Design and use of fiscal incentives to promote business RDI in CREST countries - an overview

Contribution for the CREST OMC 3% 2nd cycle expert group on fiscal measures

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Jan Nill

European Commission Joint Research Centre - Institute for Prospective Technological Studies (IPTS), Edificio Expo, c/ Inca Garcilaso s/n, E-41092 Sevilla;
Jan.Nill@cec.eu.int, http://ipts.jrc.cec.eu.int

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1 Introduction

As one instrument to encourage private R&D investment the use of fiscal measures is wide-spread in CREST countries. But there is a lack of knowledge and understanding of their effects in the short and long term. It is often argued that an appropriate design of fiscal measures is crucial for their effectiveness (OECD 2002a, European Commission 2003). The report of the CREST OMC 3% 1st cycle expert group on fiscal measures has provided a general overview and a range of recommendations. One task for the 2nd cycle expert group "Design and evaluation of fiscal measures to promote business research, development and innovation" requested by CREST is to develop guidelines for the design and use of fiscal measures.

As part of the support of the European Commission to the work of the expert group, the following paper gives a cross-country overview of options in the design and use of fiscal measures in CREST countries as far as information is available and points out some salient issues and knowledge gaps. The main empirical information sources are a recent report on the tax treatment of R&D expenses (IBFD 2004) and the results of a questionnaire survey conducted in the first half of 2004 within the 1st cycle (summarised in Expert Group on Fiscal Measures for Research 2004), complemented by information published on the web (e.g. the European TrendChart on Innovation) and personal communications in particular with members of the expert group.

According to the mandate of the group, the focus of the overview is on fiscal measures aimed at the companies performing or commissioning the RDI effort itself, hence measures focussing at researchers or foundations are not covered. In line with the expert group discussion, non R&D-related fiscal measures are excluded from the overview in order to keep the scope manageable. Fiscal measures are understood in a narrow sense, i.e. with a focus on measures which provide a specific fiscal incentive for R&D – as opposed to the general fiscal treatment of R&D, i.e. depreciation rules or the inclusion of R&D as one and similar treated eligible activity in general investment incentives.

The paper is structured as follows: Section 2 describes the variety of design options in use in different countries, covering issues such as the generosity of incentives, eligible types of R&D, R&D costs, target groups, the tax regime chosen as well as types of fiscal relief. In section 3 four emerging salient issues are explored in more detail: the increase in volume-based schemes and in design features coping with new innovative firms as well as the linkages between design options and types of R&D and firm size, respectively. For the analysis of each issue, empirical observations are linked with theoretical insights and, where available, results from evaluation studies. Section 4 concludes and indicates some implications for appropriate designs emerging from the analysis, highlighting the context dependency of design choices as well as still existing knowledge gaps which need further exploration.

2 Design options and their use – a cross-country overview

In line with the described scope, the following descriptive overview about design options and their use in CREST covers empirically a total of 23 clear national fiscal incentives for business R&D in 15 countries (see overview table in the annex). This number is similar to that of IBFD (2004) which includes some schemes which are either not specific to R&D or not based at the national level. It is, however, significantly lower than the 63 measures covered within the much broader scope of the questionnaire of the CREST OMC first cycle Expert Group on Fiscal Measures for Research (2004).

2.1 Introductory overview of the use of fiscal incentives for business R&D

Fiscal incentives for business R&D are not a new topic. Already in the beginning of the 1980s many countries used this instrument. Among countries with a long experience with fiscal measures are Belgium, France and the Netherlands and, outside Europe, Australia, Canada, Japan and the United States. In the last years, however, a number of European Countries has (re-)introduced or reinforced such schemes. By September 2005 15 of 33 CREST Countries and 13 of 25 EU Member States have fiscal incentives for business research and development - in the abovementioned narrow definition - in place: the EU members Austria, Belgium, Denmark, France, Hungary, Ireland, Italy, Malta, the Netherlands, Portugal, Slovenia, Spain and the United Kingdom as well as Norway and Turkey (see overview table in the annex for more details).

Among the countries which do not use fiscal incentives for business R&D in the sense defined above, there are some countries which use fiscal measures only for fostering the market introduction and uptake of new technologies, products and processes, e.g. Israel, Poland[1] and Romania, and some countries such as Greece and Latvia which include R&D as one of many possible items of a general investment incentive scheme.

Among the countries which do not use fiscal incentives for R&D at all are countries with high R&D intensity such as Germany, Finland and Switzerland as well as countries with low R&D intensity such as Cyprus, Estonia and Slovakia.

The following cross-country overview shows that the fiscal incentives in use covered in this paper indeed follow a variety of design approaches concerning i.e. target groups, types of R&D and types of fiscal relief. Most of the presented options are in place in at least some countries.

2.2 Deduction rates and generosity of tax incentives

The amount of tax relief and the generosity of the fiscal incentives vary considerably across countries. It is no easy task, however, to measure the generosity of a fiscal incentive in a form suitable for cross-country comparisons.

[1] A Polish fiscal incentive which mainly focuses on investments based on the purchase of new technology has recently been approved by the Polish parliament and will enter into force by 2006.

Very rough measures are the percentage rates of tax relief chosen by governments (as indicated e.g. in OECD 2002a, 2004), which are presented in the following table:

Table 1: Rates of fiscal incentives for R&D in CREST countries in place 2005

	Level of R&D	Increment of R&D
R&D tax credits	France (5%)	France (45%)
	Ireland (0-20%)	Ireland (20%)
	-[2]	Italy (30%)
	Netherlands (14-42%)	-
	Norway (18-20%)	-
	Portugal (20%)	Portugal (50%)
	Slovenia (10-20%)	-
	Spain (30%)	Spain (50%)
	Turkey (40%)	-
R&D allowances	Austria (125%)	Austria (135%)
	Belgium (13,5-20,5%[3])	-
	Denmark (100-150%)	-
	Hungary (200-300%)	-
	Malta (135-200%)	-
	United Kingdom (125-150%)	-

Source: adapted and updated from OECD (2004)

To appropriately interpret the rates of support, two design differences concerning the type of fiscal relief need already to be introduced: the form of the incentive (allowance vs. credit) and the distinction between incremental schemes, in which this rate only applies to additional research, and volume-based schemes covering all eligible R&D expenses of the beneficiaries (see also sections 2.7 and 3.1).

