSCs, credits targeted to specific worker qualification), and on the labour cost and labour demand of employers.

In a small open economy, firms may bear most of the taxes paid by highly mobile workers in order to offer wages that can be earned in larger economies, implying that mobility shifts tax incidence back to the employer. In this direction, labour taxes increase business costs to the extent that such taxes are shifted on to higher pre-tax wages paid by employers. In addition, while individuals move to jurisdictions with higher wages, in the country or state they leave, wages are bid up in response to labour shortages. Moreover sectors which employ high-skilled labour tend to have high marginal effective tax rates on labour due to the progressivity system. Given the importance of skilled labour for innovative industries, personal income tax issues should be well considered (Mintz, Chen (2008)).

Workers might not only receive labour income but can also be rewarded with capital income (shares, stock options). This implies that the incentive to work in another country will not only be influenced by the personal income taxes on labour income, including social security contributions, but also by taxes on capital income. Note also that high-skilled workers that move to work for a longer period to another country might become taxable on capital income, including pensions, in the newly resident country. This implies that differences in capital income tax treatment across different countries can become an obstacle to the movement of highly-skilled workers.

In some countries, employers do not have to pay SSC on short term contracts. Researchers can therefore be attracted because they can earn a higher wage, while total labour costs may be lower for the employer. This implies an increase in both labour supply and demand. To some degree, it seems logical that short-term workers do not have to pay SSC because they very likely will not benefit from the corresponding social security benefits. However, this might distort the domestic labour market as employers face a tax-induced disincentive to hire domestic qualified labour as the cost of hiring foreigners will be lower.

High social security contributions might discourage firms from hiring highly-skilled workers and researchers. Some countries therefore provide reductions in social security contributions – in the absence of a SSC ceiling – to reduce labour costs for employers. However, neoclassical labour market theory predicts that firms invest until the marginal cost of the worker equals the marginal return. A reduction in employer SSC then implies that firms will be willing to hire researchers with a lower level of productivity;

high-productivity workers would have been hired anyway. This then seems to imply that the impact of a reduction in SSC on productivity and innovation will be rather small, as the SSC reduction only implies that only lower productive workers will be hired additionally.

The tax system might distort the mobility of high-skilled workers less, in terms of supply, if there is a strong link between social security contributions and benefits. In the case of requited social insurance contributions – where workers pay pension contributions, for instance, but these contributions accumulate on a personal account controlled either by government or a private pension fund – workers could in principle be given the choice to either pay the social insurance contributions or not. Highly-skilled workers that are resident in another country will then very likely not pay the social insurance contributions because they are not sure whether the host country's government will actually pay a benefit (e.g. pension) to them in the future. Instead, foreign workers might receive a higher wage; (i.e. they might receive the social insurance contributions as wage income). But because of the requited nature of the social insurance contributions, this does not necessarily create a difference between home and host country workers.

Some interesting observations can be made regarding pensions and the mobility of highly-skilled workers. In order to receive a full pension, taxpayers will have to work for a certain amount of years and have contributed to the residence country's social security system. Because tax systems do not necessarily consider the fact that workers have temporarily worked abroad where they possibly paid SSC, this might create an obstacle to temporarily work abroad.

Note also that in order to benefit from a full pension, workers need to have worked at least a minimum of working years. Often, studies and training periods are not considered. This implies that high-skilled workers that invest many years in their professional skills might not be entitled to a full pension at the time of retirement. This kind of distortion is solved in some countries by allowing them, in order to obtain a full pension, to buy years spent obtaining a university degree and years spent on training. The relative payments (contribution) might then be deductible from the personal income tax base.

6. Training and education

Entrepreneurial skills and attitudes, risk-taking behaviour and creativity are crucial competencies in the economy of the future that need to be nurtured by more adaptive and innovative education and training systems. The tax treatment of expenditure on training and education as well as the tax treatment of the corresponding increase in income plays a role in providing adequate incentives for education and training, both for corporations and individuals.

