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Thanks, but no thanks: Companies? Response to R&D tax Credits

Daniel Neicu
KU Leuven - HU Brussels & Universitat Pompeu Fabra Barcelona
Managerial Economics, Strategy and Innovation
daniel.neicu@kuleuven.be

Stijn Kelchtermans
KU Leuven - HU Brussels
Managerial Economics, Strategy and Innovation
stijn.kelchtermans@kuleuven.be

Peter Teirlinck
KU Leuven - HU Brussels
Managerial Economics, Strategy and Innovation
peter.teirlinck@kuleuven.be

Abstract

Do companies learn about R&D policy measures from one another? Is such information spreading to companies with similar economic activities and located in the same region? Our paper studies the way information about new fiscal instruments for R&D travels the inter-company space.
We connect to the literature on information diffusion and peer effects in firms? decisions, as well as empirical work on the adoption of tax incentives for R&D. Moreover, we try to fill an important gap in the research on public policy for R&D. Literature on R&D tax credits is mostly concerned with the effects they produce in terms of R&D inputs or outputs (Hall and Van Reenen, 2000). However, research on the determinants of R&D tax credit use is scarce, especially in the context of analysing how firms learn about such measures.
The policy mechanism we analyse is a partial wage withholding tax exemption for highly qualified R&D personnel employed by Belgian companies. Dumont (2012) finds that, although application barriers are virtually zero, most R&D active companies do not benefit from this measure, possibly due of the lack of knowledge of its existence.
We thus consider to what extent firms with similar economic activities and located in the same region mimic peers? adoption of newly introduced tax credits for R&D, independent from eligibility requirements of the measure, a rich array of other observables that capture firms? R&D activity.
Using data from the Belgian Federal Public Service Finance, we have built our yearly sample of companies employing R&D personnel in innovative economic sectors. Our unbalanced panel contains approximately 4.800 company-year observations, representing 2.500 companies followed through 2006 - 2009.

The main explanatory variable counts, for each company and in each year, the number of peers within the same region and with the same economic activity that have received tax credits in the previous year.
We control for sector size, as well as a host of financial and non-financial firm characteristics.
Since there are no clear ex ante expectations on how the residual risk to adopt the R&D tax incentive evolves over time, we estimate a Cox survival model (Cox, 1972). Secondly, we set to test the same hypothesis under a more robust specification of discrete-time hazard rate with fixed effects. We do this in order to account for unobserved heterogeneity at company level, which might be correlated with some of our regressors.
We find positive, significant peer effects in all our models, implying that the more peers access tax credits at t-1, the higher the hazard any given company will do so at time t. We interpret this as evidence of learning through information diffusion, whose magnitude is mediated by the experience of peers located in the same region and involved in similar economic activities.
We thus show that firms adapt their management of R&D costs as information from their peers reaches them, allowing them to cope with the multitude of choices of public support they face, which are not always efficiently marketed by authorities. Furthermore, our findings indicate that peer effects are an important variable to include in the selection equation when estimating the effects of policy interventions in R&D, as they can increase the probability that a given company will use such measures.

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Thanks, but no thanks:

Companies' Response to R&D tax Credits*

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Daniel Neicu[1,2] Stijn Kelchtermans[1] Peter Teirlinck[1]

daniel.neicu@kuleuven.be stijn.kelchtermans@kuleuven.be peter.teirlinck@hubrussel.be

[1] KU Leuven – HU Brussels, Belgium

[2] Universitat Pompeu Fabra, Barcelona

Abstract

This paper investigates whether firms learn from their peers in order to optimize their R&D management. In particular, we consider to what extent R&D active firms in Belgium mimic their peers' decision to adopt a newly introduced tax exemption for wages of R&D employees. Analyzing time until first adoption of the R&D tax credit, we find significant peer effects, operating at the level of regions and sectors, on a firm's probability of accessing the R&D tax credit. We perform robustness checks to rule out unobserved correlation between firms as an alternative explanation for peer effects. Finally, we identify larger, older and more R&D intensive firms to be more responsive to peers' behavior. Our findings suggest that firms' informal networks play an important role in accessing not only technological but also managerial knowledge. These results have methodological implications for dealing with selection bias in program evaluation, and they inform policy makers how firms cope with a fragmented landscape of innovation support measures.