It should be noted, however, that the sheer percentages of government support cannot be equated with the generosity of the incentives because the latter is also heavily influenced by

1. the corporation tax rates, which have in particular an impact on the value of R&D allowances,
2. the general corporate tax treatment of R&D expenses,
3. further design options chosen which often restrict the validity of these percentages to certain target groups, types of qualifying expenditures, expense ceilings, or types of R&D (see the overview table in the annex for more details), and
4. the way how the measures are implemented in administrative practice.

[2] The implementation of the Italian tax credit for SMEs has been completely delegated to the regions, and is hence not described in detail in the overview covering clear national fiscal incentives. During the fiscal year 2004, there has been an additional national R&D tax allowance of 110% on the level and 130% on the increment of R&D in place ("Techno-Tremonti"). This incentive is included in the detailed overview.

[3] This allowance operates as a 10% bonus to a general investment allowance of 3,5% for all R&D respectful to the environmental as well as patents and energy saving measures. It applies only to investment in fixed assets in R&D. For very small firms with less than 20 employees the bonus is 17% and can be spread over the amortisation period. In addition, a fixed amount tax relief for additional researchers recruited is in place (see overview table in the annex).

One tool which copes with the first and with some elements of the second condition is the so-called B-Index. It calculates a firm's before tax benefit of a marginal increase of R&D expenses. Also the B-index shows a considerable variety in the generosity of R&D support via fiscal incentives, with Spain ranking as most generous country. Details on the method of calculation and its limitations concerning the inclusion of further design issues can be found in Warda (2001, 2005).

For a comprehensive picture of the cross-country generosity of schemes, the whole range of design options which are presented in the following sections and in the overview table in the annex should be taken into account. An appropriate indicator, which would cope also with the third and forth condition, is the foregone government budget income compared with the amount of private R&D expenses, but this indicator is usually not publicly available.

2.3 Eligible type of R&D

An important design question is which type of R&D expenditures should be eligible for an incentive scheme. The starting point is often the R&D definition of the Frascati manual (OECD 2002a, 2002b), which distinguishes between basic research, applied research and experimental development. Moreover, the generation of new knowledge and the reduction of uncertainty form part of this definition. Beyond this a substantial variety emerges as a salient issue, with about one third of the incentives being based on somewhat stricter eligibility criteria and about another third focusing more on the market orientation of the R&D (for a more detailed discussion see section 3.3).

Within nearly half of the measures, there are procedures which attempt to verify that the R&D conducted is eligible, usually linked with an ex-ante approval mechanism of R&D projects and/or detailed documentation requests. One Austrian scheme even requires patenting of the R&D results. A range of other schemes rather relies on a combination of guidelines on the applicable R&D definition and possible ex-post checks by tax inspectors.

Another design question related to the type of eligible R&D is if only research internal to the applying firm is covered or also research subcontracted to other businesses and organisations. The latter is allowed in more than half of the measures, albeit sometimes with restrictions on the types of organisations which are eligible for subcontracting. In one third of the schemes, specific provisions on subcontracting are used as incentive tool for enhancing the collaboration of business firms with other research sectors (see section 3.3 for further discussion). Two schemes in Belgium and Denmark even focus only on this type of R&D.

An interesting political approach to deal with issues related to the definition of eligible R&D has been chosen by the United Kingdom which started a rather encompassing business consultation exercise in view of the appropriateness and refinement of the R&D definition used (HM Treasury, DTI and Inland Revenue 2003).

2.4 Eligible R&D costs

A design choice with a variety of options is the type of R&D costs covered. Basically, three types of costs can be distinguished:

- Wages,
- other current expenses, e.g. costs for energy and materials input or, when applicable, costs for subcontracted research, and
- capital expenditures.

As part of the general tax treatment of R&D, which beyond the defined scope of this paper, most of the CREST countries allow for a 100 percent deduction of current expenses from the income of the corporation. And also all but one of the 23 clear incentive schemes for business R&D in use current expenses are eligible. Three schemes in Belgium and the Netherlands, however, restrict the eligible costs to the largest subcategory of current expenditures, the salaries of the researchers.

The treatment of capital expenditures for R&D - which constitute typically only a minor part of all R&D expenditures (a rate of 10% is reported in Hall 1995 and Warda 2005) - is less homogenous. About half of the fiscal incentives covered allow for certain types of capital expenditures, usually machinery and sometimes also buildings.

Moreover, beyond the incentive schemes described in detail, within the general tax treatment of R&D a number of countries accept accelerated depreciation of R&D related capital expenditures, of which the formula and restrictions vary considerably in detail. Some countries, e.g. Ireland, Spain and the United Kingdom, allow even 100% depreciation of the capital expenditures in the first year (OECD 2002a).

Finally, schemes differ to what extent cost categories such as software, patent purchase and licences are eligible.

An issue related to the calculation of R&D costs to be noted, which goes beyond the design options in the incentive schemes covered in this paper, is how R&D expenses are treated for accounting purposes. Theoretical arguments suggest that all R&D outlays should be treated rather as (intangible) asset instead of current expenses (on this topic see the report of the independent EU expert group, European Commission 2003). Also in the treatment of this issue the CREST countries vary considerably.

2.5 Target groups

A further important design issue is the definition and reach of target groups. The main questions are

- if only firms or also other R&D actors should be targeted,
- if all firms or primarily small and medium enterprises (SMEs) are focused at and
- if particular provisions are to be made for new and young firms?

