THE RELATIONSHIP BETWEEN GOVERNMENT AND BUSINESS R&D EXPENDITURE IN THE EUROPEAN UNION

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Abstract:
The present paper aims at providing an empirical contribution to the literature on the relationship between government and business R&D expenditure in the European Union. Based on an econometric model which estimates business expenditure as a function of government support through general expenditure and, state aid, respectively, we have found a positive correlation between these variables, suggesting that in most cases there is a complementary relationship according to which government expenditure creates an additional incentive for the business activities.

Key words: *governement expenditure, state aid, business expenditure, complementary relationship, crowding out effect.*

JEL classification: C54, E61, H25.

Introduction

The role of investment in technological change represents a topic of high interest for both academics and practitioners. The general concepts for the research on technological change have been provided by "the theory of economic development" (Schumpeter, 1934), which differentiated between its most important stages (invention, innovation and diffusion). Invention is generally associated with basic research and refers to the process of generating new ideas. The second stage is typically associated with research and development (R&D) and incorporates the new ideas into products and services for the market, while their expansion takes place in the third stage, which particularly allows the evaluation of the technological effects on the economy.

Modern literature has reconsidered and further developed the studies on technological change. According to the neoclassical theory, technological change through R&D investment was assumed to provide constant returns and was regarded either as development in the variety of capital goods (horizontal innovation e.g. Romer, 1990) or as an improvement in the quality of products (vertical innovation e.g. Grossman and Helpman, 1991; Aghion and Howitt, 1992). A different direction was suggested by the evolutionary theory, which considered technological change as a process characterized by a complex pattern which includes both uniformity and idiosyncrasy across time and countries (Chiaromonte and Dosi, 1993). This new orientation has also extended the technological change research towards the role of government policy and the relationship between public and private institutions (Silverberg and Verspagen, 1995).

The paper is structured in the following manner: the second section evaluates the theoretical and empirical background of the relationship between public and private R&D expenditure, focusing on the results provided by the related literature. The third section describes the methodological instruments that have been used in our research. The fourth section analyzes the results of an econometrical model in which business expenditure is estimated as a function of government support and state aid respectively,

in order to evaluate whether there is an interconnection between these variables. The last section concludes.

Literature review

There is a constantly growing theoretical and empirical literature examining the relationship between public and private R&D investment. The diversity of approaches involves that the evaluation of the data from different levels of aggregation ranges over different time periods and across a variety of scientific and technological fields, which means that it is very difficult to arrive at a definitive empirical conclusion concerning the sign and the magnitude of this relationship. The results suggest a balance between, on the one hand, the fact that public spending could be complementary and additional to private spending, and on the other hand, the fact that public funding substitutes for private investment and thus tends to have a crowding out effect on the latter.

The complementary relationship that shows a positive, statistically significant correlation between the two forms of R&D financing is generally prevalent in econometric studies carried out at macroeconomic level (Jaffe, 1989; Adams, 1990; Link and Scott, 1998; David et.al., 2000; Guellec and van Pottelsberghe, 2004; Doraszelski and Jaumandreu, 2011). In methodological terms, the macroeconomic approach is more relevant, as it allows government support to be considered as exogenous with respect to privately financed R&D, while in the case of the firm-level approaches, the assumption of exogeneity is questionable because public institutions do not provide R&D expenditure to randomly selected companies.

Econometric studies have focused largely on quantitative aspects of the complementary relationship, which does not capture intermediate results of R&D activities. For this reason, recent studies have been equally concerned about the qualitative aspects of this relationship, which refers mainly to the "behavioural" transformations of companies that have conducted R&D activities using public support and which would not have been held in their absence (Buisseret et al., 1995).

Qualitative studies support the assumption that government funding is effective in inducing firms to invest more into R&D. Moreover, the surveys that have been used confirm the existence of both direct and indirect effects of the complementary relationship, indicating that the support positively influenced firms to carry out higher risk research than would have otherwise been the case and increased their ability to network with other firms in partnership research (Clarysse et al., 2004). Also, the same can be said about the case studies on the impact of research funded by government programs (Link and Scott, 1998).