Keywords: R&D tax credits, peer effects, information diffusion.

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1. Introduction

Do companies learn about R&D policy measures from one another? Is such information spreading to companies with similar activities and located in the same geographical region? Literature on knowledge spillovers is quite abundant, trying to describe the various mechanisms of flows of information between different actors. Nonetheless, such research mainly focuses on the diffusion of knowledge produced in the R&D process, that is, knowledge related to new products or processes. Our paper seeks to shed light on the diffusion of "soft" knowledge about how to manage the R&D process, by analyzing the timing of firms' adoption of newly introduced tax incentives for R&D. In the literature on geographical clusters this diffusion of informal information is known as buzz (Storper and Venables, 2004).

Although news about public incentives for R&D is usually widespread – particularly in small economies – there tends to be a lag between the moment a given support measure becomes available to companies and its actual adoption, despite the clear and substantive positive net value such measures offer to the firm. Dumont (2012), reporting descriptive evidence on the uptake of the R&D tax incentive in Belgium, concludes that - although application barriers are virtually zero - most R&D active companies do not benefit from this measure, possibly due of the lack of knowledge of its existence. Similarly, Falk et al (2009) find that *"[...]s*mall companies seem to have little awareness of the structure of tax incentives for R&D and many of them complain about insufficient information*"*. Our analysis starts from these observations and we investigate to what extent peer effects induce firms to adopt the R&D tax credit.

Besides the general lag in adoption after introduction of the measure, the speed of adoption tends to differ across companies even when the measure becomes available to all firms at the same time. Both these aspects - the delay in adoption and the heterogeneity between adopting firms – are addressed in our empirical analysis.

Analyzing a dataset of 2,680 R&D active companies in Belgium, we find that the usage of the R&D tax credit by a firm's peers, defined at the intersection of regions and sectors, exerts a significant influence on a firm's probability of accessing the R&D tax credit. Further, we find that larger, older and more R&D intensive firms are more responsive to peers' behavior. The results complement the existing literature on the role of peer effects in decision making. More specifically, they suggest that firms' informal networks play an important role in accessing not only technological but also managerial knowledge. The main finding has methodological implications for dealing with selection bias in program evaluation (Imbens & Wooldridge, 2009) as it indicates that it is important to account for peers' behavior if one wants to explain which companies select into a given public support mechanism. With respect to policy, the results inform policy makers how firms rely on observation of peers' behavior as a mechanism to cope with a fragmented landscape of innovation support measures.

2. Literature review

Our paper ties into past research on information diffusion, peer effects, as well as studies on the determinants of receiving R&D tax credits.

Knowledge spillovers and the diffusion of information

Knowledge flows between firms have been studied extensively in the literature, e.g. see Appleyard (1996) for an overview of the management-oriented literature. In this paper, we focus on the non-deliberate, localized inter-firm transfer of managerial knowledge about the R&D process.

Whether knowledge travels (merely) intentionally has long been a subject of scrutiny: mechanisms that have been studied include, among others, employee migration (Almeida and Kogut, 1999; Gupta and Govindarajan, 2000; Hansen, 2002) and research collaborations & alliances (Schilling and Phelps, 2007). In this paper, we analyze an informal transmission channel of information, viz. the effect of the behavior of 'peer' firms on the focal firm's own decision making. This social dimension is a key issue in studying adoption decisions, that is, a comprehensive assessment necessitates rising above the level of the individual firm to include social feedback effects (Hall, 2004).

Literature on knowledge spillovers typically focuses on how innovation at the firm level is affected by flows of "productive ideas" (Jovanovic and Rob, 1989; Feinberg and Gupta, 2004) i.e. technological knowledge rather than expertise on the management of the R&D process. In this paper, we look at the diffusion of such managerial knowledge and, more specifically, we consider how firms learn about a mechanism to reduce their R&D costs.

Empirical evidence that the spreading of (technological) information is facilitated by geographical proximity has been provided by Jaffe et al. (1993), Audretsch and Feldman (1996), Fritsch and Franke (2004) and others. Accounting for the geographically localized transfer of information, our analysis will examine how firms' managerial decisions travel within regional and sector boundaries.