While the targeting of business defines the scope of this overview, within that category about three quarters of the schemes are open to all types of firms. In about half of the schemes this general openness is somewhat limited at the expense of the biggest R&D spenders by a ceiling of the overall amount of eligible R&D expenses. About one third provide higher amounts of support for SMEs, and three schemes only target SMEs.

A salient issue in targeting SMEs, however, is that this goes well beyond the formal definition of the target groups of a scheme because many design options may have a differential impact depending on firm size (see section 3.4 for a summarising in-depth discussion of this issue).

Another rather salient trend concerning target groups is that a growing number of schemes attempt to provide for young innovative or less profitable firms. In France and the Netherlands, there are specific conditions or even schemes for these targets groups, but also a number of other options how to transfer the tax relief might have a considerable impact on them (see section 3.2 for an in-depth discussion).

2.6 Tax regime chosen

A sometimes neglected design option is the choice of the tax regime which constitutes the basis for the incentive. Theoretically, a range of options consists, e.g.

- corporate income tax,
- personal income tax (including the treatment of capital gains),
- wage taxes and social security contributions,
- sub-national taxes or even
- the value-added tax or customs.

Usually the discussion focuses on the corporate income tax, which is the, or at least one, basis for the vast majority (20 of 23) of the incentives in use covered here. Nearly half of the incentives are also appropriable within the personal income tax.

Yet four of the 23 schemes are not (only) based on the income tax regime. In Belgium, there are tax exemptions for additional researchers under the wage tax. In the Netherlands, the WBSO A scheme reduces the employers wage taxes of firms which invest into R&D. Malta halves the social security contributions for newly employed academics for three years. And the young innovative company scheme in France combines exemptions from corporate taxes with lower social security contributions and local taxes. These tax regimes have the advantage that the amount of relief does not depend of the current profitability of the firm (see also section 3.2).[4]

2.7 Type of fiscal relief

[4] In some countries, there are (few) examples of schemes being based on sub-national taxes or the value-added tax. They go, however, beyond the scope of the present overview.

The design options most broadly discussed in the policy-oriented literature are the types of fiscal relief (OECD 2002a, European Commission 2003, Pottelsberghe et al. 2003).

A first question concerns the form of the incentive, the three basic forms being

- a tax deferral,
- a tax allowance and
- a tax credit.

A tax deferral is a delay in the payment of taxes, typically in form of an allowance for accelerated depreciation. In principle, certain forms of tax deferral exist in the tax treatment of R&D in nearly every country. Most of them accept the full deduction of current R&D expenses, which can be regarded conceptually as accelerated depreciation, because some of the expenses are assumed to generate future income (OECD 2002a, Pottelsberghe et al. 2003). A noteworthy counter example is Estonia which does not accept any deductions but has a very low general corporate tax rate. Another a bit less frequent way is the abovementioned variety of depreciation rules for capital expenditures.

Tax allowances and tax credits are nowadays similar frequent. A tax allowance allows for the deduction of expenses in defining the taxable income. The typical form is that significantly more than the usual 100% of R&D expenses are deductible. The value of the resulting relief depends on the applicable tax rate, too. This form is used in about half of the schemes.

The other half of the schemes are based on tax credits which are applied on the base of the tax sum to be paid and reduce this by a certain amount, which varies considerably between countries but does in no case exceed 50% of the eligible R&D expenditures (see also table 1 in section 2.2 above).[5]

A second important choice is if all R&D expenditures are eligible (so-called volume-based schemes) or if only additional research is supported. A rather large literature indicates that this choice is one of the most salient issues in designing fiscal incentives. And in the measures in use the first option is favoured increasingly, with more than half of the schemes being strictly volume based and only one scheme being solely incremental (see section 3.1 for an in-depth discussion).

A third relevant design issue is the flexibility in making use of the scheme. It is influenced by the option to carry back or carry forward unused credits, the tradability of the fiscal incentives or the availability of a credit guarantee (see section 3.2. for details).

[5] A noteworthy detail is that the carry forward of unused tax credits is technically more difficult, because it requires the creation of a specific pool for tracking (OECD 2002a).

3 Salient issues in the design of fiscal measures for business R&D

The overview has shown that a variety of design options for fiscal measures exist and are used by different countries. The description alone, however, gives only few hints why there is such a high variety and why certain countries use certain design options. For more insights, a link to theoretical debates and arguments as well as to empirical evidence about effects, if possible based on sound evaluations taking account of policy objectives and national contexts, is necessary.

In the following, four particularly salient issues which have emerged from the cross-country overview are analysed in more depth along these lines:

1. The trend towards non-incremental, volume-based schemes,
2. attempts to provide for young innovative or less profitable firms,
3. observable differences in the focus which R&D is targeted, and
4. linkages between the size of targeted firms and the choice of design options.

3.1 Non-incremental "volume-based" design and its implications

Recently the number of volume-based fiscal incentives has increased. The choice between volume-based and incremental schemes is one of the most discussed choices in the design of fiscal measures. A volume-based scheme subsidises all eligible business R&D expenses while an incremental scheme covers only additional research beyond a certain baseline.

Outline of arguments

A volume-based scheme is – other things equal - more generous to business, in particular towards companies that spend the most on R&D (and hence often large firms). This could lead to a "higher leverage" (European Commission 2003), although the extent of the incentive for conducting additional research is questionable, because a volume-based scheme also subsidises research which seems already to lead to sufficient private returns and thus provides windfall gains (OECD 2002a, Pottelsberghe et al. 2003).[6]

In turn, a volume-based scheme is more costly for government, if the broader base of the tax relief is not counterbalanced by significantly lower rates or a more narrow definition of eligible R&D types and costs.

If there is a tough budget constraint and the government expenses are hold equal for both designs, a volume-based scheme will have to use lower rates and hence the marginal effects, which are decisive from a standard neoclassical microeconomic perspective, of a volume-based scheme are lower than those of an incremental scheme.

