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Does Government Support for Private Innovation Matter? Firm-Level Evidence from Turkey and Poland

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Contents

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Abstract

The aim of the project is to analyze government support for innovation in a comparative perspective by first examining the main existing instruments of financial support for innovation in Turkey and Poland, and secondly to assess their effectiveness by applying recent econometric techniques to firm-level data for both countries obtained from the Community Innovation Survey (CIS).

Comparing Turkey to Poland is both meaningful and promising from a policy-analysis point of view. Both countries are comparable in terms of levels of economic development and technological capabilities, i.e. the ability of their economies to create knowledge and exploit it commercially. Both have undergone deep market-oriented reforms in the last decades – Turkey since 1980, Poland since 1989 – resulting in a significant catching-up of their economies. However, as the possibilities for further growth based on structural change and eliminating obstacles to business are shrinking, the problem of building a knowledge-based economy comes to the fore.

In Turkey, one can observe the growing popularity and the generous practices of public incentives in industrial R&D and innovation, in addition to the recent trends in public policies to support technological entrepreneurship and the commercialization of research output. Since 2004, significant changes and improvements have taken place in Turkey concerning science and technology policy schemes that have actually influenced the national innovation system in a number of ways. These include: an important increase in public support provided to private R&D, the diversification of direct support programmes for private R&D and innovation (which was tailored to the needs of potential innovators), a widening of the scope of existing fiscal incentives for private R&D activities and the implementation of new ones, the implementation of new call-based grant programmes targeted at technology areas and industries based on national priorities. Considering the large resource allocation for the government involvement, there is a growing and urgent need for the systematic monitoring and evaluation of R&D and innovation policies in Turkey.

In Poland, the science, technology and innovation (STI) policies were seen as less important than other reforms (financial system, privatization, pensions etc.) during the economic transition. The STI policies have lacked funding, co-ordination and vision. The institutional architecture has evolved with a lack of continuity and a short institutional memory. A major breakthrough occurred after 2004 when considerable funds for innovation were provided via EU structural funds. The three principle areas of support were the creation of technologies, technology absorption and indirect support. However, with respect to public programmes

targeting firms, technology absorption has dominated all other instruments. Consequently, it is legitimate to ask whether the EU funds are being spent in the best possible way, and in particular, whether they contribute to the enhanced innovation performance of economy.

To assess the efficiency of public support, the same econometric methodology is applied to the Turkish and Polish 2008 and 2010 editions of the Community Innovation Survey for manufacturing firms. Two models are estimated: one following the now classical CDM model and assessing the role of innovation spending, but assuming government support to be exogenous, and another controlling for the endogeneity of support but assuming a simplified version of the innovation performance equation. Depending on data availability, extensions of the analysis for both countries are offered: for Turkey the estimation of a full-fledged CDM model and for Poland the analysis of panel data for 2006-2010 and an assessment of the efficiency of specific kinds of public support.

The evidence indicates that government support contributes to higher innovation spending by firms and this in turn improves their chances to introduce product innovations. The positive impact remains valid even when a possibly non-random selection of firms for government support programmes is controlled for. The extended analysis of Turkey has proved that there is a positive relationship between innovation and firm productivity.

On the other hand, substantial differences between various kinds of public aid were identified. In particular, support from local government proved inefficient or less efficient than the support from central government or the European Union. Moreover, in Poland, grants for investment in new machinery and equipment and human resources upgrading proved to contribute significantly less to innovation performance than support for R&D activities in firms.

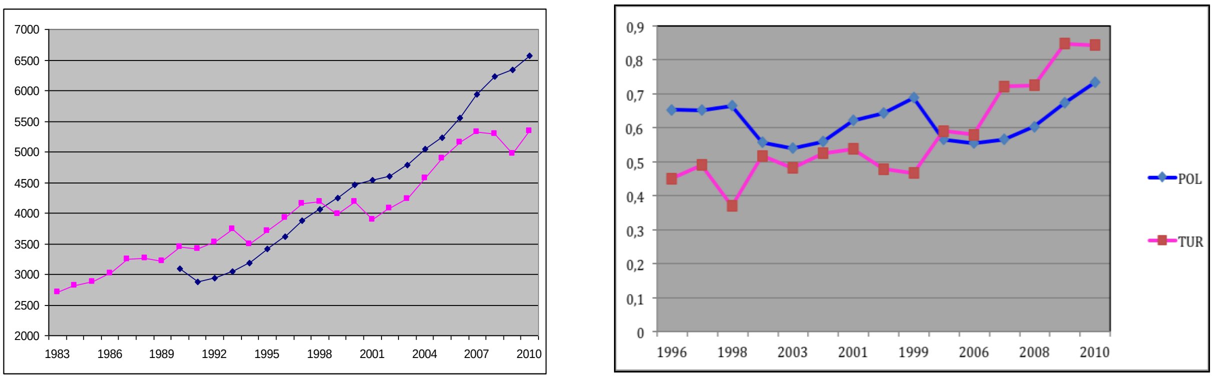
In terms of policy recommendations, this report supports an increase in the volume of innovation support and in the number of instruments used in Turkey. However, a more specific analysis is needed to explain the inefficiency of support from local government. The recommendation for Poland is to redesign the innovation support schemes for firms so as to put more focus on R&D activities and the development of truly new products and technologies.

1. Introduction

The role of innovation and technology development has been increasingly acknowledged both in social science (Fagerberg, Verspagen 2009) and in economic policy-making. Nowadays every government feels obliged to include innovation policy in its strategy, but the quality and efficiency of these policies differ across countries (cf Larédo, Mustar 2001, ch. 14). In this study, we compare the scale, scope and institutional architecture of Turkish and Polish policies aimed at supporting innovation in firms, and analyze their efficiency by applying the same methodology to the national editions of the 2008 and 2010 Community Innovation Surveys.

Comparing Turkey to Poland is both meaningful and promising from the policy-analysis point of view. Both countries are comparable in terms of economic development and so-called technological capabilities, i.e. the ability of their economies to create knowledge and exploit it commercially (see Section 2 for a more detailed analysis). Both have undergone deep market-oriented reforms in the last decades – Turkey since 1983, Poland since 1989 – resulting in a significant catching-up (cf. Figure 1). However, as the possibilities for further growth based on structural change and eliminating obstacles to business are shrinking, the problem of building a knowledge-based economy comes to the fore.

Figure 1. Poland vs. Turkey. Left panel: GDP in constant prices (constant 2000 USD). Right panel: Gross R&D expenditure as % of GDP. Source: World Bank



In Turkey, policy makers have responded to the challenge by increasing government R&D expenditure (to 0.73 GDP in 2008 from 0.45 in 1996), by strengthening key public elements of the national innovation system and by launching a wide array of innovation incentives for companies (World Bank 2009). On the other hand, in Poland, the science, technology and innovation (STI) policy is where the shortcomings and the incompleteness of past reforms become evident (Goldberg, Goddard 2011). Since 2004, EU-funded programs have dominated the landscape of Polish innovation support system, but a systematic analysis of their efficiency is still lacking.

The aim of this study is to assess the efficiency of innovation policy in the form of direct financial aid to firms. To that end we analyze the data from the Community Innovation Survey (CIS). The CIS is a Eurostat-coordinated biennial survey of firms implemented with a standard questionnaire containing a number of questions about the innovation activities of firms, their expenditure, and also about public aid for innovation. We apply the same methodology to the Turkish and Polish 2008 and 2010 editions of the survey for manufacturing firms and examine whether government aid has improved the innovation performance of companies in 2008-2010. We also offer several extensions of this analysis for country-specific data, including an investigation of a longer 2006-2010 period for Poland.

The literature aimed at assessing innovation support measures in other countries has generally found a positive relationship between the support and innovation performance of firms, but it has struggled with the question of whether or not there is a crowding-out phenomenon. Do government support programs create new investment in R&D or do they simply crowd out private investment, which is substituted by government funding? The most recent studies of advanced countries reject full crowding out: (Ali-Yrkkö 2004) for Finland, (Lach et al. 2008) for Israel, (González, Pazó 2008) for Spain, (Czarnitzki, Lopes-Bento 2013) for Flanders, (Aerts, Schmidt 2008) for Germany and Flanders1. One exception is the Wallsten (2000) study of the Small Business Innovation Research (SBIR) program in the U.S. However, the positive experience in high-income countries does not necessarily mean the situation is the same in countries like Turkey and Poland.

Since the CIS data does not contain information on the exact amount of government aid received, it does not allow for quantifying possible crowding-out effects. However it is possible to verify whether crowding out takes place or not, either by applying matching techniques or by modeling the role of support and the government decision to grant it. The latter approach is adopted in this study. The report is structured as follows: In section 2, we briefly reiterate theoretical arguments in favor of innovation support for firms. In Section 3, we compare the innovation support systems in Poland and Turkey as well as the amount of support, while in Section 4 we give an assessment of government aid in both countries. We present the results of a comparative firm-level analysis, as well as the outcome of country studies, depending on data availability. In the last section, we offer conclusions.

[1] For a list of other relevant studies, see Mairesse, Mohnen 2010, p. 18

2. Theoretical arguments for government support

The case for government support for innovation can be built both on the findings of mainstream economic theory and on the evolutionary approach. Starting with the former, innovation activity is related to several sources of market failure: the inability to assign and protect property rights, information asymmetry and risk aversion.

The outcome of innovation efforts might be hard to appropriate. Although the system of intellectual property rights offers some protection, it is usually quite expensive to use[2] and secrecy might be hard to keep, given the modern means of communication, the reliance on team-work in research and the professional mobility of skilled workers and researchers. Some discoveries are commercially applied only after a longer period of time and not necessarily in the kind of product (or even the kind of industry) they were initially expected to support. These factors discourage innovation unless a firm has a long-term technology strategy, a considerable budget for patent protection, and ideally, a variety of products in its portfolio (Nelson 1959).

External funding is another problem for a firm willing to engage in R&D activities. The inherent innovation asymmetry makes it hard for the investor to assess the usefulness of a given project and to monitor the adequacy of a firm's efforts. Thus, a possible consequence is a 'funding gap' (Hall, Lerner 2010). Information asymmetry can result in credit rationing, i.e. a complex procedure for innovative firms to access capital and avoid the negative phenomena of adverse selection (attracting bad R&D projects) and moral hazard (inefficient work or excessively risky projects), cf. (Tirole 2005).

Like other market failures, 'funding gap' problems can be amended by market forces, in this case by actors such as venture capital firms or angel investors (Goldberg, Goddard 2011). However, this is more likely to mitigate the problem in developed countries with strong innovation sectors. According to Eurostat, the ratio of total venture capital investments to GDP in 2012 in Poland was 0.2%, compared to 2.1% in Germany, 3.8% in the United Kingdom and 7.2% in Denmark.

The evolutionary approach in the economics of innovation has developed further arguments in support of government aid for innovating companies (Metcalfe 1995). Here the key concept is that of technology capabilities of firms (Pavitt 1990), i.e. their ability to adapt,

[2] According to the estimates by van Pottelsberghe and Meyer, in 2008, the average cost of obtaining a patent was about 2000 USD in the USA, while in Europe it was between 17000 USD and 35000 USD (in purchasing power parity), depending on the country scope of protection (van Bruno Pottelsberghe, 2008) .

create and commercially exploit new technologies, and that of the system of innovation (Edquist). From this point of view the development of new technologies is to a smaller extent a reflection of a competitive equilibrium than it is a result of processes of variety generation and selection. The role of technology policy is to facilitate these processes by enhancing firms' technology capabilities, supporting co-operation in the system and preventing the phenomenon of lock-in, among other things (Metcalfe 1994).