Peer effects

Peer effects have been used extensively for explaining social behavior as varied as initiation of sexual activity (Card and Giuliano, 2011) to job-searching (Nanda and Sørensen, 2010; Cappellari and Tatsiramos, 2011). However, the social connectedness of firm decision making has been studied less extensively, which is arguably due to the difficulty in directly observing inter-company interaction. Nevertheless, a number of studies have looked into the role of 'social influence' in the corporate world by considering, in various settings, whether a larger number of adopters of a certain decision increases the probability of it spreading even further. Evidence of such frequency imitation behavior has been provided in studies of market entry decisions (Gort & Konakayama, 1982; Kennedy, 2002; Lu, 2002; Debruyne & Reibstein, 2005), investment banking (Haunschild & Miner, 1997) and corporate financial policy (Leary & Roberts, 2010). Given the inherent issues with measuring peer effects in economics, we use flexible definitions of firms' peer groups. Thus, we need not make assumptions regarding any direct interaction between firms.

Tax credits

The empirical literature on tax credits for R&D, usually deals with estimating the impact on economic & innovative performance, or with additionality effects (Hall & Van Reenen, 2000; Czarnitzki et al, 2011; Takalo et al, 2013). These studies on the effect on R&D tax credits need to model the firm's selection decision to use the tax credit. We contribute to this literature by analyzing the effect of peers' decisions, controlling for determinants used in previous studies.[2]

[2] For example, Czarnitzki et al (2011) find that larger firms, with permanent R&D activities, entering new markets and in good financial health are more inclined to use tax credits. On the other hand, financially constrained SMEs seem less likely to use tax credits (Busom et al, 2012).

3. Data and Model

Data

Our dataset consists of the repository of R&D active firms in Belgium, constructed by the Belgian Science Policy Office, based on the sampling procedures of the Community Innovation Survey and the biannual OECD Business R&D survey. It includes all companies known to be R&D active and it is updated on a regular basis. The dataset entails R&D related information based on the OECD Business R&D survey and is enriched with public support measures in the field of R&D funding in the form of R&D tax credits (provided by the Ministry of Finance) and R&D subsidies (provided by the regional governments).

Given our focus on the R&D tax credit for wages of R&D workers, we have narrowed down the original dataset of companies to those firms that indicate they employ R&D personnel, and that have their main activity in an 'innovative sector'[3]. Our unbalanced panel contains 5,508 company-year observations, representing 2,680 companies observed in 2006 - 2009.

The dependent variable is a dummy indicating whether a company has received the "wage withholding (partial) tax exemption" for R&D employees in a given year.[4] The measure was introduced in 2006 for companies employing R&D personnel with PhD degrees and has been extended as of 2007 for Master degrees (other than in social sciences), across all industries. Initially, the tax exemption started at 25% of taxes on wages, but has been raised to 65% in 2008 and 75% from 2009. An important feature of the system is that companies can freely choose how to earmark the exempted tax amount.

Table 1 below shows the evolution over time of the number of companies using the tax exemption and the average and median exempted value per company in our sample.

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[3] We have followed Eurostat's definition of innovative industries as applied in the Community Innovation Surveys, complemented with other innovative industries. Our list of sectors contains NACE rev. 1.1 industries 10-37, 40, 41, 50-52, 60-67, 72, 73, 74.2, 74.3 and 90 for the 2006-2007 period, and NACE rev. 2 industries 05-39, 45-47, 49-53, 58, 61-66, 71 and 72 for 2008-2009 data.

[4] The partial tax exemption can thus be seen as a wage subsidy. Given that it only applies to taxes on wages, it clearly differs from other R&D tax credits, such as for fixed asset investments.