[6] However, the higher generosity of a scheme might attract - other things equal - the relocation of R&D activities of multinational companies, hence increase R&D locally but not globally.

Moreover, the distribution among types of firms differs. An incremental scheme benefits growing firms as well as firms which rise their research intensity. It disadvantages firms with a high but stable or shrinking level of R&D. The independent expert group (European Commission 2003) considered these distributional effects as a disadvantage of incremental schemes, but this rests on the implicit assumption that the existing R&D allocation is efficient in a dynamic perspective, too, i.e. that firms with an already high research level are best equipped to successfully explore additional research opportunities.

The main arguments in favour of volume-based schemes are lower administrative costs for governments and compliance cost for firms and lower complexity because no baseline has to be defined and to be reported by the beneficiaries, and also possible distortions by the choice of the baseline are avoided (European Commission 2003). The greater simplicity is considered particular beneficial for SMEs. On the other side, OECD (2002a) argues that taken as a group SMEs would benefit more from an incremental design due to the bias of existing R&D expenditures towards large firms. However, this argument holds only for the subgroup of growing SMEs with research activities and rests on the assumption that additional research would (and should) be done to a greater extent by SMEs.

Another argument in favour of volume-based schemes concerns the involved higher stability of support for business, because research increments and hence the amount of support of incremental schemes vary much more than research levels.[7] Several studies stress the importance of the stability of support given that R&D projects often take considerable time to be successful (e.g. Guellec and Pottelsberghe 2000, European Commission 2003). However, if this stability goes too far and the amount is considerable, it may also induce companies to simply substitute public money for private research investment. Moreover, the amount of instability introduced by incremental schemes depends on the design of the baseline and fully holds only for an incremental scheme with rolling base, in which the base changes during the lifetime of the R&D project.

Nevertheless, while earlier studies do not come to a firm conclusion, after drawing a balance of the arguments volume-based schemes were advocated for by an Independent Expert Group (European Commission 2003). Moreover, it is stated that hybrids are the most disadvantageous design approach because they tend to combine the negative aspects of both (Pottelsberghe et al. 2003).

Empirical evidence

The empirical cross-country overview shows indeed that volume-based schemes have gained ground. One repeatedly reported reason for this is that business strongly argues in favour of this design option. 13 measures in 10 countries can be considered as strictly volume-based. Another four measures are not incremental either but base the incentive on the approval of specified R&D projects. This is the general approach followed in the

[7] From a macroeconomic viewpoint, this higher variance leads to an undesirable pro-cyclical effect of incremental schemes because research increments tend to be higher in times of higher growth.

Netherlands and in Norway. The two other examples in Belgium and Denmark concern specific measures for increasing linkages between the business and the public research sector. This form might limit windfall gains but leads to higher administrative costs.

Further six measures are hybrids which combine a volume-based and an incremental approach, either by leaving a choice of the suitable approach to the firms (e.g. in Austria) or by giving higher incentives for increments.

Taken together, eight countries follow a non-incremental design approach, of which five limit themselves to a volume-based approach in the strict sense (Hungary, Malta, Slovenia, Turkey, UK).

Moreover, it can be observed that incremental schemes usually work with higher rates than volume-based schemes (see also table 1 in section 2.2). No systematic correlations with other impacts on the amount of support such as eligible R&D costs or the utilisation of ceilings are discernible. And there is anecdotal evidence that a choice in favour of incremental (parts) of incentive schemes was in some countries motivated by budget considerations.

Evaluation results

Existing evaluation studies provide some further evidence on the issue (e.g. surveyed by Mohnen 1999). Studies on the incremental US incentive system with rolling base report that the impact on the costs of research is rather small. Hall and Reenen (2000) conclude in their survey that incremental schemes with moving average greatly reduce the incentive effect of the credit. A recent econometric evaluation study on the effects of the incremental French scheme between 1982 and 1996, however, concludes that the effective tax credit had a highly significant effect on the user cost of R&D capital, estimating a long-run elasticity of around 0,6 (Mulkay/ Mairesse 2003). In one of the few cross-country evaluations, Guellec and Pottelsberghe (2000) find that frequent variations of schemes, being them incremental or volume based, reduce their effectiveness considerably. In the framework of the evaluation of the Belgian tax incentive for hiring additional researchers, a consultation of 13 selected companies indicated that only few companies used it and that many firms found this incremental incentive of 11.800 Euro per new researcher too small to significantly influence the cost of R&D activities (Pottelsberghe et al. 2003).

On the other hand, the values reported for the effectiveness of incremental measures, measured as additional research per government expenditure, tend to be significantly higher than those of volume-based measures (Dagenais et al. 1997, Brean and Leonard 1998, Klassen et al. 2004). A range of econometric studies converge towards a ratio of about one Dollar increase in business research per Dollar revenue foregone (see European Commission 2003 and Technopolis 2005 for an overview), and this is also the evaluation result of the non-incremental project-based Dutch scheme (Poot et al.). An evaluation of the incremental French scheme estimates a long term effect of an increase of business R&D which is three to four times higher than the government expenditure. All these

results, however, have to be regarded with caution, because the underlying models and sometimes also time horizons are often not directly comparable.

Due to the lack of cross-country evaluation studies, there is still little sound empirical knowledge on the question if there are differences between the types of firms or types of research favoured by volume-based or incremental incentives.

Summing up, there is no clear evidence in favour of either volume-based or incremental designs. Hence unlike often the case the debate on designs should not only focus on this choice. A certain stability of the scheme design might be more important than this. Differential effects on certain types of firms are to be expected, but the weighting of these might depend on country-specific policy objectives and contexts. Seemingly, in the policy practice of the last years this weighting has been increasingly in favour of non-incremental schemes.