Increased skills in the labour market promote employment, through both supply and demand effects, workforce mobility and increased (e.g. foreign direct) investment. Firms may be encouraged to invest if the type and level of knowledge and skills in the workforce fit well with the requirements of business operations. Creating and supporting opportunities for skills-upgrading is both an objective and a means to achieve productivity gains through innovation and a wider distribution amongst the population of benefits created by new investment.

Policy makers are encouraged to design tax policies to stimulate investment in training and education not only at the individual level but also at the corporate level. Note that employees can upgrade their skills either through in-house training or by following training courses at the facilities of external providers. OECD county experience shows that tax policies on training and education differ with the nature of the (private) investors and that several distortions can be identified, as will be argued below.

Firms could be provided with tax incentives when investing in the skills of their workforce, especially if these new skills improve the innovative capabilities of these workers. Competitive markets will under-

invest in private education and training as the market does not factor in all public/social benefits of this long term investment, for instance where a trained worker with embedded knowledge leaves a company for another or sets up his own business. The question then arises whether tax systems should provide incentives for workers that obtain training, for instance by reducing social security contributions, and what shape this expenditure treatment may take (allowances from taxable income, depreciation allowances, tax credits for expenditure on training or tax deferral). Most countries provide immediate expensing for training and education costs, which implies an effective subsidy for human capital investment and represents favourable tax treatment compared to the tax treatment of other investments that have to be depreciated over time where they generate benefits in the long term. The link between tax relief and training is also of particular interest in light of the current financial and economic crisis. Governments might consider providing tax relief to firms that retrain their staff instead of laying them off.

In making work-education decisions, individuals are affected by factors such as tax credits that reduce personal income tax liabilities or allowances that reduce taxable personal income. A key role is also played by the progressivity of the PIT system and possibly also the number of income tax brackets. Progressive personal income tax systems may have a strong impact on the (dis)incentives for individuals to follow advanced studies, leading to advanced innovative capabilities. Current tax systems imply a lower tax burden for workers that face a constant stream of income over their life-cycle, like individuals who start work at a young age as low-skilled workers; while individuals that continue education for many years forego many years of income. Even though, in present value terms, the two types of workers (low/high-skilled workers) might obtain the same total amount of income during their life, the more qualified workers effectively might be taxed more than low qualified workers that face a more constant stream of income over the life-cycle. Therefore, the tax system may provide a disincentive to study and train because of the progressivity of the personal income tax system.

Note also that the degree of tax relief for the same type of investment in training and education may be different for employees, for self-employed entrepreneurs and for employees that work in their own incorporated business. It is also important to underline that education/training providers in most countries might face a different tax treatment according to their for-profit or non-profit nature, for instance with respect to a possible VAT exemption for the sale of training services, which leads to tax-induced competitive distortions.

A recent study conducted by CEDEFOP (2009) on the use of tax incentives to promote training and education emphasizes that tax incentives on their own are insufficient. In order to be effective, tax incentives should be combined with other government provisions such as grant schemes for enterprises, loan schemes, subsidies for individuals or enterprises and training funds. The overall design of support measures should be well-designed such that the final mix of instruments is mutually reinforcing and does not result in inconsistencies and distortions (CEDEFOP (2009)).

7. Conclusion: Tax Policy Principles and Recommendations

7.1 Tax mix supportive of investment, R&D and economic growth

A recent OECD study (2009) on taxation and economic growth identifies a ranking of taxes from those most-to-least detrimental to growth. Based on this work and depending on a country's current tax mix, policy makers are encouraged to shift away from corporate income tax towards taxes on consumption and immovable property. Such a shift in tax mix would be expected to be more conducive to investment, a key driver of innovation. At the same time, it is recognised that reductions in CIT rates may be constrained by tax revenue requirements, as well as other factors, such as distortions arising from significant gaps between corporate and top marginal personal income tax rates, affecting choice of business form and earnings payout decisions or affecting the labour supply from high skilled workers.

In general investments are encouraged by a stable tax regime, with a moderate income tax applied to a broad tax base. As an exception to a broad base approach, market failure arguments encourage policy makers to consider targeting incentives, at qualifying R&D expenditure, and narrowed tax base (e.g. Patent Box system).