Table 1 Evolution of size and usage of the wage tax exemption for R&D personnel

Variable	2006	2007	2008	2009
Population of adopters	345	578	787	1,131
Nr of first-time adopters in population	345	245	241	401
Nr of firms in estimation sample	991	1,238	1,173	1,056
Nr of first-time adopters in estimation sample	158	82	93	185
Average R&D tax credit value in population (EUR)	87,911	68,217	73,149	109,565
Median R&D tax credit value in population (EUR)	25,433	16,349	33,210	35,079

The number of firms adopting the partial tax exemption increases throughout the period 2006-2009. The share of firms in the unbalanced panel that uses the R&D tax credit in 2008-2009 is higher than in the first two years after the measure was introduced, but it remains far from full adoption. The data suggests that the average and median tax exemption increases over time, which may be mainly due to the increase in the applied rate of the tax exemption (from 25% of wage withholding tax in 2006-2008 to 65% in the second semester of 2008, and 75% as of 2009). To gauge the strength of the financial incentive given by the R&D tax credit relative to other public support measures for R&D, we compare it to the average regional subsidy for R&D projects in 2009. The average R&D subsidy (286,587 Euro) is in the same order of magnitude than the average wage tax exemption (109,565 Euro in the estimation sample, or 223,705 Euro for a broader set of sectors).[5] In other words, the R&D tax exemption represents a financial benefit for the firm that it may be expected not to leave on the table. Finally, there is variation in the usage of the R&D tax credit across both industries and regions (see Table 3 in appendix), with Brussels having a slightly higher adoption rate (on average 5.3% of firms at the NACE 4-digit industry level) than Flanders (3.9%) and Wallonia (3.7%). Our definition of “peers” will take into account both the industry and regional dimension, and we will control for them in the empirical analysis.

Our main explanatory variable counts, for each company and in each year, the percentage of other firms within the same region[6] and 4-digit NACE sector, the ‘peers’, that have received the R&D tax credit in the preceding year.[7] Following Debruyne and Reibstein (2005), who

[5] Average and median regional subsidy values according to Dumont (2012).
[6] We use the three main economic and administrative regions in Belgium, namely Flanders, Wallonia and the Brussels Capital Region. The split by region in the definition of peers is motivated by the fact that the regions have a different economic profile (growth, employment, key industries, etc.), have different main languages (Dutch for Flanders, French for Wallonia, and bilingual Dutch/French for the Brussels Capital Region) and are decentralized in terms of political governance. Note however that fiscal policy (and thus also the focal R&D tax credit) is a federal i.e. national matter.
[7] As a robustness check, we also defined peers based on sector membership only. This allowed us to test which specification better explains the variation in the decision to use the tax credit as we do not observe the direct links between companies. Since the models using the industry and region definition of peers provided a closer fit with the data, we stick to this definition throughout the paper.

investigated peer effects on firms' market entry decisions, we also motivate the lag of the peer variable by the fact that we do not observe the exact timing of the decision to apply for the R&D tax credit, but only the end-of-year result.[8] Further, the lag allows for the expected delay between the moment peers make their decision to apply for the tax credit and the moment when the information reaches the followers. Our approach of using a count of companies accessing R&D tax credits within a specific sector and region as a proxy for direct and indirect peer effects is based on widely accepted models of information diffusion within geographical and technological clusters[9]. However, our specification does not impose any particular structure on the network of a firm's peers. This is consistent with previous studies on direct and indirect knowledge spillovers, which showed that both direct and indirect links between firms can have a significant impact on their innovative performance (e.g. Ahuja, 2000).

Since the R&D tax credit initially provided for a higher tax exemption for "young and innovative companies" (a rate of 50% from 2006 to mid-2008, while also being able to use it for R&D support personnel), we include a YIC dummy. In order to define YICs, we calculate their R&D intensity as the ratio of intra-mural R&D spending to total costs, while also filtering out large and old companies from the definition.[10] The YIC dummy also captures the potentially higher propensity of YICs to use public support for R&D, given that innovation is at the heart of their value proposition, even more so than for the other R&D active companies in the sample. Because of this strategic emphasis on innovation, YICs may learn about the R&D tax credit sooner than other companies, in particular because they may have their roots in government-sponsored R&D projects. Also, investors and/or members of the management team for such companies may be well versed in accessing the public support system for innovation, based on prior experience and therefore do not have to learn about the existence of specific support measures in the way other companies need to. Prior research has also shown SMEs to be more financially constrained in their innovation activities (Czarnitzki & Hottenrott, 2011), which may induce them – more than other firms - to proactively seek out financial support to reduce R&D costs. To separate the cost reduction objective from other aspects like the strategic orientation on innovation and other managerial resources, we include

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[8] In the setting we study, applying for the tax exemption is essentially the same as receiving it, since companies only need to provide proof that the R&D employees are eligible for the tax credit by submitting copies of their higher education degrees, arguably a very modest effort.