3.2 Design features coping with non profit-making innovative firms

A range of observable designs of fiscal incentives tries to tackle the issue how to make the incentives effective also for companies which do not generate profits (yet) with their activities and hence have no taxable income to which the relief could be applied. The CREST OMC 3% 1st cycle Expert group on fiscal measures (2004) recommended giving more attention and consideration to this issue.

Outline of arguments

It is a common concern in the economics of research and innovation that important new knowledge and R&D advances are often generated by "outsiders" and new firms, while well established actors are more likely to be bound to well established paths of knowledge accumulation. Important R&D advances are brought about by *young companies which* build their existence on research intensive activities. It is well known that especially for young innovative companies who build their existence on research intensive activities this is often not the case.

The implications of this problem for the design of fiscal incentives have received less attention. A partial remedy could be the option to carry forward the unused incentives until a time when the firm is again in a tax position. However, the effects might be limited due to the time value of money (Pottelsberghe et al. 2003). Moreover, it is no help in case of liquidity constraints. In principle direct tax refunds of unused fiscal incentives should be more effective because they provide upfront cash. The incentive is in this case similar to a grant. In theory, the tradability of tax credits might lead to the same effect but the related transaction costs might limit the effectiveness for SMEs.

Empirical evidence

One result of the 1st cycle Expert group on fiscal measures (2004) was that specific fiscal measures play only a limited role in the policy-mix to support the creation and early growth of research-intensive firms. But also certain design features of fiscal incentives

might cope with some of their limitations and are increasingly used by a range of countries. Carry forward of unused incentives up to ten years is indeed possible for the majority of measures in use. The availability of this option is often linked to the characteristics of the general tax system.

Direct cash refunds of unused fiscal incentives are in use in four countries, Austria, France, Norway and the UK. France and the UK[8] limit the usability to young companies and companies in hardship or to SMEs, respectively. Recent experience in Norway and the UK show that the take-up of this option is quite widespread and can make-up a significant part of the expenses of a scheme.

The tradability of tax credits which is possible e.g. in the United States does not seem to constitute a relevant design option in European fiscal incentive schemes.

Finally two measures in the Netherlands and in Belgium are noteworthy which avoid the problem of innovative loss-making firms to benefit from incentives. Here it is a side effect of the choice of another tax regime which is not based on income but on the wage tax for researchers.

Evaluation results

A general caveat concerning this issue already noted by the 1st cycle expert group is that the evidence on the uptake, effectiveness and efficiency of such design options in favour of non-profit making innovative firms is still very limited. In particular, no available evaluations seems to cover this point yet. Hence the results of the ongoing evaluations of the schemes in Norway and the UK, both countries which include cash refunds as design element targeted at innovative loss-making firms, will be of particular interest.

3.3 Design options and RDI types encouraged

Although there are observable differences in the focus which R&D is targeted by fiscal incentives in different countries, the question which type of research and development is and can be incited by fiscal incentives and appropriate design options is rather neglected in recent policy debates. One reason may be that the recent theoretical debate on the underlying issues and rationales has become more differentiated.

Outline of arguments

The well-known neoclassical rationale for the public support of business R&D, i.e. the divergence between private and social returns of research, is often linked to the argument that basic research and research on generic technologies, where the appropriation of returns is particularly difficult, should be particularly encouraged. The innovation system literature rather highlights that effective linkages between different research actors are important, and that functioning research and innovation systems take advantage of mutual

[8] It should be noted however, that some other countries, e.g. Ireland, Finland and Switzerland, try to achieve similar aims in the framework of specific programmes for start-ups. If such programmes are in place, a related specific design feature of a fiscal incentive is not necessary.

spillovers between different research projects conducted. And evolutionary or neo-Schumpeterian economic approaches highlight that appropriability conditions as well as technological opportunities differ considerably between sectors. Moreover, knowledge is often specific and its uptake by other actors might require appropriate "absorptive capacity". R&D can hence also be used to build this capacity, i.e. as a learning resource (Cohen and Levinthal 1989). The latter argument may apply for certain (small) firms as well as for sectors or for small countries (OECD 2002a).

These different arguments point to diverging implications for the appropriate design of fiscal incentives concerning the eligible types of R&D, although this issue is rarely explored in more detail in the literature. One step to make these arguments more operational for policy is to link them with different problem contexts:

- When the *exploration of novel and still rather generic research directions*, in which the social returns are not (yet) easily privately appropriable, is the most relevant problem, a rather narrow definition of eligible R&D with a focus on general novelty of the knowledge generated and with a focus on the research part of R&D is appropriate. Even a focus on certain research fields with sufficient evidence on high spillovers would be - other things equal - consistent with this problem context.
- When *missing linkages between elements of the research and innovation system*, such as between science and business or producers and users of R&D, are an important problem, not so much the definition of R&D expenditures is relevant but the constellation in which R&D is conducted. Corresponding definitions of eligible R&D projects then should rather try to ensure that the creation of linkages is favoured or at least not inhibited, e.g. by allowing for subcontracting of research and by favouring collaborative research between different sectors.
- When the problem consists rather in the *businesses' uptake of new knowledge* generated by scientific institutions or abroad, this is consistent with a broad R&D definition which explicitly includes development and design parts of R&D which are closer related to commercialisation, and is less stringent on the novelty criteria.

One important caveat resulting from the scope on fiscal incentives should be mentioned: each of the mentioned problems could also be addressed by other policy instruments, and fiscal incentives need not necessarily be the most effective instrument to deal with them. This is important for comparisons with patterns of use observed in practice. However, the theory-based reference to different problem contexts for R&D types to be encouraged can also be used as basis to tentatively explore - other things equal - possible implications for the appropriateness of further design options:

- When the problem is the exploration of novel and still rather generic research directions, it is important to check that such research is indeed performed, hence the inclusion of an *ex-ante verification mechanism* and an *incremental design* which only supports additional research to the one already encouraged by the market are corollaries. Finally, given that private returns are not straightforward to achieve, the

inclusion of design features which allow firms to benefit from *the tax incentives independent from the level of current profits* (see section 3.2) is a suitable amendment.