3. Government support for innovation in Turkey and Poland

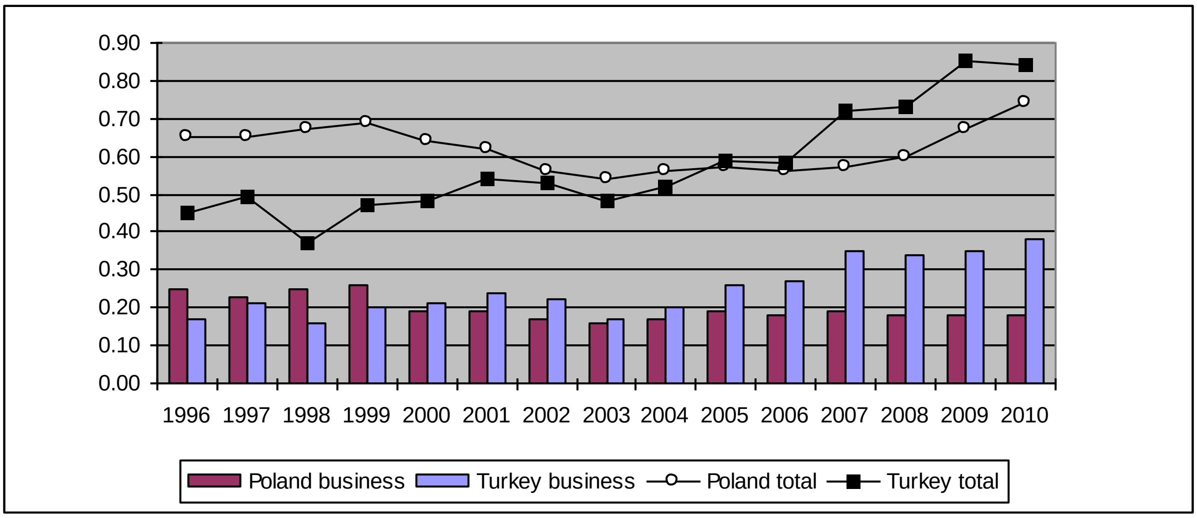
While Turkey and Poland represent roughly similar levels of development, an analysis of the technological indicators in both countries reveals some differences (section 3.1. below). Also. government policy with respect to innovation support in firms is quite dissimilar (section 3.2).

3.1. STI indicators for Turkey and Poland

For a comparative analysis of countries, international rankings are a good starting point. In fact, in innovation studies there is quite a rich amount of literature on the measurement of 'national technological capabilities'. Archibugi and Coco (2004 and 2005) review existing rankings and propose their own indicator based on a database they set up for 131 countries for two years: 1990 and 2000. The variables considered include measures related to R&D performance (citations, patents), technological infrastructure (internet penetration, energy consumption) and human resources (schooling rates). According to the proposed 'ArCo' indicator, Poland was ranked 39th in 1990 and 34th in 2000, while Turkey was ranked 75th and 65th, respectively. On the other hand, a cluster analysis performed on the same dataset by Castellacci and Archibugi (2008) produced just three clusters of countries, labeled advanced, followers, and marginalized, and both Turkey and Poland qualified for the same middle group.

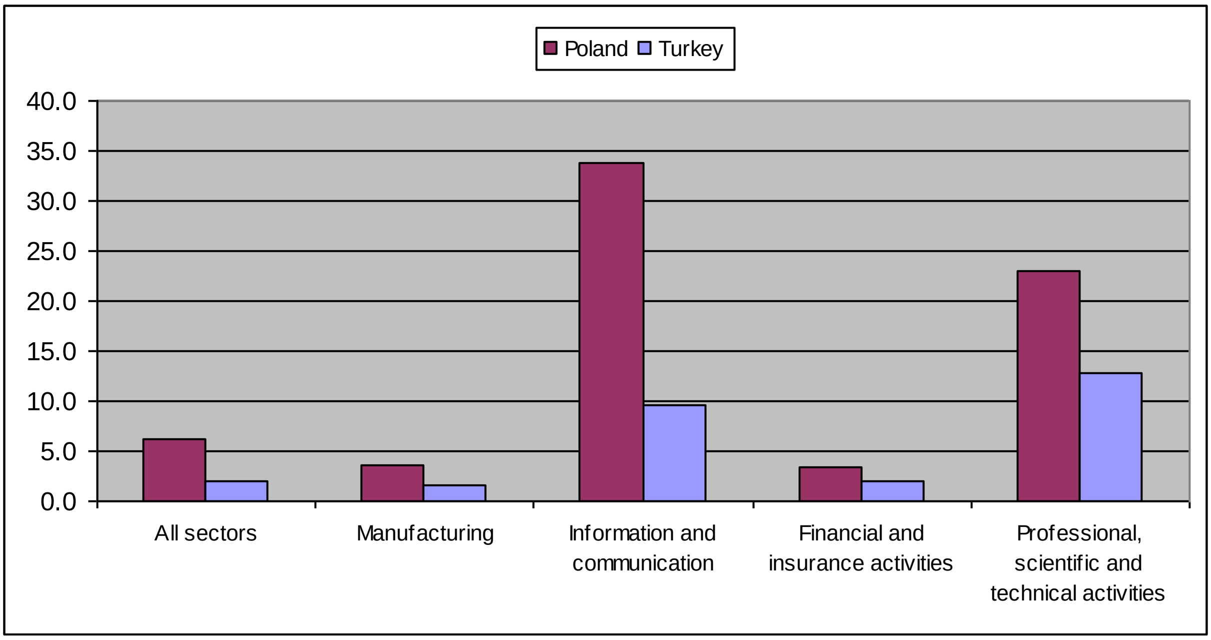
Looking at the basic R&D indicators for Poland and Turkey leads to mixed results. To start with, since 2005, Turkey has been ahead of Poland in terms of gross expenditure on R&D (GERD) and this has largely been due to its higher business expenditure (BERD), which had already surpassed Polish expenditure in 2000 (Figure 2). Note the difference in trends: while GERD has clearly been rising in Turkey, the number for Poland has been declining or has remained stagnant for many years, and only started growing in 2008. Even more striking is the dissimilar developments of BERD, which has been growing in Turkey over the last 10 years while in Poland it remained at the same level at best.

Figure 2. GERD and BERD in Poland and Turkey. Source: OECD



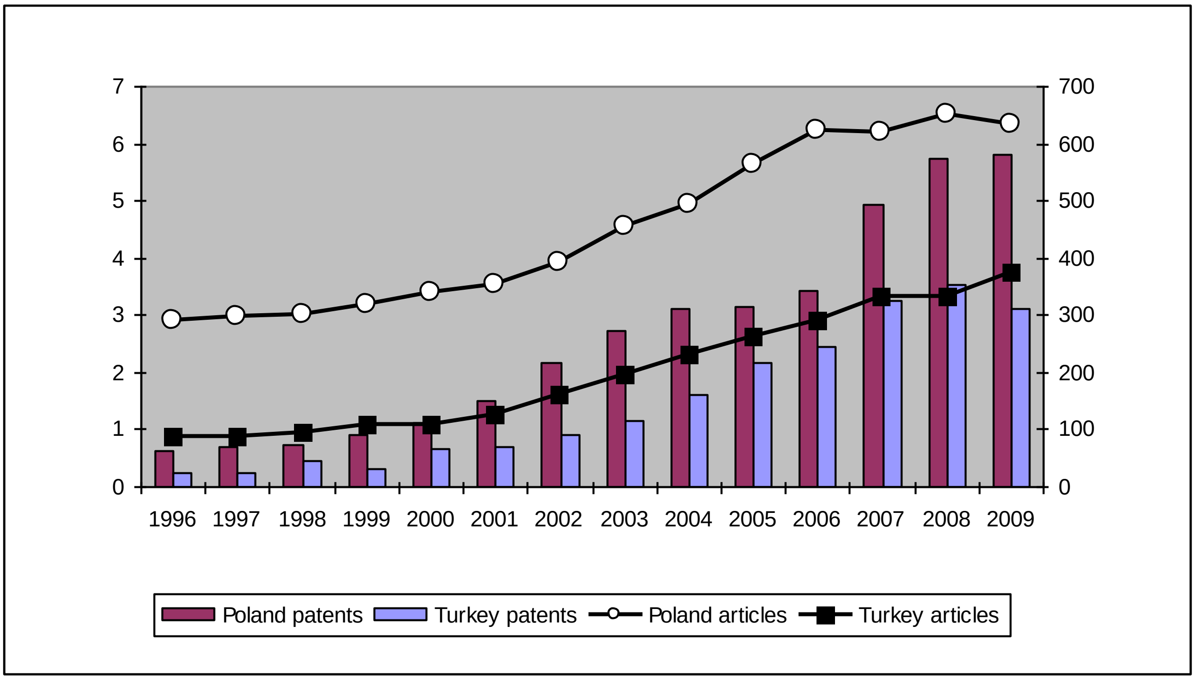
On the other hand, Poland seems to have better human resources for innovation. The share of scientists and engineers in industry workforce is higher in Poland in every sector analyzed by Eurostat with the exception of public administration (cf. Figure 3).

Figure 3. Percentage of scientists and engineers in employment in 2010 in the age group 25-64 by industry. Source: Eurostat



Finally, the basic outcome indicators suggest that the scientific and technological output of both countries reflects the differences in human resources rather than in expenditure. Both the relative number of patents at the European Patent Office and the relative number of citable scientific articles are consistently higher for Poland than for Turkey. While the indicators illustrated in Figure 4 refer to the most general categories (patents obtained by all sectors, articles in all scientific disciplines), a more careful analysis of specific sectors and fields gives a fairly similar picture.

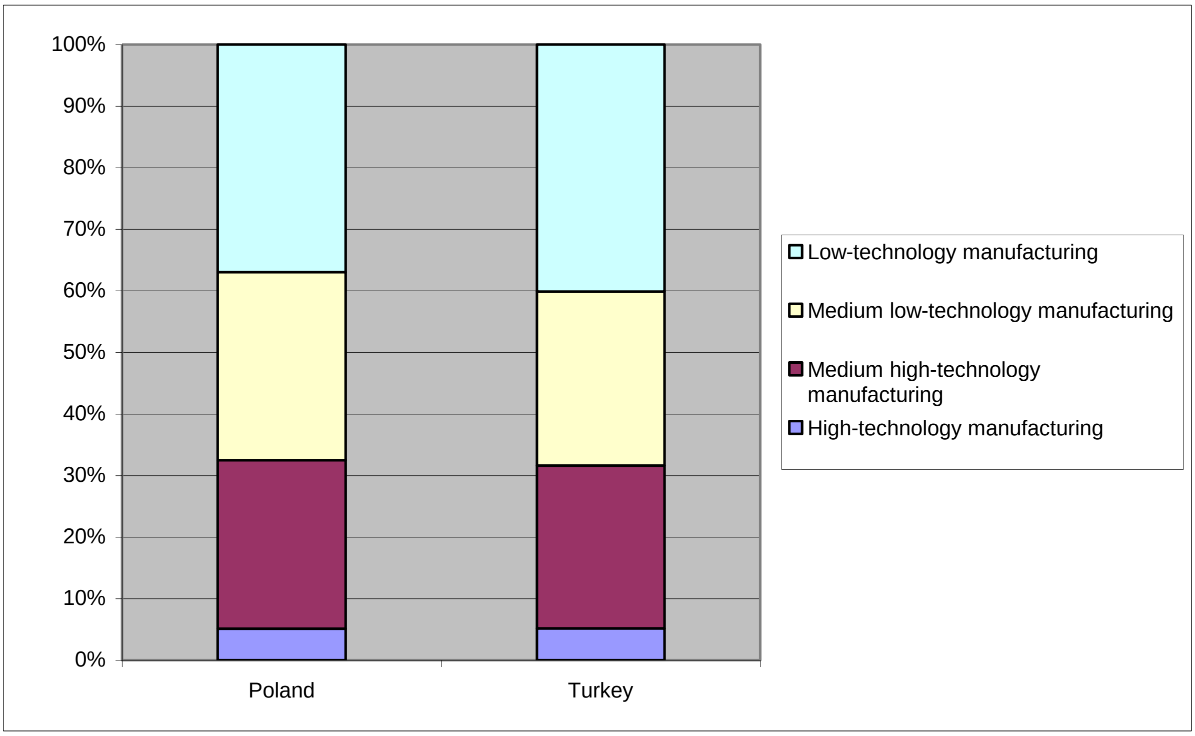
Figure 4. The number of patents obtained at the European Patent Office per 1 mil inhabitants (left scale) and the number of citable documents (scientific articles) in the SCOPUS database per 1 mil inhabitants (right scale). Source: Eurostat (patents), (SCImago 2007) (articles)



These differences are unlikely to be explained by the production structure: in fact a breakdown of manufacturing value added by technology levels shows a striking similarity between both countries:

Figure 5 compares the two structures using the OECD 1995 taxonomy of technology intensity of industries (cf. Hatzichronoglou, 1997).