[9] See Porter (2000), Leamer and Storper (2001), Bathelt et al. (2004), Alcacer and Chung (2007), among others.

[10] In accordance with the Belgian Science Policy Office's definition of YICs, a company needs to be less than 10 years old, have less than 50 employees, have an annual turnover lower than 7.3 million Euro, have total assets of maximum 3.65 million Euro, and spend more than 15% of its total cost on R&D.

proxies of firms' financial health in our analysis. In particular, we use (the lagged logarithm of) the current ratio and the earnings before interest and taxes (EBIT).

In order to avoid a spurious attribution of the usage of R&D tax credits to peer effects, the empirical analysis must control for all sources of correlation between the focal firm and the adopting peers that may explain the adoption decision. In other words, one needs to be careful claiming that a focal firm's decision to apply for the R&D tax credit is inspired by the behavior of its peers while in fact it may be due to some underlying shared characteristic. A crucial attribute in this respect is a firm's 'savviness' in using public support for R&D, which we proxy by an indicator of whether the firm received tax exemptions in 2005 for R&D employees involved in collaboration projects with research institutes or universities (the only R&D-employee related tax incentive in vigor at the time). In the same vein, we also include a (lagged) indicator capturing whether the company has received regional subsidies for R&D activities. In our analysis we control for firm age, firm size (in full-time equivalent employees), R&D employees as a percentage of total personnel (lagged by one year), sector, sector size[11], year and region.[12]

Finally, we interact the number of peers with the YIC indicator: given the more limited managerial resources of YICs compared to larger innovative firms, we expect they may rely more intensely on peers as an information source for their R&D management. We also include an interaction for the YIC and year dummies to account for the fact that these companies received a higher exemption in the first years of application of the measure.

Table 4 in appendix shows yearly[13] summary statistics for the main variables in the estimation sample.[14] Table 5 presents descriptive statistics for key variables, comparing users and non-

[11] We measure sector size in a similar manner to the peers variable: firstly at geographical and industry level, then only by industry.

[12] The data does not allow including a good control for a firm's membership to a corporate group. This is relevant for our analysis in the sense that our peer effects measure may pick up information flows between entities of the same corporate group, rather than between competitors. In particular, our econometric model considers the time until first adoption of the tax credit, meaning that a control for group membership is important if one expected that firms in a group adopted the tax credit faster than independent firms. However, this issue only arises if a corporate group has multiple entities within the same sector and region since a firm's peer group is defined at this level. In other words, the definition of peers is at a sufficiently disaggregated level to prevent the peer effect being driven by learning between corporate group members. Furthermore, the information on group membership in the OECD R&D survey indicates that group membership mostly concerns being part of international enterprise, which is unlikely to matter for a firm's learning about the national tax credit we focus on in our study.

[13] From 2008 onwards, the sampling procedure of the R&D survey has changed in order to include more small companies, which explains the decrease in average firm size over the years in our sample. However, because our measure of peer effects is based on the entire population of tax exemption users as a percentage of the population of active companies per sector and region, this change in sampling does not bias the effect of our main explanatory variable.

users of the tax credit. Note the positive correlation between adoption of the R&D tax credit and the number of adopting peers. The table also indicates the importance of the control variables discussed earlier i.e. recipients of a tax credit in 2005 for R&D cooperation and/or R&D subsidies are more likely to use the tax credit for R&D employees.