- When the problem is rather one of missing linkages, a *non-incremental scheme* working on the basis of project approvals as *ex-ante verification mechanism* might be an obvious design option, because it allows for a focus on the (collaborative) character instead of the pure (additional) quantity of R&D undertaken. Given that collaboration and linkages are established by human beings and might involve time efforts, a focus on current expenses or even wages as *eligible R&D cost* might be particular appropriate.
- When the problem consists rather in the uptake of new knowledge, this is consistent with the inclusion of both *current expenses* and *capital expenditure* into eligible *R&D cost*, because more development oriented activities often require capital investments which moreover serve as additional way to transfer (embodied) knowledge. The consideration of the needs of *SMEs as target group* seems to be particularly appropriate in this context (see also the following section 3.4).

Empirical evidence

How do these theoretical considerations fit with the available empirical evidence? While an in-depth analysis would require additional research on problem contexts and (often not readily available) policy objectives in each country, which is beyond of the scope of this paper, some hints can be already drawn from the present cross-country comparison.

First, it reveals indeed a certain variety of R&D definitions. Many countries start in some way from the OECD Frascati definition used for statistic purposes (OECD 2002b, see section 2.3). This definition has a certain bias towards the spillover-related problem context, focusing on research related elements of R&D and containing (general) novelty as important criterion. Main sources of variation between countries are to what extent development is included into eligible R&D (France and Denmark are here rather strict), how strict the novelty criterion is interpreted (e.g. the Netherlands exclude improvements of existing techniques) and how much the R&D definition is bound towards marketable results (examples for the latter are Belgium, Spain, Portugal and Italy).

About one third of the measures is linked to a narrow definition rather oriented toward the research part of R&D and/or strict novelty requirements (see also OECD 2002a) while another third is inclined to a broader definition of eligible R&D more oriented towards development and commercial usefulness of the knowledge. The latter orientation is mostly found in countries in which R&D intensity is below the European average, which might fit with the proposed differentiation of problem contexts.[9] Moreover it is

[9] It should be kept in mind that R&D tax incentives which are only an integral part of general investment incentives, with similar rates and provisions applicable as for other activities (in use e.g. in Greece and Hungary), are beyond the scope of this paper and hence not included in these figures. An inclusion, however, would still strengthen empirical evidence for the argument.

interesting to note that on the basis of a consultation process with business the UK definition, which rather follows a middle way, has been modified. It is argued that substituting "advance in science and technology" for "novelty" as criterion, and hence moving partly away from the OECD definition, makes the R&D definition easier to understand and to apply for companies (Inland Revenue 2003).

It is also noteworthy that there are only very few examples of a targeting of fiscal incentives towards a specific research field. Examples are the UK scheme for vaccine research, the Information Technology focus of a former Italian scheme and the restriction towards environmentally beneficial research in one Belgian fiscal measure. While the mentioned areas can be easily related to the spillover-related problem context, the scarcity of examples suits with the hypothesis that fiscal incentives might be a less appropriate instrument when research areas with particular high expected social returns are to be tackled (OECD 2002a). Direct measures with its selection mechanisms might be better suited than tax law to distinguish qualifying activities appropriately.

Another result of the cross-country comparison consistent with the introduced differentiation of problem contexts is that indeed a range of countries try to explicitly enhance collaboration of business with other research sectors (e.g. Belgium, Denmark, Hungary, Norway, Portugal and Spain), either by higher incentives or even specific schemes. Moreover, subcontracting is possible in more than half of the measures.

Concerning the suggested linkages of targeted R&D types with other design features, the cross-country comparison does not provide a lot of convincing empirical evidence. However, there are some correlations between a research oriented R&D definition and the use of options which de-link the incentive from current profits, and between the use of a development oriented definition with an SME focus by the use of ceilings Seemingly, other influencing factors are equally or more important (see also section 3.4).

Evaluation results

Beyond these first hints there is little empirically sound knowledge, for which type of R&D the incentives are mostly and can be effectively used, how this depends of design features and how effective specific design features such as those enhancing collaborative research are. Certain answers to the survey part of a recent evaluation of a non-incremental Dutch fiscal measure shed some light on these issues. The WBSO schemehas a rather research-oriented definition of eligible R&D and allows for subcontracting but does not provide specific collaboration incentives. The policy objectives referenced in the evaluation study of Poot et al. can be related to the first (spillover-related) and the third (innovation-related) problem context. This corresponds with the mix of design features chosen. The survey answers point out that *higher-risk R&D* (which is not necessarily the same as R&D with high spillovers) seems not to be particularly encouraged by this scheme; only for SMEs a neutral score in this respect is reported. Participating firms (with the exception of very small ones) rather disagree with the statement that the fiscal measure encouraged *R&D cooperation with others*. In particular SME noted that the

scheme contributed to *more frequent performance of R&D inhouse* (Poot et al.). These effects are consistent with the arguments of this subsection.

Sound empirical evidence on some of the issues might result from further evaluations of schemes which include an approval mechanism that provides some information about the envisaged type of R&D. The ongoing evaluation of SkatteFUNN in Norway which intends to address the collaboration and knowledge transfer issue (Haegeland 2005) is of particular interest in this context. If such data sources are not available, surveys combined with case studies might also provide some further evidence.

3.4 Design options and the size of firms

Another salient topic is the question to what extent and, if at all, how fiscal incentives and its design should account for differences in firm size. In practice, there is a growing tendency that fiscal incentives for business R&D try to favour SMEs (OECD 2002a). Also recent calculations of the B-Index as measure of the generosity of schemes show that it varies between small and large firms in a range of OECD countries (Warda 2005).