Figure 5. Value added shares of manufacturing subsectors in 2009. Source: Eurostat



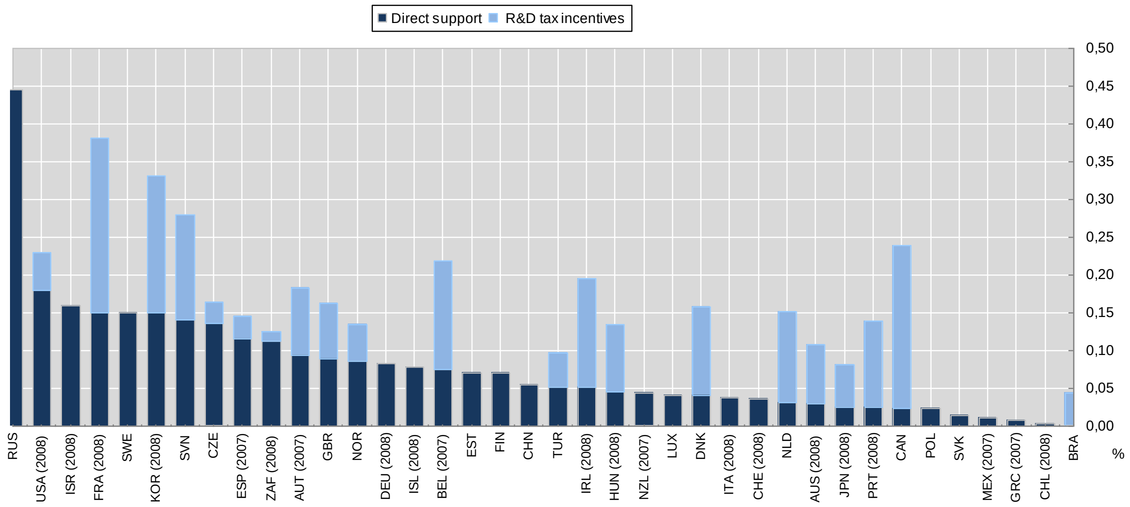
To sum up, Turkey and Poland are quite similar in terms of industrial structure and occupy similar places in international technology rankings. Poland is in the lead in terms of human resources related to technology development and in terms of technology performance. On the other hand, Turkish expenditure on R&D as a percentage of GDP is higher than Polish expenditure and it has been on the rise for a at least 15 years, while the Polish GERD only recently recovered to the 1996 level. The difference in business R&D expenditure is even more profound.

3.2 The amount and structure of government support for innovation

Amount of support

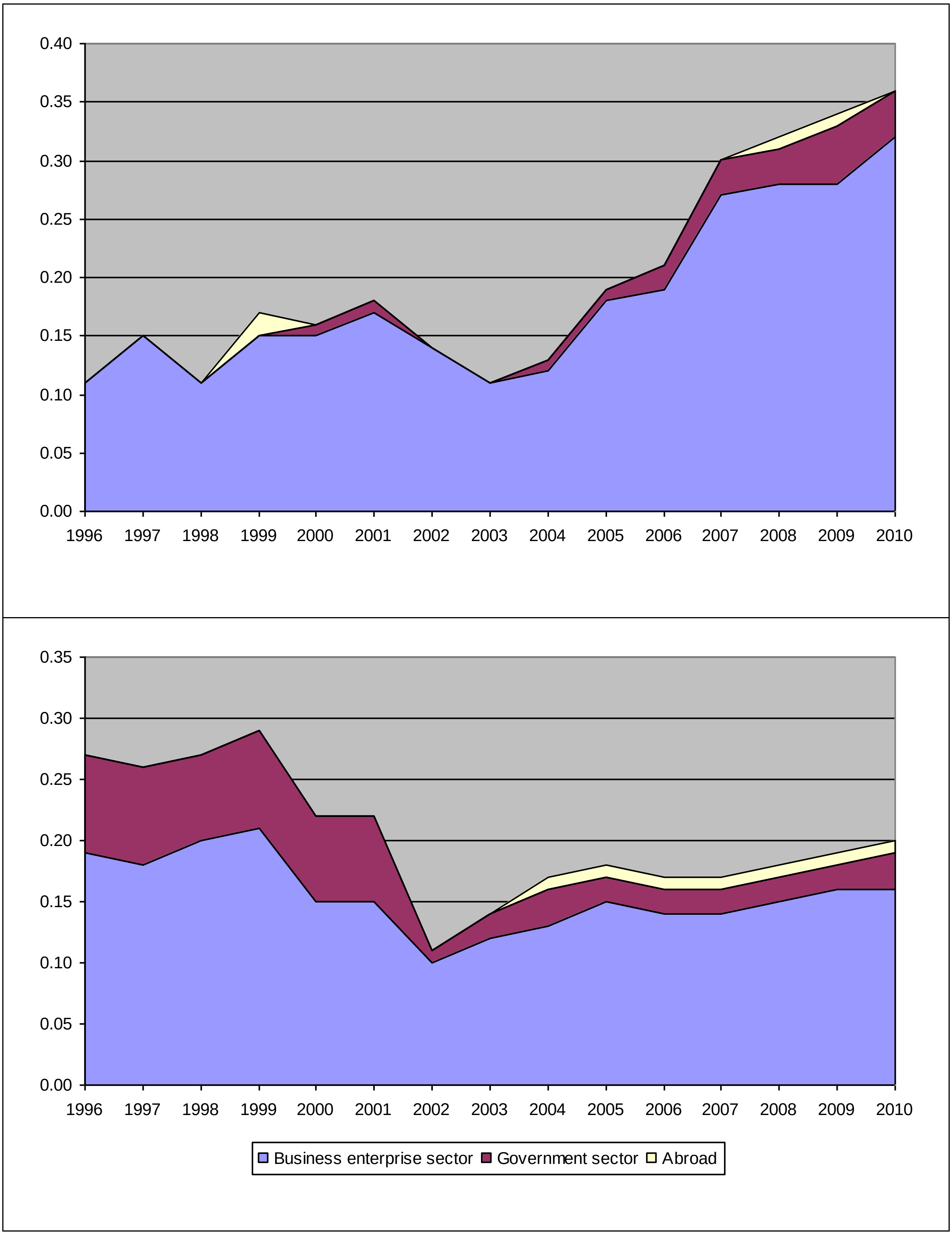
Since there is no internationally comparable data on the amount of government support for innovation, we first discuss the data on government support for business-performed R&D, which is a related but much more restrictive concept (especially in the case of Poland). The amount of government aid in this respect is quite small by international standards in Poland, and moderate in Turkey (Figure 6).

Figure 6. Direct and indirect (tax incentives) government funding of business R&D as a percentage of GDP: 2009 Source: OECD



However the low rank occupied by both countries is partly determined by a generally smaller scale of business-performed R&D. In fact, Turkey and Poland are quite dissimilar as far as the role of government is concerned, and the contrast becomes evident when one observes the dynamics of these processes. In Turkey, the intensified business R&D activities have been funded to an increasing extent by government money (Figure 7, upper panel). On the other hand, government aid for industrial R&D in Poland declined between 1999 and 2002 (even in absolute terms) and it has remained stable since 2003 (Figure 7, lower panel). As a result, while the share of government-funded R&D in total business R&D declined in Poland from 28.2% in 1996 to 12.7% in 2010, the respective ratio in Turkey grew from 1.9% to 10.4%. Let us discuss the details of the relevant government policies.

Figure 7. R&D performed by the business sector by the source of funding in Turkey (upper panel) and Poland (lower panel), as a percentage of GDP. Source: OECD



Direct support for innovation in Turkey

In Turkey, the principal government actor is the Scientific and Technological Research Council of Turkey (TUBITAK). Founded in 1963, it has a long institutional history. However, modern innovation support policies only started in the early 1990s3, and even then the range and scale of government policies was initially limited. In 1995, The Money-Credit and Coordination Board had assigned the Scientific and Technological Research Council of Turkey (TUBITAK) and the Undersecretariat of Foreign Trade (UFT, which became the Ministry of Economics in 2011) the task of managing public support to promote industrial R&D and innovation activities. Accordingly, aiming to expedite the process of converting technology into profit, the Technology and Innovation Support Programs Directorate (TEYDEB) was established at TUBITAK to fund the technology development and innovation activities of companies in Turkey. TEYDEB's mission is to boost the global competitiveness of Turkish private companies equipped with RTDI capabilities and to play a leading role in the creation of an entrepreneurship culture to improve the prosperity of the country.

Although TEYDEB is a major actor of the NIS in Turkey 4 , there are other public organizations that play a significant role in the process of funding R&D and innovation activities in Turkey. Table 1 below shows those actors and their contribution to the public support of R&D in Turkey as far as direct supports, or subsidies, are concerned. Data in Table 1 indicate that annual public expenditure in USD for R&D and support programs in Turkey rose by more than 34% in four years and on average about one billion dollars was allocated by the government as financial support of R&D and innovation in Turkey over the 2005-2008 period. Note that these subsidies do not cover only private firms but also universities and other public research institutes. In addition to TEYDEB, other key organizations implementing public support programs and other incentives promoting industrial R&D activities in Turkey include the Undersecretariat of Foreign Trade (UFT, or the Ministry of Economics since 2011) through the provision of financial support to TUBITAK until 2010, the Technology Development Foundation of Turkey (TTGV) and the Small and Medium-size Industry Development Organization (KOSGEB) affiliated with the Ministry of Science, Technology and Industry (MoTI).

[3] Although some tax-based R&D incentives existed in Turkey since the mid-1980s, there was a consensus that they were ineffective in promoting R&D expenditures of firms (OECD 1995).
[4] According to the Turkish Statistical Institute (Turkstat), 86% of total public funding for business R&D in Turkey over the 2003-2006 period was provided by TUBITAK through its industrial R&D projects support programme.