In the situations when public expenditure tends to substitute private expenditure, government intervention fails to correct the market failures for which it was intended and may have negative effects on the functioning of the market mechanisms by selectively conferring advantages to specific firms, sectors or research areas, that may further result in misallocation of resources and reductions in social welfare (Goolsbee, 1998; Lach, 2002). The substitution ("crowding-out") effect can occur in the situations when, in order to avoid criticism concerning wasting public funds, governments might invest in projects with lower risk profile and higher private returns ("pick-the-winner" strategy) that would have been undertaken in the absence of public support (Wallsten, 2000; Czarnitzki and Fier, 2002). In addition, both variables are likely to be influenced by exogenous factors (e.g. costs of production, economic cycles) that may diminish the relevance of relationship analyzed in this case.

Government expenditure includes a diversity of direct (by form of state aid) and indirect measures (by form of fiscal incentives) which might contribute in a different manner to the fostering of business enterprise R&D. The problem of granting state aid to companies investigates the possibility, the conditions and the efficiency of

government interventions in the economy. The economic literature provides very different conclusions concerning these topics, ranging from keynesian economic policy, which stresses the importance of state interventions for stabilizing the business cycle, to neoclassical considerations, which regard the government interventions more as a complement of the self-regulating market mechanisms. Despite different approaches of the problem, one of the most important unifying aspects of this literature concerns the fact that state aid is used as a regulatory policy instrument, while its effectiveness and efficiency have been related to the support of economic development through the effects on innovation, investment or employment.

Methodology

The present paper aims at providing a contribution to the empirical literature while it focuses primarly on establishing a possible macroeconomic correlation between public and private R&D support in the EU. In this respect, we have considered that R&D private expenditure can be estimated as a function of government support, in order to evaluate whether there is a certain interconnection between these variables.

The main variables of the study are R&D expenditure supplied by government sector, on the one hand, and business enterprise sector, on the other hand, which have been considered in both relative and absolute terms. The relation between these variables was estimated through a panel model which used seemly unrelated regression (SUR) and ordinary least squares estimation (OLS). However, since there is a diversity of direct and indirect government measures that might have an impact on the privat sector expenditure, we have focused our econometric study on state aid, as it represents one of the most significant government measures from both a quantitative and a qualitative perspective.

Taking into consideration the depreciation of the economic value of knowledge in time, we have appreciated that this economic value is likely to be realized after the innovation effort was made. As a result, we have incorporated this economic aspect in an econometric sense by using time lags, which are related to the fact that one of the most significant particularities of R&D activity is time lapsing between the introduction of an innovation through a research project and the moment when the results of the research are embodied into a new product or process, which becomes profitable.

Results of the empirical analysis

In relative terms, the analysis of government and business R&D investment reveals that, in most cases, the evolution of these variables follows the same direction when considering average values for the period 2005-2007 and 2008-2010 respectively. State aid to R&D represents a relatively small share in government funding, while business expenditure has the largest share relative to the GDP in the majority of situations. The only exceptions when governement expenditure is larger are represented by Bulgaria, Cyprus, Poland and Romania. This suggests that the relationship between public and private R&D investment has been influenced by economic and political considerations of the European integration process, while the persistance of disparities between Member States in this respect depends to a large extent on their capacity to apply the EU directives regarding the enhancement of the public support for innovation and technological change.