Outline of arguments

The usual starting point of arguments for considering firm size is that SMEs are confronted with particular barriers when performing R&D activities. They have fewer possibilities take advantage of economics of scale in R&D and to pool risks by investing in a variety of different R&D projects than large firms. SMEs often face liquidity constraints due to a more difficult access to credit financing, which constrain investments that generate returns only at some time in the future. On the other side, as already mentioned in section 3.2, important R&D advances are often brought about by new, and hence still smaller, firms which form a small and quite particular but important subgroup of small and medium enterprises.

The literature on the linkages of these issues with the design of fiscal incentives (for a summary see e.g. Hutschenreiter 2002) argues that the lower access barriers to fiscal incentives compared with direct measures are a particular advantage for small and medium-sized firms. And there are a range of arguments that there is a differential impact of certain design options on small and big firms which should be taken into account:

Some issues related to the *form of the fiscal relief* have already been discussed in subsections 3.1 and 3.2. *Volume-based schemes* facilitate by their simplicity the general access of SMEs. But compared with *incremental schemes* they favour less the subgroup of new small firms with low but fast growing R&D expenditures. A *ceiling* on the overall amount of eligible expenses might be an effective tool to prevent that most of the available budget for a fiscal incentive goes to large companies. *Cash refunds* as alternatives to *carry forward provisions* in case of lack of taxable profits are deemed of importance for SMEs and in particular new firms because they ease growth constraints imposed by liquidity problems. The *tradability of tax deductions* between firms might lead, as in other trading schemes, to transaction costs which hinder SMEs to use them.

A further firm-size related argument which has been raised concerns the implication of *tax credits* vs. *tax allowances*. It is argued that the higher visibility of tax credits and its direct relation to R&D budgets might be important for large firms with decentralised decision making structures (OECD 2002a), although the Independent Expert Group considers this only as relevant if the credit constitutes itself taxable income (European Commission 2003)[10]. If a tax allowance is chosen, then possible firm-size dependent differences in the corporate income tax system have to be taken into account. Otherwise identical nominal *deduction rates* of tax allowances might lead to a differential generosity for smaller and larger firms.

But also the *eligible type of R&D* might not be neutral towards firm size (see section 3.3). The indirect mechanism is that a large amount of SMEs operates rather far from the technological frontier and hence may profit less from an incentive which is based on a narrow R&D definition focusing on general novelty. This does not hold, however, for often new small but research-intensive firms (e.g. spin-offs).

Finally, also *tax regime chosen* is deemed to have a differential impact related to firm size. If it is only the corporation income tax, certain types of firms, which are led by self-employed persons (mostly SMEs), are not able to benefit from the fiscal incentive.

Including such considerations into the design choice might be particular important if the absorption of new knowledge is considered as relevant problem (see section 3.3). However, it is sometimes warned against that fiscal measures should be oriented too specifically or even only towards SMEs. It is argued that incentive schemes should not lose its neutrality by focusing too specifically on certain goals (Hutschenreiter 2002).

Empirical evidence

When these arguments are compared with the empirical patterns of use, the following picture emerges. The growing tendency of fiscal incentives which favour by some design features SME is confirmed by the present overview. Eight measures provide higher amounts of support[11] or other preferential conditions for SMEs, e.g. more generous conditions concerning subcontracting or collaborative projects. Three schemes in France (the young innovative company), the Netherlands (WBSO B) and the SME tax credit in the United Kingdom[12] only target SMEs, the first two are combined with additional advantages for new firms. A practical implication of such a specific targeting is the need for an approval of the scheme under the EU State Aid framework.

[10] OECD (2002a) argues that tax allowances are more appropriate for SME because they would lower the taxable income, while tax credits work only if there is a relevant tax liability, which is assumed to be lower for small firms due to a worse economic situation. However, if both forms of incentives are calculated in a way that the net relief is the same, i.e. take the corporate income tax rate into account, then there should be no difference. The problem of too low profits for benefiting from a scheme (see section 3.2 for a more detailed discussion) can appear under both forms.

[11] Another reason for higher amounts of support might be that the underlying tax system is already more generous towards SMEs and hence higher relief rates are necessary to create a similar incentive.

[12] Although in the UK formally the SME scheme has been extended to other firms; the design options chosen for SME are still significantly different to be treated as a separate scheme.

At the same time, the openness of schemes tends to increase. Norway and the UK have extended or amended their schemes to cover larger firms, too, while keeping some preferential conditions for SMEs. In about half of the schemes the general openness is somewhat limited at the expense of the biggest R&D spenders by an upper ceiling of eligible R&D expenses. Empirically, such a ceiling seems to be indeed on effective tool to ensure that smaller enterprises receive a significant share of the tax relief. For example, the large majority of the projects supported by the non-incremental project-based Norwegian SkatteFUNN scheme with a low ceiling is conducted by firms below 50 employees (Haegeland 2005). Also in the framework of the predominantly incremental French CIR Scheme with a higher ceiling firms below 50 employees accounted 2003 for around 40% of the government expenses while doing less then 15% of the R&D (Ministère délégué à l'Enseignement supérieur et à la Recherche 2004).

Ten of the 23 incentives are also appropriable within the personal income tax and hence open for SME lead by self-employed, which are of considerable economic importance in a number of countries. However, countries like the UK which base the incentive only on the corporate income tax argue that there is no particular need to set up separate schemes if, as it is the case in the UK, sole-traders can benefit indirectly as subcontractors of corporations (Inland Revenue 2003).

Evaluation results

The results of the abovementioned evaluation of the Dutch WBSO scheme, which contains a range of preferential conditions for SME, e.g. higher relief rates, a ceiling and additional relief for new firms, point to a particular effectiveness of the scheme for firms below 50 employees (Poot et al.). The survey conducted distinguishes between size groups of firms. In particular SME noted that the scheme contributed to more frequent performance of R&D inhouse (for other results see section 3.3). Preliminary results of the evaluation of the non-incremental project-based Norwegian SkatteFUNN scheme with a low ceiling indicate that the percentage of firms which increase R&D has been clearly higher in the introduction year 2003 of the scheme compared with earlier years for firms with no or few anterior R&D (Haegeland 2005).