Table 1. Public Expenditure on Innovation and Technology Programs in Turkey

Implementing Agency	2005	2006	2007	2008
Universities	274.2	278.7	256.3	253.5
TUBITAK (TUBITAK Research Centers)	108.8	155	141.8	183.3
TUBITAK (Turkey Research Area Programs)	346.	415	425	450
Academic Research Projects	90	80	85,0	105
Industrial Research Projects (of companies) TEYDEB	116	215	215	175
Research Projects of Public Institutions	50	50	50	65
Defense and Space Research Projects	50	60	65,0	80
Researcher Development	25	5	5	15
Science and Technology Awareness	15	5	5	10
Public Institutions (Outside TUBITAK)	36.2	49.3	80.2	78.2
Nuclear Energy Council (TAEK)	6.3	13.1	20	18.9
Ministry of Industry and Trade **	-	11	16.9	17.6
Ministry of Agriculture and Rural Affairs	2.2	2.5	4	3.6
Ministry of Health	0.1	6.2	5.2	4.9
National Boron Research Institute ***	0.1	3	6	6.3
Ministry of Energy ***	-	-	-	1
KOSGEB	12.5	5.4	4.6	6.5
TTGV	8.9	35.6	35.4	35.5
State Planning Organization (DPT),	1.1	10	18	18
Undersecretary of Foreign Trade (DTM)	40	42	63.5	n/a
TOTAL (TL)	**1182.4**	**1441.8**	**1501.9**	**1527.3**
TOTAL (USD)	**877.6**	**1002.6**	**1148.4**	**1175.5**

* TUBITAK funds the projects of other institutions' R&D projects
**Includes SANTEZ program that supports PhD students' theses that aim to solve company- specific problems and the support for the physical infrastructure of technoparks.
*** Includes programs in which the projects of other institutions are supported.
Source: World Bank (2009)

TEYDEB subsidies are granted within the framework of different programmes (the first year of implementation is in parentheses)5:

- Industrial R&D Projects Grant Programme (**1995**)
- R&D Project Brokerage Events Grant Programme (2**001**)
- SME RDI (Research, Development & Innovation) Grant Programme (2007)

[5] This section is partly based on Tandogan and Pamukcu (2011).

- International Industrial R&D Projects Grant Programme (**2007**)
- (1505) University-Industry Collaboration Grant Programme (**2011**)
- (1511) Research Technology Development and Innovation Projects in Priority Areas Grant Programme (**2012**)
- (1512) Techno-Entrepreneurship Multiphase Programme (**2012)**
- (1513) Technology Transfer Offices (TTO) Grant Programme (**2012**)
- (1514) Technology Venture Capital Firms Grant Programme (**2012**)

In Table 2 below we present a number of indicators on all the programmes implemented by TEYDEB. The applicants, which are either large firms or SMEs, select one of the following technology groups according to their projects' focus: (i) machinery and manufacturing technologies, (ii) electrical and electronics, (iii) information technologies, (iv) materials, metallurgical and chemical technologies, or (v) biotechnology, agriculture, environmental and food technologies. The qualified projects are supported by means of non-reimbursable grants covering 50-60% of their eligible expenses in a matching fund scheme.

The objective of the TEYDEB support program is to enhance the international competitiveness of industrial companies in Turkey by means of higher R&D and innovation expenditures. This especially concerns the R&D phases of product and process innovations until the prototype formation but excludes investments in the manufacturing stage or any marketing and organizational innovations. Over 1995-2009, 4,752 firms applied to the programme and submitted 10,161 R&D projects, of which, 6,122 were supported. The volume of support received by beneficiary firms was 1.07 billion USD and 80% of this amount was spent after 2005. The total amount of R&D expenditures carried out by enterprises during this period was 2.13 billion USD. An upward trend has been observed since 2004 in the evolution of the total number of industrial R&D grants provided by TEYDEB. The amount of average subsidy per supported project also increased more than threefold, from 80,000 USD in 2002 to 270,000 USD in 2007.

Both large firms and SMEs can apply to the industrial R&D support programme. In order to promote the R&D activities of SMEs, TEYDEB launched a new R&D funding scheme in 2007 targeting only SMEs. In this way, it provides grants of up to 75% of the expenditures of eligible SMEs' first two R&D projects. The SME programme helped significantly boost the share of SMEs in the total number of applicants. The decrease in the number of proposals in 2009 is believed to have been caused by the 2008 global economic crisis.

The evolution of TUBITAK-TEYDEB grants provided via the industrial R&D projects support programme soared more than ten times in ten years, thanks to a generous budget allocation of the government aimed at increasing the volume and scope of public R&D incentives since 2005.

Table 2. Performance of TEYDEB's R&D and innovation support programs in Turkey: 2000-2011

	2000	2002	2004	2006	2008	2010	2011*
# project applications	260	374	503	711	2,285	1,755	1,399
# firms applying (cumulative)	176	269	360	481	1,679	1.350	1,141
# new firms applying	99	154	230	290	1,199	741	589
# applications supported	180	286	374	534	1,199	1,075	851
# projects finished	165	164	204	298	583	1,094	564
# stock of projects supported	469	538	792	961	1,790	1,654	1,842
R&D expenditures conducted* **	217.6	277.3	199.2	538.5	582.3	647.7	337.4
Value of projects supported* **	175.5	183.9	148.3	374.6	425,6	492,2	272.7
Value of support reimbursed* **	51.8	63	89.8	210.6	265.4	305	172.4

(*) October, 2011 (**) Estimate (***) cumulative value by October, 31st 2011 (***) 2011 prices, million TL 1995-99: 86.6 million TL
Source. TEYDEB

Is addition to the stable evolution of direct support programs in recent years, indirect support mechanisms for business R&D and innovation have also recently been strengthened in Turkey. The new fiscal incentives enforced by Law 5746 in 2008 have provided a tax lift of nearly 1.2 billion TL to 1,200 R&D performer tax payers in the last four years. During the same period, 132 research centers 6 with almost 15,000 R&D personnel have been accredited by the Ministry of Industry and Trade to benefit from those incentives. The total number of R&D personnel employed in research centers and promoted with income tax exemptions reached 8581 at the end of 2009. Further indirect measures include income and corporate tax exemptions for firms established in the Technology Development Zones (TDZs)7 located in university districts and the Industrial Thesis Projects (SANTEZ) Program, which supports PhD students whose theses aim to solve company-specific problems.

In 2012, TUBITAK launched three new grant programmes to support the commercialization of research outputs and techno entrepreneurship. It also developed and announced an Entrepreneurial and Innovative University Index (EIUI) with the aim of measuring and

[6] A research center is defined by Law 5746 as a separate organization located in Turkey with at least 50 FTE researchers employed to perform scheduled R&D activities on a regular basis.

[7] Between 2002 and Oct 31st 2012, 2,037 technology-based firms with 16,677 employees in 47 technology development zones located in university campuses benefited from this incentive in Turkey (Supreme Council of Science and Technology) .

fostering innovative activities in universities. This composite index is derived from 23 separate indices in five dimensions including scientific and technological research capacity, commercialization, entrepreneurial and innovative capacity, IPR stock and collaboration capacity of the university. The first 50 universities in the ranking based on EIUI were invited to the first call of the TTO Grant Programme in 2012 and 10 university-based technology transfer offices are rewarded a grant up to 1 million TL per year for up to 10 years.

The innovation support in Turkey financed by the European Union basically originates from the Framework Programmes (FP). In FP-6, Turkish beneficiaries received 59 million euro over the 2003-2006 period which was only 32% of Turkey's total national contribution to the programme. As listed in Table 3 below, the share of Turkish partners increased to 155.6 million euro, which corresponds to 78% of national contribution. The first three industries and their shares in FP-7 funded projects are ICT (20.3%), manufacture of machinery and equipment (8.4), and energy (8.3%).

Table 3. Contribution of EU Framework Programme 7: 2007-2012 (Million Euro)

Year	National Funding	EU Funding	Total Funding	Share of Turkish Partners	Number of Turkish Partners
2007	9.9	12.5	22.4	27.4	148
2008	26.3	4.5	30.8	20.0	129
2009	24.6	16.6	41.2	28.2	165
2010	19.8	34.3	54.1	29.4	218
2011	50.2	12.3	62.5	38.3	193
2012	69.5	-	69.5	12.3 [1]	65
Total	**200.3**	**80.2**	**280.5**	**155.6**	**918**

[1] Until 31st Oct 2012, does not include 55 FP7 calls which was not finalized yet
Source: (Supreme Council of Science and Technology)

Beside the Framework Programmes, the Competitiveness and Innovation Framework Programme (CIP) run by the Ministry of Science Industry and Technology contributed 3-5 % of total EU funding in Turkey since 2007.

Direct support for innovation in Poland

"Since the fall of the Communist regime, the Polish government has never given policy issues related to innovation and the transition to a Knowledge-Based Economy a high priority – its attention has always been focused rather on the problems of the shrinking 'old economy', in particular extractive and heavy industries. The responsibility for innovation- and technology related initiatives is scattered amongst various ministries and agencies, no institution with the responsibility for coordinating these initiatives has ever been designated, and no comprehensive and coherent strategy has ever been developed in this area."

While this opinion, formulated by (Woodward et al.: 13) might seem somehow harsh, it describes quite accurately the history of the Polish science, technology and innovation policy since 1989. However it must be stressed that the EU accession in 2004 and the related inflow of considerable funds from the EU structural policy has imposed a certain planning and controlling structure on science, technology and innovation policy in Poland.

The institutional setting for supporting innovation activities in firms has been evolving and it has probably not reached a stable state yet. For more than a decade, the key actor has been the Polish Agency for Enterprise Development (PARP), created in 2001-2002 as a result of a merger of four different government agencies and foundations dealing with SME and technology development support. Although the PARP has always been oriented chiefly at supporting SMEs [8] and it has been dissociated from some other government bodies responsible for science and technology policy (e.g. Ministry of Science), it has been assigned the task of distributing a large part of EU funds aimed at supporting innovation in the private sector.

It is worth stressing that the institutional architecture behind the government policies with respect to science and higher education sector has also been evolving. In 2007, another important actor in the Polish innovation system, the National Centre for Research and Development (NCBR), was created. The NCBR is responsible for disbursing the part of structural funds that has been allocated for the sciences and higher education in Poland.

While there was some support for innovation in firms prior to 2004, it is fair to say that systemic direct support for innovation in enterprises took off in Poland only after 2004. At the moment of writing, Poland has participated in two Financial Perspectives of the EU: 2000-2006 and 2007-2013. Given that Poland joined in the middle of the first financial perspective, and that the national institutions faced major challenges in learning new mechanisms in the initial phase of the membership, it is not surprising that between 2004-2006, EU-funded innovation policy took a simplified form. The only relevant scheme was the Sectoral Operational Programme, the ‘Improvement of the Competitiveness of Enterprises’.

Under the current Financial Perspective there are several programmes that include measures aimed at supporting innovations in enterprises. These are:

- ‘Innovative Economy’ Operational Programme
- ‘Human Capital’ Operational Programme
- ‘Eastern Poland Development’ Operational Programme

[8] While presenting the Agency’s agenda at a seminar in 2003, the head of PARP at that time did not even mention innovation-related activities.

- 16 Regional Programmes

We shall discuss each of them individually.