Model

Since there are no clear ex ante expectations on how the residual risk to adopt the R&D tax incentive evolves over time, we estimate a Cox proportional hazard model (Cox, 1972). The equation we estimate is the following:

$$
\begin{aligned}
P[tax\ credit]_{it} \\
&= \beta_1 R\&Demployees_{i,t-1} + \beta_2 peers_{i,t-1} + \beta_3 sector\ size_{i,t-1} \\
&+ \beta_4 peers * sect\ size_{i,t-1} + \beta_5 YIC_{it} + \beta_6 YIC * peers_{i,t-1} \\
&+ company\ char. + time\ dummies + industry\ dummies \\
&+ region\ dummies + \varepsilon_{it}
\end{aligned}
$$

We specify a Cox survival model using cluster-robust errors, with the reception of an R&D tax credit as the event of interest. As we are interested in the effect of peers on the initial adoption decision of a company, we use a single-failure model. This means that, once a company fails (i.e. receives the R&D tax credit), it is removed from the sample. This set-up is in line with the data, given that companies basically never opt out of receiving tax credits once they become receivers (there are only 8 exceptions to this rule in the data).

In order to account for unobserved heterogeneity at company level (which the Cox model allows to address in a limited way only, using a frailty term), we estimate the same specification using a discrete-time logit model with fixed effects.

4. Results

The parameter estimates of the two models (proportional hazard and fixed effects logit) of the likelihood of adopting the R&D tax credit are reported in Table 2. We find a positive, significant peer effect in all models, that is, the more peer firms access the R&D tax credit in period t-1, the higher the probability that the focal firm will do so at time t. We interpret this

[14] The table includes the observations prior to and including the first year of using the R&D tax credit. This way the table is consistent with the estimation sample, for which we use a single 'failure' survival model. Thus, all companies that receive the tax credit in a given year drop from the sample in subsequent periods.

as evidence of learning through information diffusion, whose magnitude is mediated by the behavior of peers in the same region and industry.

The magnitude of the peer effects in the Cox models, given by the exponentiated coefficient for the peers variable, is a 2.7% - 3.5% increase in the 'hazard' to adopt the R&D tax credit for every additional percentage of peers having done so, ceteris paribus, which indicates a marked response to peers' decisions.[15]

We perform a split sample analysis in order to pin down the type of firm that is most responsive to peers' decisions. More specifically, we check whether peer effects operate differently depending on firm size, age, and R&D intensity. The split has been made around the median values of age (21 years old), full time equivalent employees (41 employees), and R&D intensity measured as a percentage of R&D employees in total personnel (2%). The analysis reveals that larger and older firms are most susceptible to peer effects (β=.037 and .036) relative to all other types of companies. Furthermore, more R&D intensive companies also differ in terms of learning from their peers, the coefficient of the effect being .018 and significant at 5%, while there seems to be no peer effect on the less R&D intensive firms. The coefficients of the peer effect on young and on small firms are also insignificant. This implies that these companies experience no peer effects. We interpret these results with caution, but there seems to be an experience effect present in older and larger companies, which might form more connections with peers over time.

When accounting for unobserved heterogeneity at firm level, we find that a rise of 1% in peers using tax credits increases the hazard of receiving tax credits at time t by a ratio of 3.25. However, this number needs to be treated with caution, as it does not imply anything about the baseline probability of receiving tax credits. It does represent, nevertheless, strong evidence of the presence of peer effects.

Across our analysis, we find some evidence that YICs behave differently with regards to using the partial wage tax exemption. Although not consistently significant, YICs do seem to have more chances of using the tax credit ceteris paribus (β=.454 in the full sample Cox and .598 in the R&D intensive sub-sample). However, we find no effect of the interaction with the peers variable, implying that their social ties are no different than those of other companies.

[15] As a robustness check, we defined peers as companies in the same industry rather than firms in the same industry and region. The magnitude of the peer effect is even larger in this case, between 2.7% and 5%.

In line with previous findings on the use of R&D tax credits (e.g. see Czarnitzki et al (2011)), we find that larger firms – in terms of total employees, R&D employees, or earnings – are more likely to use the partial wage tax exemption sooner. Moreover, we find that companies who have used wage tax exemptions for cooperating on R&D (in 2005) are also more likely to use the measure we analyze, the same being true for companies having previously accessed regional R&D subsidies. This result is specifically manifest for SMEs and older companies.

However, most of the effects of company characteristics disappear in our fixed effects models. We interpret this as proof that they capture some latent, firm-specific know how in terms of R&D cost reduction through fiscal alleviation, which is captured by the firm-level fixed effect in the logit specification, although the reduced sample size for this model may also play a role.