Other evaluation studies note the heterogeneity of effective relief between different size groups (Hall and Reenen 2000). But in general there still seems to be a lack of evaluation results on the impacts of certain design features on different size classes of firms, let alone distinguishing different SME subgroups according to their research intensity. Cross-country evaluations would be of particular interest in this respect.

Summing up, there are many design options by which the particularities related to firm size can be addressed without the need to limit the incentive scheme as such to a certain target group. But the internal heterogeneity of SMEs as group should be taken into account. As the analysis has shown, volume-based vs. incremental design and the definition of eligible types of R&D are but two design issues of which the appropriateness differs crucially depending if all SMEs or only the small but important subgroup of new enterprises shall be targeted.

4 Conclusion

The overview has shown that there is a variety of design options in use. The further analysis has explored some salient issues in more detail and has indicated some reasons why there is such a variety. It has also identified existing knowledge gaps. The existing policy-oriented literature is often a mixture of expert knowledge, (often implicit) theory and anecdotal evidence. Theoretical studies focus mostly on the economics of fiscal incentives as such, and much less on the analysis of different design options. Moreover, they draw much more on public finance and general microeconomics than on recent approaches to the economics of research and innovation. And sound empirical evaluations of fiscal measures, in particular concerning European experiences, are rare and when they exist, they often do not tell much about specific design issues. Given the difference in industrial structure and tax systems between the US, Canada and Europe, it is questionable to what extent North-American evaluation results can be transferred.

Hence the *general* conclusions concerning an appropriate design of fiscal incentives for business R&D which emerge from the analysis are somewhat limited in scope:

- There is no comprehensive evidence in favour of either *volume-based or incremental designs*. Hence the debate on designs should not only focus on this choice. The appropriate choice depends e.g. of the weighting of differential effects on certain types of firms and the importance given to administrative aspects.
- Important R&D advances are brought about by *young companies which* build their existence on research intensive activities and *do not generate profits yet*. While standard fiscal incentives do not provide effective support in this situation, there are workable design options such as cash refunds or deductions from wage taxes instead of corporation income taxes which are able to cope with this problem.
- There are a growing number of fiscal incentives which relate the eligible type of R&D or the rate of support to *specific forms of collaboration* between business and other research sectors. Hence corresponding provisions on *subcontracting* can be used as a tool to address problems of missing linkages between actors. However, prior to a (still lacking) sound evaluation of such design options as well as a comparison with alternative instruments to tackle the issue nothing robust can be said about its effectiveness.
- The particularities of innovative *SMEs* can be addressed by a range of design options without the need to limit the incentive scheme as such to this target group. But the internal heterogeneity of SMEs as group has to be taken into account. Volume-based vs. incremental design and the definition of eligible types of R&D are but two design issues for which specific conclusions differ crucially when all SME or only the small but important subgroup of new enterprises shall be targeted.
- The knowledge base related to the effectiveness and impact of different design options is still quite scarce. Hence there is a *need for sound evaluations* and cross-

country studies, using databases and methods which allow for the *explicit assessment of differences in design* and its impact.

The analysis conducted points out that one explanation of the observed empirical variety of designs as well as of the limits to general conclusions might be that the working of designs is *context-dependent*. These contexts might significantly differ at the level of firms, sectors, perceived problems of national R&D systems countries and corresponding policy objectives. Some elements of these different contexts have been addressed in section 3.3 and 3.4. This leads to a further conclusion:

- Design guidelines should take relevant *contexts and their diversity* into account, because different problems and related policy targets have an impact on design choices of fiscal incentives for business R&D.

Highlighting the context-dependency of design choices, however, is only a weak conclusion because if each possibly different context were relevant there would be little use in formulating general guidelines on these issues. But some of the mentioned different context factors might be reflected in important persistent types of differences of national contexts. Concerning the choice of the general approach to encourage business R&D the importance of the national context is already well established (e.g. OECD 2002a, Expert Group on Fiscal Measures 2004). Also on some specific design issues stronger conclusions would be possible when such national context-types could be linked robustly to the effectiveness of the use of certain design options of fiscal incentives.

Presently, such linkages can only be presented in form of hypotheses which would need more research and more comprehensive search for robust empirical evidence as possible within the scope of this paper. Hence the following examples for such hypotheses should not be read as policy recommendations but as indications for further studies:

- If fiscal incentives for R&D are used by countries with well performing research and innovation systems, the appropriate design might be rather an incremental or a project-based and not very generous one, based on a research-oriented definition of eligible types of R&D.
- If fiscal incentives for business R&D are used by countries with a comparatively low R&D intensity which are in many areas rather users of new R&D knowledge, but have significant general corporate income taxes, a more commercialisation-oriented R&D definition, higher deduction rates and a volume-based design easy to take up by SMEs might constitute appropriate design features.

These hypotheses seem to be roughly consistent with some empirical observations made in the present overview, e.g. design features of schemes used in France, Denmark and the Netherlands. R&D definitions which are oriented stronger towards commercial usefulness are rather found in Southern European and some Eastern European countries. The hypotheses resonate well with the observed cross-country generosity of fiscal incentives, as measured by the B-index (Warda 2005).

Finally it is noteworthy that some parts of the analysis point to an interdependence of the design of fiscal measures and its effectiveness with other policies which influence the research and innovation system, i.e. direct support measures, education policies influencing the supply of researchers and wider policies towards the knowledge infrastructure. Hence, as already argued by the Independent Expert Group (European Commission 2003), fiscal measures should also be regarded in the context of the national policy mix.

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Annex: Country overview table of fiscal incentives for business R&D

(separate document: FiscInc country overview IPTS 051005)