The **'Innovative Economy' Operational Programme** is directed towards all entrepreneurs who want to implement innovative projects. The following issues are addressed:

- technology transfer
- weaknesses of business environment institutions
- low coverage of ICT infrastructure
- low level of cooperation between RDIs, universities and private enterprises
- universities' and RDIs' inadequate capacity for advanced research

It is worth stressing that a considerable amount of money in this programme has been reserved for e-businesses and the development of e-potential in all parts of the Polish innovation system.

The 'Human Capital' Operational Programme includes interventions related to human capital development, active labour market policies, and improvements in basic and university education. Its goal is also to increase the competitiveness and innovativeness of Polish businesses. The measures specified in the programme focus on improving the skills of entrepreneurs and academics that are relevant to innovation and enterprise development as well as on strengthening business environment.

The 'Eastern Poland Development' Programme focuses on Poland's eastern regions (mainly agrarian and barely industrialized), which are among the poorest in the EU. It addresses multiple issues, ranging from infrastructure development and tourism through education and human capital. Parts of the programme that are particularly interesting from the innovation policy point of view include stimulating the development of a knowledge based competitive economy, access to broadband internet, the development of selected metropolitan functions of voivodship cities, improving accessibility and standard of transport links, etc.

Finally, each of Poland's 16 voivodships has its own **Regional Programme.** These schemes focus on SMEs and micro-enterprises (in their parts dedicated to the private sector) and are responsible for about 10% of EU structural funds disbursed in Poland. It is worth stressing that the money is distributed by regional governments and not by central actors like the PARP.

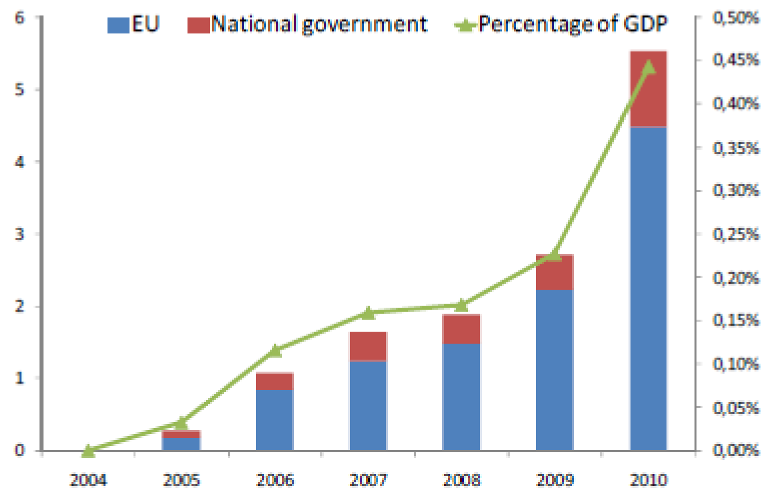
It has to be acknowledged that the operational programmes cover a whole range of innovation activities in the economy. They can be roughly divided into three groups, that we labeled 'The Creation of Technologies', 'The Absorption of Technologies' and 'Indirect support'. The principal areas of intervention are listed in Table 4.

Table 4. Areas of technological intervention in the EU structural programmes in Poland 2006-2013

The Creation of Technologies	The Absorption of Technologies	Indirect support
- Research and development - Early Stage Product Development - Specialized services - Also: company formation, VC, incubators	- Investment in new technologies, related training and related marketing expenditures - Development of e-potential	- Human Capital - Research infrastructure - Internet infrastructure, broadband development

Obviously, only a subset of programmes funded by the EU address companies directly. However the amount of money is enormous (Figure 8), especially if we compare it to the money spent in Poland on R&D. As much as 92% has been disbursed in the form of grants and matching grants (IBS 2011).

Figure 8. Public support for innovation in firms. billions of PLN in constant prices (left axis) and as a percentage of GDP (right axis)



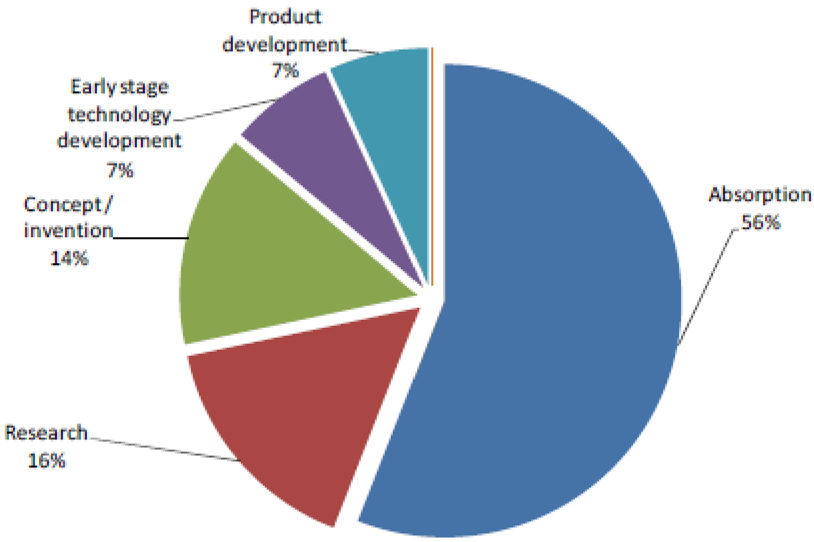
Note: "National government' denotes both the Polish contribution to EU programmes and non-EU programmes
Source: (IBS 2011)

Note that the amount of non-EU innovation-related support has been growing as well. "These programs have typically a narrow scope and are implemented by various government agencies such as NCBR, the Ministry of Economy or the Patent Office. Examples of those programs are: Technology Initiative and IniTech (grants for applied science projects), Tax Deduction for Innovation scheme and the National Capital Fund (in part financed by the EU)"

(IBS, 2011). Generally speaking, these programmes are relatively more focused on R&D and relatively less on capital deepening than the EU programmes are.

How has this money been spent? Thanks to research (IBS, 2011), we know the structure of grants disbursed by the kind of innovation activity. The outcome of their analysis, presented in Figure 9 is quite interesting. In fact, more than a half of all the money spent has been used for ‘Absorption’, i.e. to buy machinery and equipment (as well as software and intellectual property rights to a minor degree).

Figure 9. Public support for innovation from EU funds in Poland by kind of innovative activity funded in 2004-2010.

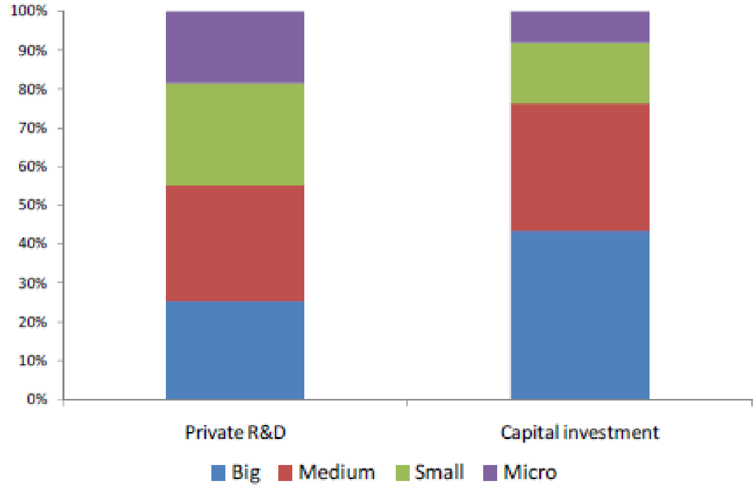


Source: (IBS 2011)

Almost half of all the absorption funds went to big companies (with more than 250 employees, or a turnover of more than 50 million euro, or a balance sheet total of more than 43 million euro)9 and only about 20% to small and microenterprises (employing less than 50 or less than 10 people, respectively).

[9] This is the Eurostat definition of a large firm that follows the Commission Recommendation of 6 May 2003.

Figure 10. R&D and absorption grants by size of recipient firm
Source: (IBS 2011)



While three times as much money has been spent on the purchase of machinery, equipment and technology as on actual R&D (cf. Figure 9), the R&D grants play a relatively much bigger role in lower-tech industries (IBS 2011).

Is the current scheme efficient? On one hand, the dominant role of absorption grants makes one suspicious about the sensibility of the whole set of EU-sponsored programmes as instruments for the promotion of innovation in the Polish private sector. It is interesting to note that all the arguments invoked in support of government intervention in Section 2 hardly refer to investments in machinery and equipment; while such aid might be sensible in the case of SMEs, which are particularly vulnerable to a 'funding gap', it has little to do with truly innovative undertakings. On the other hand, these observations are not sufficient to reach robust conclusions. However there are reasons to worry about the efficiency of the current schemes based on the analysis of the process of selection of grantees. A more detailed discussion follows.

Firstly, IBS (2011) analyzed the outcome of the selection process and found that the structure of applicants with respect to several firm- and industry characteristics is significantly different from the structure of grantees. The characteristics analyzed are: industry technology intensity, productivity, R&D spending intensity and innovation spending intensity. Secondly, the same study compared the populations of firms that applied for investments and R&D grants and found that they are quite different in terms of industry structure. However these differences disappear when the respective populations of grantees are compared. The authors conclude that a likely reason might be the deficiency of the selection procedure resulting in the same kinds of firms being given grants regardless of the actual project submitted for support. This hypothesis is given considerable support by the assessments conducted by CASE-Advisors (2008a, 2008b and 2010), who thoroughly analyzed the selection criteria and the procedures applied in the 'Innovative Economy' Operational Programme.

Some elements of comparative analysis

We identified considerable differences in government policies aimed at supporting innovation in firms in Turkey and in Poland. Turkey is characterized by increasing government support for innovation, a longer institutional history and a coordinated, autonomous science, technology and innovation (STI) policy aimed at increasing the innovation performance of the economy (although the evaluation of that policy is still pending). Poland, on the other hand, has seen its institutional landscape change several times, with government support declining and then increasing considerably largely thanks to EU funding. Generally speaking, the STI policy in Poland lacked co-ordination, and while the EU accession imposed some structure, it also shifted the priorities towards spending as much EU funds as possible and away from the actual STI policy goals. A major difference between the government programmes in the two countries is that while in Turkey they are strictly oriented at R&D and the development of truly new products and processes, the EU-financed innovation policy in Poland consists to a large extent of grants for investments in new machinery and equipment.

4. Empirical analysis of government aid efficiency

4.1. About the Community Innovation Survey

The Community Innovation Survey is the principal survey of innovation activities of firms in the European Economic Areas and the EU candidate and associate countries. Moreover, a few dozen other countries run one or more editions of their own 'CIS-like' enterprise surveys, based, like the original CIS, on the Oslo Manual (see below). Started in 1993, the actual CIS is coordinated by Eurostat, implying that there is a 'core questionnaire' present in every national study (additional questions are included by the national statistical offices). Initially the survey was run every four years but as of 2004, the frequency has increased. Currently, there is a 'full' survey organized every four years, and a 'reduced' version, with a shorter core questionnaire, two years after every full survey. The Polish Statistical Office has participated in the Community Innovation Survey since its third edition in 2000. This is also the case for

Turkey since the Turkish Statistical Institute has conducted innovations surveys based on CIS methodology since the mid-1900s.

The methodology of the survey is based on the Oslo Manual, first published in 1992 and then revised in 1996 and 2005. The Oslo Manual '…defines what is meant by an innovation, the different ways in which an enterprise can innovate, ways of quantitatively measuring innovation on the input and on the output side, various degrees of novelty of innovation, and various questions regarding the sources, the effects, the obstacles and the modalities of innovation' (Mairesse and Mohnen 2010: 3). The CIS contains questions referring to revenue and expenditure in the most recent years (e.g. in 2010 in CIS 2008-2010), as well as questions about various aspects of innovation in the three years preceding each edition of the survey (e.g. in 2008-2010).