Table 1. The public and private R&D investment in the EU (mean values)

	State aid expenditure (% of GDP)		Government expenditure (% of GDP)		Business expenditure (% of GDP)	
Country	2005-2007	2008-2010	2005-2007	2008-2010	2005-2007	2008-2010
Belgium	0.06	0.16	0.15	0.18	1.28	1.33
Bulgaria	n.a.	0.03	0.29	0.26	0.12	0.2
Czech Rep.	0.1	0.15	0.29	0.3	0.92	0.91
Denmark	0.02	0.06	0.13	0.06	1.71	2.05
Germany	0.07	0.08	0.35	0.4	1.8	1.89
Estonia	0.02	0.02	0.12	0.16	0.48	0.67
Ireland	0.01	0.06	0.09	0.07	0.82	1.11
Greece	0.03	0.01	0.12	n.a.	0.18	n.a.
Spain	0.07	0.1	0.2	0.27	0.66	0.72
France	0.05	0.1	0.35	0.33	1.32	1.37
Italy	0.06	0.05	0.18	0.17	0.57	0.66
Cyprus	0.03	0.01	0.12	0.1	0.1	0.1
Latvia	0	0	0.12	0.14	0.26	0.18
Lithuania	0.01	0.01	0.18	0.17	0.2	0.21
Luxembourg	0.04	0.09	0.2	0.27	1.37	1.21
Hungary	0.05	0.06	0.25	0.22	0.46	0.63
Malta	0	0.01	0.02	0.02	0.39	0.36
Netherlands	0.05	0.05	0.23	0.22	0.99	0.87
Austria	0.06	0.09	0.13	0.15	1.74	1.86
Poland	0.01	0.01	0.21	0.23	0.18	0.19
Portugal	0.01	0.02	0.11	0.11	0.45	0.75
Romania	n.a.	0.04	0.16	0.19	0.21	0.18
Slovenia	0.08	0.11	0.36	0.38	0.89	1.23
Slovakia	0.01	0.01	0.16	0.17	0.21	0.22
Finland	0.1	0.13	0.31	0.34	2.48	2.75
Sweden	0.03	0.03	0.17	0.16	2.6	2.54
UK	0.03	0.03	0.17	0.17	1.08	1.1

Source: author's own calculations based on data from Eurostat

When considering the possibility of establishing a relationship between government and business expenditure in absolute terms (million EUR), we have found that the coefficient of the governement expenditure is positive and statistically significant, showing that there is a positive correlation between these variables. The positive correlation indicates that if one indicator goes up positively, the other one follows the same direction. In this context, one can notice that government R&D expenditure explains 78% of the business R&D expenditure, which means that the relationship between the variables is robust. Consequently, these results prove that governement expenditure contributes in an important manner to the development of the business expenditure, which supports a complementary relationship between these variables.

Table 2. The relationship between R&D government sector expenditure and R&D business enterprise sector expenditure

Method : Panel EGLS (Period SUR)
Dependent variable : Business enterprise sector expenditure
Sample: 1 162
Periods included: 6
Cross-sections included: 27

Equation : Business expenditures = C(1)+ C(2)*Government expenditure

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	1048.792	309.6091	3.387472	0.0009
C(2)	3.719171	0.172811	21.52157	0.0000

Source: author's own calculations based on data from Eurostat

Weighted Statistics

R-squared	Adjusted R-squared	F-statistic	Prob (F-statistic)	Mean dependent var	Sum squared resid
0.787168	0.785804	576.9728	0.000000	0.582320	123.2782

Source: author's own calculations based on data from Eurostat

According to our findings, state aid represents a significant contribution within general governement expenditure in the EU, for the period 2005-2010, since its coefficient is positive and statistically significant when estimating a relationship between state aid and business enterprise expenditure. Moreover, state aid investment explains 68% of business enterprise expenditure, which proves that in this case government expenditure stimulates private investment in R&D activities. These results confirm the existence of a complementary relationship between state aid, as a direct form of government support, on the one hand, and business enterprise expenditure, on the other hand.