The case for R&D subsidies is not clear cut, and may be questioned on a number of grounds, including practical experience showing that R&D subsidy programs tend to impose a significant administrative burden on government (e.g. in identifying qualifying R&D activity), depending on the efficiency of the bodies administering the program (e.g. tax administration) and the design of the subsidy instrument (e.g. R&D tax credit). The market failure argument is also difficult to translate into active policy. Spill over benefits are generally hard to measure, as is the additional (incremental) amount of R&D activity that would be triggered by tax relief. Also, spill over benefits may not be contained within and between industries in a country offering incentives, and may flow beyond the border (i.e. where specialized R&D staff immigrates abroad), implying that only some portion should be factored in.

R&D tax subsidies may be attractive relative to R&D discretionary grants, to the extent that fewer public resources are needed to administer the program, with some economies of scale realized when relying on an existing tax administration body. While new functions would be required (specialized audit skills), certain existing structures and functions could be used. R&D performers may also be able to more efficiently decide the best use of funds, under a tax incentive program. On the other hand, and depending on the robustness of auditing practices for R&D tax claims, scope for subsidizing non-targeted R&D (e.g. that mainly involves a re-labelling of activities, in order to qualify) may be greater than with a discretionary grant scheme (again depending on the degree of oversight).

R&D tax credits may be a relatively attractive incentive mechanism, compared to enriched tax allowances or deductions for qualifying current and capital R&D costs, in that the amount of relief provided is not fixed to the (personal or corporate) income tax rate. Volume-based offer certain advantages relative to 'incremental' tax credits, despite generally larger 'windfall gains' associated with the former. At the same time, even with incremental credits, much of the subsidy may be to R&D that would have been undertaken in the absence of the tax relief. Refundable (non-wastable) R&D tax credit programs, if introduced to assist non-taxable firms, should be designed and administered with considerable care.

In many OECD countries, firms performing tax-assisted R&D are able to largely avoid domestic corporate income tax on returns on R&D (e.g. patents). For example, through special cost sharing agreements between domestic parent companies and foreign subsidiaries and through the application of non-arms length prices on inter-affiliate transactions (so-called "transfer prices"), profits on the exploitation of R&D may be shielded from domestic home country tax. Such structure may also be used to artificially reduce host country taxable profits earned on other business activities. This can occur where a foreign IP holding company licences an intellectual property to its parent, or loans capital (derived from offshore licensing activity) to its parent, and charges non arm's length prices (generally difficult to identify in the case of intangible due to limited observations in the market of similar transactions).

Avoidance of home country tax on tax-subsidized R&D violates the matching principle (to tax returns generated by expenses (associated with tax incentive relief) that have been deducted against the tax base, while depleting home country tax revenues. With a reduction in domestic tax revenues requiring cuts to public expenditure programmes and /or increased reliance on other taxes, domestic welfare may be compromised. Countries are therefore encouraged to have in place anti-avoidance rules (e.g. Controlled Foreign Companies rules) and transfer pricing rules to address aggressive tax planning.

7.2 Taxation supportive of entrepreneurship

Personal income tax (PIT) on wage and capital income, corporate income tax (CIT), and social security contributions (employer, employer, self-employed) together may distort two decision margins: 1) to move from dependent employment to establishing a business (whether incorporated or unincorporated); and 2) to structure a business in incorporated or unincorporated form. The first is relevant to business creation, while the second is particularly relevant to tax effects on growth, if it is accepted that he incorporated form is generally the preferred legal form for a business to gain sufficient outside capital to develop and grow.

A recent OECD study considers how tax systems may affect an individual's decision of whether to remain in dependent employment or to instead become an 'entrepreneur' by starting one own business). Potential distortions are examined by comparing "all-in" average statutory tax rates (ASTRs) – factoring corporate and personal income tax, plus social security contributions – for a hypothetical individual taxpayer who provides both labour and capital inputs to derive income either as a dependent employee (with capital invested in bonds), or a single owner/worker of an unincorporated business. The tax burden of a hypothetical taxpayer varies depending on three key factors that need to be controlled for: the amount of income earned; the relative contributions of labour and capital inputs in deriving the income (which may vary significantly by type of business activity, and may be able to be manipulated), and dividend distribution policy.