From the point of view of the aim of this study, it is important to note that the conditions that make a certain change in a firm's product or method of production count as 'innovation' are quite loose. 'An innovation is the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organizational method in business practices, workplace organisation or external relations' (OECD 2005: 46). Even if this definition is restricted to product and process innovations, it still includes changes that are new to the firm only. This implies, however, that whenever a firm benefiting from government support buys, modifies, or extends its product portfolio or buys new equipment (which usually implies an improved production method because of the ongoing technological change in the manufacturing of equipment), it can consider itself an innovator. Consequently, the recipients of government aid are almost guaranteed to appear as innovating firms in the CIS. And the firms that received support but completely failed to innovate, are impossible to detect because, and this is an important characteristic of the CIS, firms that did not attempt to introduce any product or process innovations, are exempted from answering most of the questions, including the question about government support! Firms that attempted innovation but failed with one or more projects do fill out the whole questionnaire, but here the problem is that a vast majority of those firms (93% in the Polish 2010 CIS) also declares having introduced some successful innovation projects. However one cannot tell whether government support was used for the failed or successful (in terms of the Oslo Manual) innovation projects.

The way to circumvent the problem is either to quantify the innovation performance, e.g. by observing the revenue from new products, or to apply a more restrictive definition of successful innovation, wherein only firms that introduce product innovations new to the market are counted as innovators. We will apply the former method in the analysis of Turkish firms, and the latter in the comparative study of both countries.

The government aid itself is only recorded in the CIS as a dummy variable, i.e. firms answer whether they received public support from innovation, but do not specify the amount of that support. Both Turkish and Polish questionnaires include questions about the exact source of public support: whether it was from the (central) government, the European Union or local government. Moreover, in the Polish CIS 2010, firms were also asked about the direction of support: was it for R&D, for new equipment, or for activities related to human resources development. However, this data is not available in the Turkish CIS,.

Finally, it is important to stress that the CIS is generally quite poor when it comes to general information about the enterprises. Firms are only required to answer questions about their revenue (but not always), the number of staff, whether they are members of groups of firms (where a group of firms is defined as a set of companies owned by the same person or entity), the main markets to which they sell, and, interestingly, the barriers to innovation activities (financial, organizational, related to knowledge). Moreover all firms answer questions about innovation in marketing and firm organization.

National surveys might include some additional questions but these are usually quite few in number. In our case, the Polish CIS contains a question about the country of location of the mother company for firms that are group members and about the share of staff with tertiary or secondary education. The Turkish CIS, on the other hand, asked about the share of foreign partners in equity and the number of PhD holders. There was no quantitative information concerning firm sales or any other output indicators such as production or value added.

4.2. Description of the dataset and descriptive statistics

Firm-level data from the Community Innovation Survey are not easily available for Poland or Turkey. Neither of the countries makes the microdata available for researchers at the Eurostat’s Safecenter in Luxembourg. While Turkstat has its own safecenter in Ankara, in Poland, it is possible to purchase raw data, but the information about revenues and expenditure is considered confidential, resulting in considerable restrictions with respect to the scope of data made available to researchers.

Consequently, we could base our research on two editions of the CIS in Poland: 2008 and 2010, and on one edition of the Turkish CIS (2010). While in the case of Poland we had data on manufacturing firms, the Turkish dataset also contained services firms. Due to the confidentiality conditions imposed by the Polish Central Statistical Office (CSO), the data on expenditure was made available on a per-capita basis only, while data on revenue was unavailable (we only had data on the share of innovative products in total sales). Moreover, the Polish would not disclose the information about the exact number of staff; instead we had indicators of the size category in which a firm belongs (small, medium, big). In the case of Turkey, there were no restrictions of that kind.

In Poland, all the manufacturing firms employing more than 49 persons were surveyed, and a sample of firms employing 10-49 people. The result was 10,328 observations in the 2006 CIS and 9,858 in the 2010 CIS. In Turkey, the survey was conducted on a representative sample of all firms employing at least 10 employees. The resulting number of observations amounted to 5767 for the Turkish 2008-2010 CIS. The variables used in the comparative analysis are listed in Table 5.

Table 5. Variables used in the comparative analysis of Turkey and Poland

Dummy Variable	**Explanation**
innovator	Firm had positive innovation expenditure
İnnovator_OECD	(the same as above)
radical_in	Firm introduced a product innovation new to the market
Group	Firm is member of a group of firms
Export	Firm is engaged in export activities
sup_inn	Firm received public support from any source
support_EU	Firm received public support from EU funds
support_gov	Firm received public support from the central government
support_loc	Firm received public support from local government
manhigh	Firm operates in a high-tech manufacturing industry, according to the OECD classification
manmedhigh	Firm operates in a medium-high tech manufacturing industry, according to the OECD classification
manmedlow	Firm operates in a medium-low tech manufacturing industry, according to the OECD classification
coll_othfirm	Firm co-operated with other firms for innovation activities
Continuous variable	**Explanation**
linexpemp	The log of innovation expenditure per employee

Table 6 presents the structure of the datasets by 2-digit NACE (rev. 2) industries by indicating sector-level distribution of the number of firms for both countries. Both breakdowns are quite similar: the correlation coefficient between the Polish and Turkish vectors in 2010 was 0.72. The manufacture of food products (NACE code 10) is the biggest industry in Poland and the second-biggest in Turkey. The manufacture of fabricated metal products, except machinery and equipment (25), played a considerable role in both countries too (bigger in Poland, though). On the other hand, the dominant industry in the Turkish datasets: manufacturing of apparel (14) and of textiles (13) were relatively much less important in the Polish sample.

Table 6. Structure of the datasets by 2-digit NACE-Rev 2 industries

NACE-Rev 2 Code	Industry	PL 2008	PL 2010	TR 2010
10	Manufacture of food products	16.3%	15.1%	10.9%
11	Manufacture of beverages	0.9%	1.4%	0.3%
12	Manufacture of tobacco products	0.1%	0.1%	0.2%
13	Manufacture of textiles	2.9%	3.3%	10.1%
14	Manufacture of apparel	6.5%	5.2%	11.9%
15	Manufacture of leather and related products	1.9%	2.1%	2.8%
16	Manufacture of wood and wood and cork products, except furniture; manufacture of straw articles and plaiting materials	4.8%	4.5%	1.9%
17	Manufacture of paper and paper products	2.9%	3.5%	1.2%
18	Printing and reproduction of recorded media	1.7%	2.4%	2.0%
19	Manufacture of coke and refined petroleum products	0.4%	0.4%	0.3%
20	Manufacture of chemicals and chemical products	2.9%	3.2%	3.1%
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.7%	0.9%	1.1%
22	Manufacture of rubber and plastic products	7.1%	7.2%	6.1%
23	Manufacture of other non-metallic mineral products	5.6%	5.2%	8.3%
24	Manufacture of basic metals	2.3%	2.9%	5.4%
25	Manufacture of fabricated metal products, except machinery and equipment	13.5%	11.6%	9.0%
26	Manufacture of computer, electronic and optical products	2.6%	2.7%	1.0%
27	Manufacture of electrical equipment	3.1%	3.9%	3.4%
28	Manufacture of machinery and equipment n.e.c.	6.7%	6.1%	6.6%
29	Manufacture of motor vehicles, trailers and semi-trailers	3.7%	4.0%	4.7%
30	Manufacture of other transport equipment	1.4%	1.7%	1.0%
31	Manufacture of furniture	5.6%	5.6%	4.3%
32	Other manufacturing	1.9%	2.6%	2.6%
33	Repair and installation of machinery and equipment	4.8%	4.1%	1.8%

Generally speaking, however, in both countries, low-tech and middle-low tech industries dominated (cf.Table 7). This is not surprising given the structure of manufacturing in Turkey and Poland discussed above in Section 3.1. Medium-high industries accounted for 18-19% of the sample, while high-tech firms constituted a fringe of 2-3%.

Table 7. Distribution of number of manufacturing firms in Poland and Turkey according to technology intensity of sectors

	PL 2008	PL 2010	TR 2010
High tech	3.3%	3.6%	2.2%
Medium-high tech	17.7%	19.1%	18.8%
Medium-low tech	30.3%	29.1%	31.5%
Low tech	48.6%	48.3%	47.5%

Contrary to the distribution of firms between sectors of the economy, which is rather similar in the two countries, the distribution of firms by size (measured by the number of employees) shows significant differences (Table 8). Indeed, the share of medium-sized firms was much higher in Poland (53.8%) than in Turkey (21.3%) in 2010. A direct consequence of this situation is that the proportion of small manufacturing firms in Turkey is almost 25 points higher than in Poland. This might be due to differences in sector-level specialization of both economies and in their economic development levels. Finally, the share of large firms is almost nine points larger in Turkey than in Poland.

Table 8. Distribution of manufacturing firms by size

	PL 2008	PL 2010	TR 2010
Large (250+)	13.9%	13.8%	22.5%
Medium (50-249)	52.2%	53.8%	21.3%
Small (10-49)	33.7%	32.3%	56.3%
Confidential	0.1%	0.1%	-

Next, we present comparative data on innovators and innovation expenditures for both countries (Table 9). Innovating firms are defined broadly as those firms that have positive innovation expenditures while radical innovators are those firms that introduced product innovations new to the market, which are to be contrasted with those firms (not examined here) that introduced innovations new to the firm only. In 2010, the proportion of innovators in Poland was 23.8% and 32.6 % in Turkey. The difference is larger for radical innovators, with 23.8% for Turkey and 12.9% for Poland.

Table 9. Percentage of innovating firms

	PL 2008	PL 2010	TR 2010
Innovating firms	26.4%	23.8%	32.6
Radical innovators	15.3%	12.9%	23.8

Note: ‘innovating firms’ stands for companies with positive innovation expenditure.
‘Radical innovators’ are firms that introduced product innovations new to the market.

Data on innovation expenditures per employee (only for innovators) in both countries in 2010 are presented in Tables 10 and 11. The average value for this variable is larger in Turkey (36,000 euro) than in Poland (5,000 euro). However, there is extreme dispersion in the case of Turkey with a standard deviation of 1,170,000 euros, with the result that the first three quartiles of this variable are lower in Turkey compared to Poland, suggesting much higher values for the fourth quartile.

Table 10. Innovation expenditure per employee (in thousand of national currency)

	PL 2008	PL 2010	TR 2010
Mean	19.38	20.16	73.9
std dev	52.01	94.32	2,400
1 quartile	2.00	1.60	0.14
median	6.20	5.50	2.31
3 quartile	17.40	16.70	8.41

Note: Only firms with positive innovation expenditure are considered

Table 11. Innovation expenditure per employee in thousand of euro

	PL 2008	PL 2010	TR 2010
Mean	5.52	5.05	36.05
std dev	14.82	23.64	1,170
1 quartile	0.57	0.40	0.069
median	1.77	1.38	1.13
3 quartile	4.96	4.19	4.10

Note: Only firms with positive innovation expenditure are considered

In Table 12, we present data first on the overall proportion of manufacturing firms that receive innovation support and then disaggregate data by type of beneficiary. 6.7% of all manufacturing firms in Poland and 15.6% of all manufacturing firms in Turkey benefit from innovation support schemes. There are also significant differences between the two countries as far as the type of support is concerned. Indeed, most innovation support in Turkey is granted by the central government (14.9 %) while the dominant type of support in Poland comes via EU funds (5.1 %). In Turkey, innovation support channeled through local administrations or bodies represents 1.4% of all firms while EU funds – mostly from 7th FP – concern only 1% of all firms. Hence, it seems that the distribution of innovation support among different types is relatively more balanced in Poland than in Turkey.