Table 3. The relationship between R&D state aid and R&D business enterprise sector expenditure

Method : Panel EGLS (Period SUR)
Dependent variable : Business enterprise sector expenditure
Sample: 1 162
Periods included: 6
Cross-sections included: 27

Equation : Business expenditures = C(1)+ C(2)*State aid

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	1005.344	492.2471	2.042356	0.0428
C(2)	11.83201	0.720047	16.43228	0.0000

Source: author's own calculations based on data from Eurostat

Weighted Statistics

R-squared	Adjusted R-squared	F-statistic	Prob (F-statistic)	Mean dependent var	Sum squared resid
0.685001	0.682994	341.4139	0.000000	0.649523	118.6961

Source: author's own calculations based on data from Eurostat

In the relationship between these variables, we have considered useful to introduce a time lag between the period when state aid was granted and the period when business enterprise expenditure was measured. As a result, we have found that state aid from the previous year explains 79% of business enterprise expenditure of the current year, which means that state aid continue exerting an effect on business activity after the government support was made.

Table 4. The relationship between R&D state aid and R&D business enterprise sector expenditure

Method : Panel EGLS (Period SUR)
Dependent variable : Business enterprise sector expenditure
Sample: 1 162
Periods included: 5
Cross-sections included: 27

Equation : Business expenditures = C(1)+ C(2)*State aid(-1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	1153.852	462.5465	2.494565	0.0139
C(2)	14.07196	0.658473	21.37061	0.0000

Source: author's own calculations based on data from Eurostat

Weighted Statistics

R-squared	Adjusted R-squared	F-statistic	Prob (F-statistic)	Mean dependent var	Sum squared resid
0.798773	0.797225	516.0362	0.000000	0.344302	112.9608

Source: author's own calculations based on data from Eurostat

In order to evaluate to what extent does state aid programs tend to maintain their effects on private investment after they have been granted, we have extended the time lag to a period of two years. The positive relationship between the variables persists when extending the time lag to two years and in this situation the statistical significance of the relationship is 73%. While governement support through state aid significantly contributes to the development of business activity after the grant has been provided, we appreciate that it is reasonable to expect even longer lags for spillovers because of the additional diffusion lag and also for the basic R&D because of the longer invention to innovation lag.

Table 5. The relationship between R&D state aid and R&D business enterprise sector expenditure

Method : Panel EGLS (Period SUR)
Dependent variable : Business enterprise sector expenditure
Sample: 1 162
Periods included: 4
Cross-sections included: 27

Equation : Business expenditures = C(1)+ C(2)*State aid(-2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	1293.654	563.9928	2.293743	0.0238
C(2)	14.57346	0.939801	15.50696	0.0000

Source: author's own calculations based on data from Eurostat

Weighted Statistics

R-squared	Adjusted R-squared	F-statistic	Prob (F-statistic)	Mean dependent var	Sum squared resid
0.730696	0.728081	279.4671	0.000000	0.751154	86.06979

Source: author's own calculations based on data from Eurostat

Conclusions

From the main findings of our analysis, we can conclude that in most cases government expenditure does stimulate private R&D investment. The case of state aid is representative in this context, since econometric evidence has shown that state aid contributes in the same manner as the general governement expenditure. Furthermore, the correlation between these variables is robust, which means that in the cases that have been analyzed, the results suggest a complementary relationship between state aid and business R&D expenditure.

From a political perspective, the Commission had constantly argued that state aid should be mainly used as a regulatory instrument, designed to correct or compensate situations when the market fails to provide the optimum results. Although according to this perspective, government support to R&D activities should be directed mainly on reducing the economic disparities between regions and countries across the EU, the practice has proved that Member States follow a more diverse set of objectives concerning the governement support. We consider that the implications of our findings support the fact that, apart from diminishing the market imperfections, government support can also be used in a proactive manner, as a complementary instrument aimed at fostering private investment in technological progress. Government support increases the capacity of the business sector to incorporate technologies developed in public or private research units.

We consider that further research should include a qualitative dimension in this respect that should focus on providing answers regarding effective channels of improving the relationship between public and private sector. However, since there is a variety of financial instruments designed to act as incentives for business R&D, there is a strong need for a better institutional and financial coordination between public and private authorities involved in financing R&D, on the one hand, and direct and indirect instruments of intervention, on the other hand, in order to stimulate a constant flow of knowledge between these two sectors.

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