Policy makers are encouraged to examine the potential distortions of their tax systems, to determine whether changes are possible to provide more neutral tax treatment.

7.3. Attractive tax regime for mobile skilled workers

A country's tax system may discourage mobile skilled workers from choosing that country as a location for employment, on a short- or longer term basis. Discouraging factors may include:

- a high average tax rate on wage income at relatively high income levels, factoring in personal income tax (PIT) (e.g. linked to a highly progressive PIT rate structure), and social security contributions (employee and employer (where shifted back onto wage income), or self-employed).
- taxation of foreign source investment and/or pension income (i.e. derived from savings held in another (home) country). While personal taxation of investment income on a worldwide basis is widely observed and can be expected where a person is resident in a given host country on a long-term basis, it may be a discouraging factor if applied to individuals resident only on a short-term basis (e.g. less than 1 year). Rules limiting taxation of foreign source income of individual may be introduced on a statutory basis, or through tax treaties.
- weak actuarial link between social security contributions and social benefits received. For individuals taking up work on a short-term basis (implying limited and possibly no receipt of social benefits (e.g. old age security, unemployment insurance), the imposition of social security contributions on wage income may be discouraging regardless of the actuarial link. However, for those considering taking up residence permanently, the stronger the actuarial link, the less it is that social security contributions will be regarded as a 'tax' – implying limited discouraging effects on employment decisions.

Policy makers are encouraged to consider whether tax policy adjustments (and tax treaty developments) are possible that would improve the attractiveness of their country to mobile skilled workers as a location for employment.

7.4. Addressing possible tax impediments to risk-taking

Asymmetric tax treatment of gains and losses, as well as potential tax distortions discouraging business incorporation, may tend to discourage risk-taking and stifle innovative business enterprise. Policy makers are encouraged to assess whether significant tax distortions exist and discourage risk-taking, and whether tax policy could be adjusted to lessen possible tax impediments, while ensuring protection of the tax base.

Asymmetric tax treatment of business profits and losses – with profit taxed at an effective rate, of say t, while business losses are deductible at an effective tax rate less than t – may discourage individuals from investing in innovative and relatively high-risk business activities.

At the same time, governments are understandably concerned about tax-planning opportunities created where business losses can not only be carried forward (and possibly back) to be deducted against future (and possibly prior year) profits, but can also be deducted against other income (e.g. investment income and possibly wage income). OECD country practices in the delineation of so-called 'ring-fencing' rules, limiting business loss deductions, exhibit considerable variation. Countries are encouraged to consider whether current practice in their country is discouraging risk-taking and should be modified.

Similarly, asymmetric tax treatment of capital gains and losses realized on shares issued by high-risk innovative companies may discourage equity investment in such companies. As opportunities typically exist to artificially characterize certain consumption activities as business activities – and thereby realize business losses as capital losses on shares of companies undertaking such activities – policy makers may be reluctant to broaden the scope for capital loss deduction rules to allow losses to set off against other types of taxable income. However, given the particular importance of equity financing to young start-up innovative firms (with insufficient 'hard' capital to provide as collateral for loans), and with shareholder returns typically in the form of capital gains (rather than dividends) for growth firms reinvesting their earnings, policy makers are encouraged to consider tax policy approaches and experiences in other countries and consider whether the current approach is optimal.

Establishing a company in unincorporated rather than incorporated business form may offer certain advantages: relatively less costly if significant legal fees are required in the drafting/registering articles of incorporation; may give business owners (sole proprietors, general partners) greater control over business decisions. However, incorporation may be attractive at a certain stage of development, as it reduces the level of (capital) risk to business owners by providing greater protection of personal assets. Incorporation may also enable improved access to finance and continuity of life.