Table 2 Regression results

	Cox proportional hazard models							FE logit model
	all firms	large firms	small firms	old firms	young firms	R&D intensive firms	non R&D intensive firms	all firms
R&D personnel$_{t-1}$	**0.008**	**0.019**	**0.006**	**0.022**	**0.006**	**0.007**	**0.064**	**0.982**
	(0.001)***	(0.003)***	(0.002)***	(0.004)***	(0.002)***	(0.002)***	(0.027)**	(0.013)
peers$_{t-1}$	**0.025**	**0.037**	**0.012**	**0.036**	**0.008**	**0.018**	**0.026**	**3.252**
	(0.007)***	(0.009)***	(0.012)	(0.009)***	(0.013)	(0.007)**	(0.023)	(0.607)***
YIC	**0.454**		**0.129**		**0.284**	**0.598**		**0.644**
	(0.254)*		(0.305)		(0.282)	(0.249)**		(0.989)
YIC*peers	**-0.005**		**-0.001**		**0.000**	**0.000**		**0.902**
	(0.017)		(0.024)		(0.019)	(0.017)		(0.235)
sector size$_{t-1}$	**-0.000**	**0.000**	**-0.000**	**0.000**	**-0.000**	**0.000**	**-0.001**	**0.995**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.004)
ln(age)	**-0.174**	**-0.123**	**-0.162**	**0.048**	**-0.222**	**-0.188**	**-0.293**	
	(0.059)***	(0.099)	(0.196)	(0.147)	(0.110)**	(0.066)***	(0.148)**	
ln(fte)	**0.462**	**0.417**	**0.576**	**0.473**	**0.393**	**0.528**	**0.586**	**4.580**
	(0.033)***	(0.052)***	(0.114)***	(0.067)***	(0.064)***	(0.038)***	(0.100)***	(4.518)
current ratio$_{t-1}$	**0.002**	**-0.011**	**0.004**	**-0.010**	**0.023**	**0.009**	**-0.015**	**0.974**
	(0.008)	(0.019)	(0.006)	(0.023)	(0.019)	(0.017)	(0.055)	(0.071)
EBIT$_{t-1}$	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**1.000**
	(0.000)	(0.000)*	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R&D subsidy$_{t-1}$	**0.539**	**0.356**	**0.844**	**0.223**	**0.703**	**0.465**	**0.508**	**0.881**
	(0.091)***	(0.113)***	(0.162)***	(0.144)	(0.122)***	(0.096)***	(0.305)*	(0.306)
tax credit for R&D collab$_{2005}$	**0.263**	**0.308**	**0.037**	**0.520**	**0.040**	**0.133**	**-42.630**	
	(0.144)*	(0.188)	(0.261)	(0.208)**	(0.194)	(0.147)	(0.000)	
old		**0.008**	**-0.245**					
		(0.146)	(0.252)					
large				**0.438**	**0.147**			
				(0.220)**	(0.198)			
Log likelihood	-3,648.01	-2,295.47	-984.47	-1,520.61	-1,717.40	-2,900.82	-478.91	-162.30
Nr of firms	2,680	1,253	1,487	1,348	1,433	1,922	964	271
Nr of observations	5,508	2,776	2,732	2,810	2,698	3,921	1,587	783
Nr of firms using tax credit	535	369	166	253	282	449	86	271

Standard errors in parentheses. Significance levels 0.1% (***), 5% (**), 10% (*).

Peer firms are defined based on industry (NACE 4-digit level) and region.

Subsamples: *Large firms* defined as employing more personnel than the median (= 41 full-time equivalent employees). *Old firms* defined as above sample median age (=at least 21 years old). R&D intensive firms have at least 2% (=sample median) of their personnel working in R&D.

YIC*year interactions not shown in table (not significant).

5. Conclusions

In this paper we identified peer effects as an important driver of adoption of volume-based tax credits for R&D. We show that firms optimize their R&D management as information from their peers reaches them, allowing them to cope with the multitude of public support mechanisms they face, and which are not always efficiently ‘marketed’ by public authorities.