Table 12. Percentage of manufacturing firms receiving innovation support by source of support

	PL 2008	PL 2010	TR 2010
support from local gov	1.2%	1.3%	1.4%
support from central gov	2.9%	2.4%	14.9%
support from the EU	5.1%	5.1%	1.0%
any support	7.9%	6.7%	15.6%

Table 13 and Table 14 disaggregate further data presented in the previous table by manufacturing industries, respectively for Poland and Turkey. In Poland, firms from the following industries are among the most significant beneficiaries of innovation support, i.e. significantly above the average value of 6.7%: manufacture of other transport equipment (13.0%), manufacture of chemicals and chemical products (12.9%), manufacture of coke and refined petroleum products (12.5%), manufacture of computer, electronic and optical products (10.9%), manufacture of electrical equipment (10.3%) and manufacture of basic metals (10.0%). As far as Turkey is concerned, manufacturing industries with a proportion of innovation support beneficiaries significantly larger than the average value (15.6%) are: manufacture of coke and refined petroleum products (37.5%), manufacture of basic pharmaceutical products and pharmaceutical preparations (34.5%), manufacture of computer, electronic and optical products (30.8%), manufacture of machinery and equipment n.e.c. (28.7%) and manufacture of electrical equipment (27.2%).

Table 13. Proportion of Polish firms receiving innovation support by source of support and industry

Code	Industry	Any source	EU	Central gov	Local gov
10	Manufacture of food products	4.76%	3.69%	0.87%	0.94%
11	Manufacture of beverages	4.23%	4.23%	1.41%	0.70%
12	Manufacture of tobacco products	0.00%	0.00%	0.00%	0.00%
13	Manufacture of textiles	1.55%	1.55%	0.31%	0.31%
14	Manufacture of apparel	1.36%	1.36%	0.39%	0.19%
15	Manufacture of leather and related products	3.92%	2.94%	1.47%	0.98%
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	4.04%	3.14%	1.79%	1.35%
17	Manufacture of paper and paper products	5.75%	4.31%	1.72%	1.15%
18	Printing and reproduction of recorded media	11.02%	8.47%	2.12%	3.39%
19	Manufacture of coke and refined petroleum products	12.50%	12.50%	5.00%	5.00%
20	Manufacture of chemicals and chemical products	12.85%	9.72%	5.33%	1.57%
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	10.00%	7.78%	5.56%	2.22%
22	Manufacture of rubber and plastic products	9.04%	7.91%	1.84%	2.12%
23	Manufacture of other non-metallic mineral products	6.47%	5.69%	1.57%	0.59%
24	Manufacture of basic metals	10.00%	3.79%	7.24%	1.38%
25	Manufacture of fabricated metal products, except machinery and equipment	7.24%	5.41%	2.62%	1.31%
26	Manufacture of computer, electronic and optical products	10.86%	5.99%	5.99%	2.25%
27	Manufacture of electrical equipment	10.31%	7.22%	3.61%	1.55%
28	Manufacture of machinery and equipment n.e.c.	8.91%	7.26%	3.80%	1.65%
29	Manufacture of motor vehicles, trailers and semi-trailers	8.56%	6.55%	2.27%	1.26%
30	Manufacture of other transport equipment	13.02%	7.69%	9.47%	3.55%
31	Manufacture of furniture	4.16%	3.44%	0.36%	0.72%
32	Other manufacturing	5.88%	5.10%	1.57%	1.57%
33	Repair and installation of machinery and equipment	5.45%	2.97%	3.22%	0.50%

Table 14. Proportion of Turkish firms receiving innovation support by the source of support and industry

Code	Industry	Any source	EU	Central gov	Local gov
10	Manufacture of food products	12.2%	11.9%	1.0%	0.7%
11	Manufacture of beverages	0.0%	0.0%	0.0%	0.0%
12	Manufacture of tobacco products	0.0%	0.0%	0.0%	0.0%
13	Manufacture of textiles	9.2%	8.8%	0.7%	0.7%
14	Manufacture of wearing apparel	7.5%	6.9%	0.6%	0.0%
15	Manufacture of leather and related products	12.0%	10.7%	2.7%	0.0%
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	8.0%	6.0%	2.0%	0.0%
17	Manufacture of paper and paper products	9.4%	9.4%	0.0%	0.0%
18	Printing and reproduction of recorded media	3.7%	1.9%	1.9%	0.0%
19	Manufacture of coke and refined petroleum products	37.5%	37.5%	0.0%	0.0%
20	Manufacture of chemicals and chemical products	20.5%	20.5%	1.2%	1.2%
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	34.5%	34.5%	0.0%	0.0%
22	Manufacture of rubber and plastic products	19.0%	16.6%	1.8%	1.8%
23	Manufacture of other non-metallic mineral products	11.7%	10.8%	1.3%	0.4%
24	Manufacture of basic metals	13.9%	13.9%	0.7%	0.7%
25	Manufacture of fabricated metal products, except machinery and equipment	19.5%	18.7%	1.2%	0.8%
26	Manufacture of computer, electronic and optical products	30.8%	30.8%	0.0%	7.7%
27	Manufacture of electrical equipment	27.2%	27.2%	5.4%	3.3%
28	Manufacture of machinery and equipment n.e.c.	28.7%	27.0%	2.2%	1.1%
29	Manufacture of motor vehicles, trailers and semi-trailers	29.1%	29.1%	3.1%	3.1%
30	Manufacture of other transport equipment	18.5%	18.5%	0.0%	7.4%
31	Manufacture of furniture	18.1%	18.1%	0.0%	0.0%
32	Other manufacturing	11.3%	11.3%	2.8%	1.4%
33	Repair and installation of machinery and equipment	12.2%	12.2%	2.0%	0.0%

The similarity among Turkey and Poland concerning the most important beneficiary sectors is seen more easily in Table 15 and 16. In Poland, the proportion of firms benefiting from any innovation support increases monotonically when one goes from low (4.5 %) and medium-low (8.2 %) technology sectors to medium-high and high-tech ones (10.6%). Hence, the figures presented in Table 15 for any types of innovation support reflect mainly innovation support originating from the EU and central government. This trend is also valid for the three types of support presented in Table 16. As for Turkey, a similar linear progression in the proportion of beneficiaries is observed, with 9.9% for low-tech industries and 36.2% for high-tech ones. These figures reflect mainly the importance of innovation support provided by the central government. In the case of high-tech sectors, a value of 0% for local innovation support is to be noted as well as a relatively high value of 6.9% for EU support.

Table 15. Percentage of Polish firms receiving innovation support by source of support and technology profile of the company

	Any source	EU	Central gov	Local gov
High-tech	10.6%	6.4%	5.9%	1.2%
Medium-high tech	10.2%	7.6%	4.2%	1.7%
Medium-low tech	8.2%	6.1%	3.1%	1.6%
Low-tech	4.5%	3.5%	1.2%	1.0%

Table 16. Percentage of Turkish firms receiving innovation support by source of support and technology profile of the company

	Any source	EU	Central gov	Local gov
High-tech	36.2%	36.2%	0.0%	6.9%
Medium-high tech	27.1%	26.5%	3.0%	2.0%
Medium-low tech	15.7%	14.7%	1.4%	0.8%
Low-tech	9.9%	9.5%	0.9%	0.4%

Finally, Table 17 and Table 18 present data on the proportion of beneficiary firms according to three size classes: small firms (10-49 employees) medium-sized firms (50-249 employees) and large firms (at least 250 employees). In both countries, there seems to be an inverse relationship between firm size and the proportion of firms receiving innovation support: respectively in Poland and in Turkey, 12.3% and 24.3% of large firms benefit from innovation support, while this figure drops to 7.7% and 12.5% for medium-sized firms and to 2.8% and 11.8% for small firms. The aforementioned inverse relationship holds for support originating from the EU and central government but less so for aid granted by local authorities.

Table 17. Percentage of Polish firms receiving innovation support by source of support and size of company

	Any source	EU	Central gov	Local gov
Large	12.3%	8.6%	6.4%	1.5%
Medium	7.7%	5.9%	2.4%	1.6%
Small	2.8%	2.2%	0.5%	0.7%
Conf	0.0%	0.0%	0.0%	0.0%

Table 18. Percentage of Turkish firms receiving innovation support by source of support and size of company

	Any source	EU	Central gov	Local gov
Large	24.3%	23,6%	2,2%	2.3%
Medium	12.5%	12,4%	0.4%	0.4%
Small	11.8%	11,0%	1.3%	0.4
Conf	0.0%	0.0%	0.0%	0.0%

We can summarize the main findings of the comparative analysis between Poland and Turkey based on the innovation surveys in 2010 as follows. As far as manufacturing firms are concerned:

- The majority of firms are located in low-tech and medium-tech industries in both countries – they represent more than 75% of all manufacturing firms in the samples.
- The distribution by firm size differs significantly between the two countries: small firms constitute slightly more than half of all firms in Turkey (56.3%) against one third in Poland (32.3%). On the other hand, medium-sized firms dominate the Polish manufacturing industry (53.8%), while this is not the case in Turkey (21.3%). The proportion of large firms differs as well between the two countries (22.5% in Turkey against 13.8% in Poland).
- Average innovation expenditure is higher in Turkey (36,100 euro) than in Poland (5,050 euro) but it is characterized by an extreme disparity in Turkey (so that the median and the third quartile of this variable is lower in Turkey than in Poland)
- The share of innovators in Turkey (32.6%) is nearly ten points higher than the corresponding value in Poland (23.8%).
- The proportion of firms benefiting from any type of innovation support is higher in Turkey (15.6%) than in Poland (6.7%).
- The dominant type of innovation support in Poland is EU funds (5.1%) while support granted by the central government is the most important one in Turkey (14.9%). The distribution of support types is more balanced in Poland than in Turkey.
- The proportion of innovation support beneficiaries increases with the technological complexity of the industries they operate in; this is the case in both countries and for all types of support.
- The proportion of beneficiaries increases with firm size for support granted by the EU and central government, but less for support granted by local authorities.

4.3 Methodology

Introductory remarks

Our research is particularly challenging from the methodological point of view, because it combines problems related to the analysis of innovation surveys and those inherent to the evaluation of government intervention. The former include modeling the complicated relationship between innovation input and output (and often – firm productivity). The latter is caused by a possibly non-random selection of firms that are subject to government support.

As for modeling innovation activities, the standard procedure in the literature has become the CDM model. It is called this in honor of the authors of the seminal 1998 paper: Crépon, Duguet and Mairesse. The CDM model is an integrated model linking sequentially firm-level innovation input to innovation output to firm-level performance (Figure 11).

Figure 11.The scheme of a CDM model

Innovation input (decision and investment) ➔ *Innovation output* ➔ *Productivity*

The innovation input of firms is measured through their R&D activities while their innovation output is proxied by an indicator of the degree of innovativeness such as the share of innovative products in firms' sales, innovative sales per employee or the number of patents obtained. Labour productivity, or if possible total factor productivity, is used to measure performance at the firm level.