While avoiding possible tax distortions to the choice of business form may not be possible in each case, policy makers should be encouraged to establish whether tax distortions exist – taking into account personal and corporate income tax, as well as social security contributions, under the unincorporated versus incorporated business options – to determine which policy approach is optimal.

7.5. Reliance on environmental taxes and tradable permits to green economies

It is widely accepted that the use of economic instruments, in particular, environmentally-related taxes, and tradable permits, is preferable to regulation, as a means to address environmental degradation, such as excessive CO2 emissions.

Measures to address 'international competitiveness' concerns over broad use of such instruments – for example, channelling some portion of environmental tax revenues back to affected industries – should be carefully designed so as to not offset the intended abatement incentive effect of the instrument. While political economy issues cannot be ignored, it should be recognized that such compensation measures are generally very difficult to efficiently administer.

Providing tax relief through R&D tax incentives for expenditures on environmentally-clean technologies may address market failure where inadequate recognition is given by R&D performers of positive spillover effects. At the same time, tax assistance for such expenditure can introduce distortions against alternative abatement approaches that may be more efficient (e.g. the use of cleaner fuel, as opposed to investment in carbon 'scrubbers').

The tax treatment of the purchase and sale of tradable permits on domestic and cross-border transactions should aim to achieve efficient marginal abatement incentive effects of tradable permits. At the same time, tax policies adopted as regards the treatment of such permits must be feasible at a reasonable cost to both tax administrators and taxpayers.

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ANNEX 1

This Annex includes the information used to obtain the "technological receipts/business R&D expenditures" ratio in Figure 3. The table and the chart represent the underlying data.

Information on technological receipts is obtained from the Technology Balance of Payments which includes:

- Royalties and license fees
- Sale / purchase of patents and inventions
- Technology-related services
- R&D carried out abroad

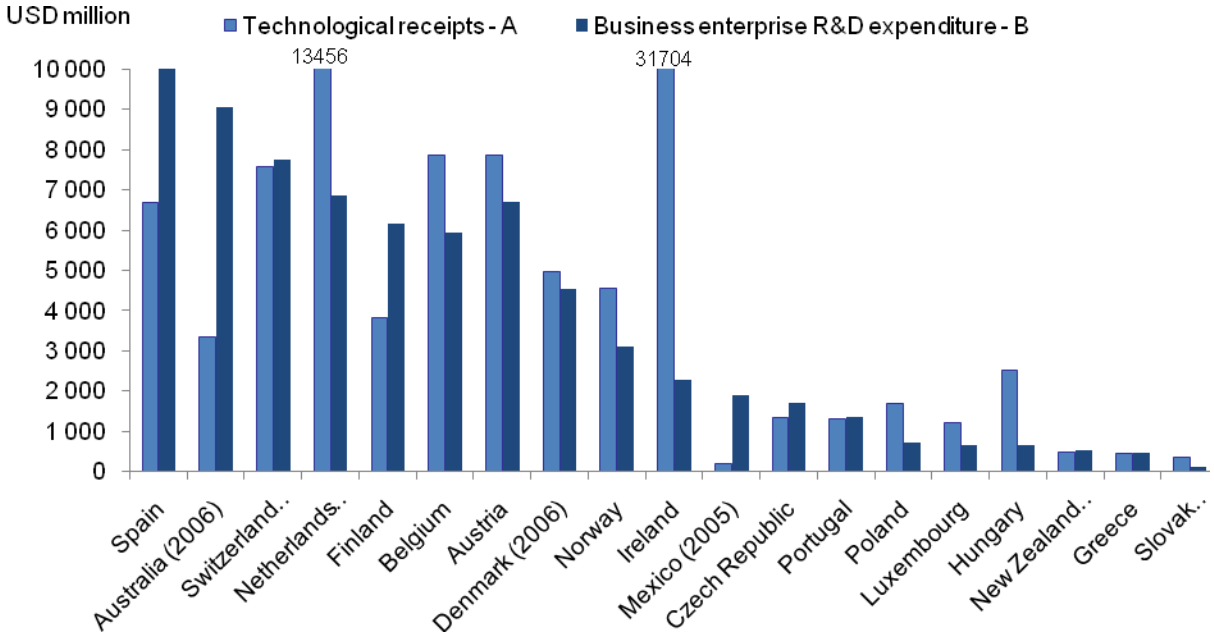
In some cases some items are missing (especially sale/purchase of patents and inventions) or are not correctly defined.