Furthermore, we find that peer effects are present in an industry both at regional and national level, thus contributing to current literature on information spillovers in geographical proximity. A methodological contribution of our findings is that they demonstrate the use of peer effects as a variable to include in the selection equation when estimating the effects of policy interventions in R&D.

Our results have implications for the design of the communication of innovation policy, as there is an apparent information deficit about such support measures, which firms deal with by learning from their peers. This deficit might stem from the high number of available innovation support mechanisms for companies, as is the case in Flanders (Soete, 2012) and other European countries. Moreover, the evaluation of R&D fiscal incentives' efficacy should always take into account the ease with which companies receive relevant information, which translates into opportunity costs of the application process, a major barrier that policy makers need to consider before designing such frameworks.

Our results also hint at a possible interaction between subsidies and tax credits for R&D, in the sense that companies having received subsidies in the past seem more knowledgeable about fiscal incentives than those who haven't done so. Finally, an interesting avenue for further research is to build on the technology diffusion literature to disentangle alternative explanations for the diffusion pattern of public incentives for R&D. While the issue of choosing the 'right' technology is absent in the case of public incentives for innovation, further work will help to understand to what extent, as Geroski (2000) states, "diffusion is a social process that is something other than the sum of its parts".

Appendix

Table 3 Sector size and sector-level R&D tax credit usage, per region

Variable	Mean	Std. Dev.	Min	Max
		Brussels Capital Region (N=581)		
sector size	36.16	52.06	1	266
exemption usage (%)	5.26	15.37	0	100
		Flanders (N=1,179)		
sector size	140.61	268.48	1	2,541
exemption usage (%)	3.86	10.39	0	100
		Wallonia (N=853)		
sector size	64.93	132.37	1	898
exemption usage (%)	3.65	8.78	0	100

Sector size counts the number of active companies within a sector (NACE 4-digit level) and region.
Exemption usage refers to the percentage of companies having used wage tax exemptions per sector and region.
N (number of observations) is at the firm x year level.

Table 4 Summary statistics

Variable	2006 (N=991)		2007 (N=1,238)		2008 (N=1,173)		2009 (N=1,056)	
	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
R&D tax credit use	0.16	0.37	0.07	0.25	0.08	0.27	0.09	0.29
R&D personnel (as % of total personnel)	14.17	19.89	12.56	19.4	12.49	18.24	10.68	17.48
Nr of peers using tax credit	1.89	3.69	2.52	4.39	4.65	7.69	6.33	10.23
sector size	145.58	266.11	189.16	324.31	177.76	260.01	201.65	293.98
YIC	0.04	0.21	0.02	0.15	0.03	0.18	0.03	0.16
age	27.69	20.38	26.68	18.7	25.89	18.23	25.03	17.82
employees (fte)	222.26	631.37	146.92	480.31	143.21	474.11	101.46	466.75
current ratio	2.06	2.37	2.13	2.44	2.37	7.9	2.4	3.73
EBIT (1000's of Euros)	3,705	10,400	2,734	8,924	2,243	8,113	1,318	6,030
tax credit for R&D collab$_{2005}$	0.04	0.19	0.01	0.12	0.02	0.12	0.01	0.09
R&D subsidy	0.29	0.45	0.21	0.41	0.21	0.41	0.15	0.36

Table 5 Summary statistics, by use of tax credits, all years

Variable	Non users of the tax credit			Users of the tax credit		
	obs	mean	s.d.	obs	mean	s.d.
R&D personnel (as % of total personnel)	4,974	12.02	18.79	535	18.83	24.89
Nr of peers using tax credit	4,974	4.12	7.61	535	5.24	7.5
sector size	4,974	187.01	293.26	535	154.65	257.66
YIC	4,974	0.03	0.17	535	0.07	0.25
age	4,974	25.9	18.3	535	26.28	21.18
employees (fte)	4,974	118.67	416.06	535	354.82	981.07
current ratio	4,822	2.27	4.71	520	2.36	3.37
EBIT (1000's of Euros)	4,822	1,918	7,220	520	5,620	13,700
tax credit for R&D collab$_{2005}$	4,974	0.01	0.1	535	0.07	0.25
R&D subsidy	4,974	0.18	0.39	535	0.41	0.49

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