Information on R&D expenditures is collected from a joint OECD/Eurostat questionnaire. The definition of R&D expenditures is taken from the "OECD Economic Globalisation Indicators" Report, which refers to the classification from the Frascati Manual:

> "R&D expenditure covers all expenditures for activities undertaken for the purpose of discovering or developing new products (goods and services), including improved versions of existing products, or discovering or developing new or more efficient [production processes]. In the context of this document, these expenditures relate exclusively to the enterprise sector, in which are included "all firms, organisations and institutions whose primary activity is the market production of goods and services for sale to the general public at an economically significant price…". R&D expenditure comprises: current costs and capital expenditure. Current costs are composed of: labour costs, which are the largest component of current costs, and other current costs, which comprise non-capital purchases of materials, supplies and equipment to support R&D in a given year. Capital expenditure is the annual gross expenditure on fixed assets used in the R&D programmes. It should be reported in full for the period when it took place and should not be registered as an element of depreciation (Frascati Manual, § 358, 360, 374). Capital expenditure is composed of expenditure on:
>
> - Land and building,
> - Investment and equipment,
> - Computer software."

Country	Technological receipts - A	Business enterprise R&D expenditure - B	ratio A/B
Ireland	31 704	2 286	13.87
Hungary	2 501	673	3.71
Slovak Republic (2006)	349	117	2.99
Poland	1 699	732	2.32
Netherlands (2006)	13 456	6 875	1.96
Luxembourg	1 198	677	1.77
Norway	4 548	3 129	1.45
Sweden	16 544	12 007	1.38
Belgium	7 855	5 936	1.32
Austria	7 874	6 694	1.18
Denmark (2006)	4 978	4 550	1.09
United Kingdom	34 622	32 237	1.07
Switzerland (2004)	7 584	7 768	0.98
Portugal	1 319	1 353	0.98
Greece	446	484	0.92
New Zealand (2005)	475	537	0.88
Canada	12 161	14 685	0.83
Czech Republic	1 327	1 707	0.78
Germany	40 008	58 634	0.68
Spain	6 675	10 202	0.65
Finland	3 817	6 177	0.62
Italy	5 737	11 668	0.49
Australia (2006)	3 331	9 063	0.37
United States	85 919	265 193	0.32
France (2003)	5 188	24 430	0.21
Japan	21 080	117 452	0.18
Mexico (2005)	180	1 914	0.09
Korea (2006)	1 897	22 127	0.09

Source: OECD, April 2009



Source: OECD, April 2009

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1 With depreciation allowances calculated on a nominal basis, the present value of future claims is eroded with inflation. The illustration assumes a constant rate of inflation.

2 An alternative design provides a credit for current investment in excess of an average of investment over preceding years (e.g. 3 years): $IITC_t=\lambda(I_t-(I_{t-1}+I_{t-2}+I_{t-3})/3)$.

3 Carryover provisions for accelerated depreciation may be determined by loss carryover rules where depreciation claims are mandatory. Where depreciation claims are discretionary, separate carryover provisions for unused capital cost allowances would normally apply. Investment tax credits would normally have carryover provisions specific to that incentive.

4 Managers may indicate that an R&D tax subsidy was a deciding factor in undertaking R&D, even where it was not, in order to continue to benefit from tax relief, if there is a perception that the results of the survey will be taken into account by policy makers in deciding future R&D tax policy. Another bias risk is that managers may focus on their own vision or performance rather than the features of the business environment as the factor encouraging R&D.

5 A cost-effectiveness assessment is sometimes referred to as a test of 'additionality', or an assessment of the 'bang for the buck'.

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