The problem of non-random selection of firms for government intervention can be addressed by applying the Heckman procedure, consisting of two steps. In the first one, the probability of obtaining government support is modeled using a probit, and, in addition, a new variable called the inverse Mill's ratio (IMR) is estimated. In the second step, the innovation performance of a firm is modeled but instead of using government support as an explanatory variable, one includes IMR on the right-hand side. As shown in Heckman (1976 and 1979), the statistical significance of the coefficient associated with IMR can be interpreted as an indicator of a statistically significant relationship of the original treatment variable (in this case – government support) 'net' of the selection bias.

Ideally, we would like to combine the two models i.e. to precede the CDM model sketched in Figure 11 with a government support equation, we would calculate the respective inverse Mills ratio and use it in the next steps. The problem is that the CDM model itself relies on the Heckman procedure (see below). Working with two IMRs proved difficult due to a small number of explanatory variables available in the CIS dataset and the resulting co-linearity. Consequently, we developed two empirical strategies: one following the CDM model but assuming government support to be exogenous, and another controlling for the endogeneity of support but assuming a simplified version of the innovation performance equation.

Below, we first present the CDM model, then we introduce the shortened version of the CDM model used in our analysis, and finally we discuss the model accounting for the possible endogeneity of government support.

The CDM model

The idea of the CDM approach is to model different stages in a sequential manner going from the innovation input to its output and finally the impact of the latter variable on firm performance (cf. the sequence in Figure 11): Hereafter, we will first present different equations that form the CDM model, as they were initially introduced in Crepon (1998 , 44).

Modeling R&D propensity and intensity of firms. R&D is modeled within the framework of a generalized Tobit model. In this model, the first equation is related to the propensity to invest in R&D or the R&D decision of firms. It is expressed as a latent variable, rd_i^*, which is given by equation (1) (I indexes firms)

$$rd_i^* = \beta X_i + u_i \tag{1.1}$$

The left-hand side variable is a latent variable which is not observed. It proxies something like the expected present value of benefits accruing to firms due to launching R&D activities. The first element oo the right-hand side is a vector containing explanatory variables for the R&D decision and an associated vector of coefficients. The second element is a random disturbance term.

In the second stage, we introduce the variable rd_i which, contrarily to rd_i^*, is observed and takes the value of 1 for those firms in which the latent variable is negative or zero, and the value of 0 if it is positive.

$$rd_i = \begin{cases} 1 & if \quad rd_i^* > 0 \\ 0 & if \quad rd_i^* \leq 0 \end{cases} \tag{1.2}$$

The second equation of the generalized Tobit model relates to the R&D intensity of firms or equivalently to their R&D expenditures – whether expressed in absolute values or normalized by sales. The R&D effort of the firm is noted by the latent variable rde_i^*, which is modeled as a function of a number of explanatory variables – contained in the vector W with an associated coefficient vector α – and a random disturbance term v_i :

$$rde_i^* = \alpha W_i + v_i \tag{1.3}$$

The unobserved latent variable rde_i^* is linked to the observed actual R&D expenditures of firm i – to be denoted by rde_i – in the following way:

$$rde_i = \begin{cases} rde_i^* = \propto W_i + v_i & if \;\; rde_i = 1 \\ 0 & if \;\; rde_i = 0 \end{cases} \quad (1.4)$$

Equation (1.2) is called the selection or decision equation and takes into account all the firms while the outcome equation (1.4) concentrates on those firms conducting R&D activities. Error terms in equations (1.1) and (1.3) are assumed to be bivariate normal with zero mean, variances $\sigma_v^2 = 1$ and σ_u^2. The correlation coefficient between the two error terms is denoted by $\rho_{uv} \neq 0$.

Innovation output (knowledge) equation. R&D activities carried out by firms might give rise to new knowledge, triggering innovation(s). The innovation or knowledge production function is given by the following equation:

$$Inno_i = \delta rde_i + \gamma Z_i + \varepsilon_i \quad (1.5)$$

The coefficient δ is of particular importance since its estimate – magnitude and sign – will inform us about the impact of R&D conducted by firms on their innovation activities. Vector Z contains firm-specific control variables. In the original CDM model, this equation is estimated only on the sample of innovative firms and an indicator of the extent of selection bias thus introduced – Mill's ratio obtained from the estimation of equation (1.2) – is included in the vector of explanatory variables, i.e. Z. The statistical significance of this variable informs us about the importance of the selection bias issue. However, in recent empirical applications of the CDM model, all of the firms, whether they innovate or not, are included in the estimation of equation (1.5). Data on R&D expenditures for non-innovative firms comes from the unconditional prediction of R&D investment based on equation (1.4). The observed R&D investment in equation (1.5), rde_i, is replaced with the expected or predicted value of the same variable based on equation (1.4), i.e. rde_i^*. Proceeding in this manner enables the researcher to circumvent the selection bias problem since all of the firms – whether they are innovative or not – are used in the estimation of equation (1.5)10.

Different indicators of innovation output are used as dependent variables in equation (1.5): (i) the share of innovative products in sales (ii) the decision to carry out products and/or process innovations (or any other type of innovation) or (iii) the number of patents applied for or acquired. In case binary indicator(s) is (are) used, univariate or bivariate/trivariate probit equations can be estimated using simulated maximum likelihood methods in the last two cases.

[10] For non-innovative firms, the values of all the variables related to innovation activities are set at zero as no data is available for them.

Productivity equation. The performance indicator used in CDM studies is measured through firm-level productivity, especially through labor productivity since data on firm-level capital is seldom available. In case a constant returns to scale, the Cobb-Douglas production function is adopted, whose basic formulation is:

$$y_i = \gamma k_i + \delta Inno_i + \theta W_i + \tau_i \tag{1.6}$$

Where *y* is labor productivity (output – however measured – per worker), *k* is a proxy of physical capital per worker (measured often by investment per worker), *Inno* is innovation or knowledge input proxied by different alternative variables (see supra) and *W* denotes additional control variables.

In order to alleviate the endogeneity of the *Inno* variable in equation (1.6)[11], the predicted values of this variable based on equation (5) are used in the Cobb-Douglas production function. From this stage on, differences arise as to the sample used in estimations and to the relationship assumed between innovation output and productivity. Indeed, using the predicted values of *Inno,* some studies estimate equation (6) on the whole sample comprising innovative and non-innovative firms while others use only non-innovative firms to investigate the direction and magnitude of the impact of innovation output on firm productivity. Besides, some studies assume the existence of a bi-directional causality between productivity and the outcome of innovation activities of firms and estimate therefore equations (1.5) and (1.6) in a simultaneous equation framework – on the sample of innovative firms only.

CDM-based models estimated in this report

In this report, the full CDM model could not be estimated for Poland and Turkey for a number of reasons. First, since our data is from innovation surveys, data on R&D expenditures is available therein only for firms introducing innovations, which makes the estimation of the first stage of the CDM model impossible. Second, due to the confidentiality restrictions applied by the CSO, there is no revenue or production variable in the Polish data set necessary to construct an indicator of firm-level productivity, which is not a problem in the case of Turkey. On the other hand, the aim of our study is to assess the efficiency of government aid for innovation, which makes it necessary to include government support variables in the equations. Our inspiration here was the OECD 2009 study of innovation in firms in 18 countries.

[11] Due to unobserved constant or slowly changing firm-level factors, omitted variables or reverse causality which may affect both the productivity and innovation output.

Therefore, the common model to be estimated both for Poland and Turkey – called the *core model* in the next section – will include two parts and three equations. The first part includes innovation decision and innovation expenditure equations which are estimated using the Heckman procedure. The second part contains the innovation output equation and is estimated by probit. The selection issue in the first part of the model is addressed by the Heckman selection model which does account for non-innovators while estimating the innovation expenditure equation. As for the innovation output expenditure equation, which is estimated using data only on innovating firms, the selection issue is handled by including the inverse Mill's ratio obtained from the previous stage in the equation. No productivity equation is estimated in the *core model* and the possible effect of innovation support will be estimated on innovation expenditure (input additionality) and innovation output (output additionality). The model has a certain affinity with the Microdata project, i.e. the OECD 2009 study of innovation activities in firms in 18 countries (discussed in more detail in the next subsection)

The choice of independent variables in each specific equation is discussed in the results section. The innovation decision variable is a firm-level variable and takes the value of 1 if a firm has positive innovation expenditures (which is rather a broad definition but it is used in the OECD 2009 study) and 0 if its innovation expenditures are nil. Data on innovation expenditures are available in innovation surveys and this variable is used in our study as innovation expenditures per capita, mainly because it is available in that format in the Polish survey. As to the innovation output indicator, a dummy variable is used in the model that takes the value of 1 if a firm introduces a innovation that is new to the market, i.e. a radical innovation, and zero otherwise.

The core model was estimated only on manufacturing firms since data in the Polish survey is available only for the manufacturing sector. In the Turkish CIS, a representative sample is collected for the entire economy, therefore it includes mining, manufacturing, industries other than manufacturing, and services. Since fewer firms were surveyed in the Turkish survey than in Poland (5,767 and 9,858, respectively), the number of observations used for Turkey is reduced substantially if we restrain the estimation sample only to the manufacturing industry – which is the case for the *core model* to be discussed below . Therefore, we will also estimate the common model for Turkey by using data for all the sectors and briefly discuss the findings.

In the case of Turkey, we were able to match the innovation survey with data coming from another data set, namely the Structural Business Survey for the year 2010. This enabled us to use variables in the econometric exercise that were not included in the innovation survey such as production, value added, exports, imports, etc. The main point is that an indicator of firm-level productivity was constructed which enabled us to add the productivity equation to the CDM model. The specification and estimation of the model was carried out in accordance with the OECD 2009 study and will be examined below. On the other hand, in the Polish extension of the core analysis, we take advantage of having two implementations of the CIS and estimate the panel version of the model (see section 4).

Endogenous support model

Apart from the model with exogenous government support, we consider a model in which support depends on firms' features. In the first step of the model with endogenous support, we estimate the parameters of the binary choice model:

$$\sup\_inn_i* = \mathbf{z}_i\boldsymbol{\alpha} + \varepsilon_i, \qquad \varepsilon_i \sim N(0,1), \tag{2.1a}$$

$$\sup\_inn_i = 1\{\sup\_inn_i* \geq 0\}, \tag{2.1b}$$

where:

$\mathbf{z}_i = [1 \quad medium_i \quad large_i \quad manhigh_i \quad manmedhigh_i \quad manmedlow_i]$.

After estimating the parameters of model (2.1a)-(2.1b), we calculate the expectations of the unobservable variable $\sup\_inn_i*$ in the following way:

$$E(\sup\_inn_i* \mid \sup\_inn_i* \geq 0) = \mathbf{z}_i\hat{\boldsymbol{\alpha}} + \frac{\phi(\mathbf{z}_i\hat{\boldsymbol{\alpha}})}{\Phi(\mathbf{z}_i\hat{\boldsymbol{\alpha}})}, \tag{2.2a}$$

$$E(\sup\_inn_i* \mid \sup\_inn_i* < 0) = \mathbf{z}_i\hat{\boldsymbol{\alpha}} - \frac{\phi(\mathbf{z}_i\hat{\boldsymbol{\alpha}})}{1-\Phi(\mathbf{z}_i\hat{\boldsymbol{\alpha}})}. \tag{2.2b}$$

In the last step, we estimate the parameters of the binary choice model for radical innovation:

$$radical_i^* = \mathbf{w}_i\boldsymbol{\beta} + \xi_i, \qquad \xi_i \sim N(0,1), \tag{2.3a}$$

$$radical_i = 1\{radical_i^* \geq 0\}, \tag{2.3b}$$

where:

$w_i = [1 \quad medium_i \quad large_i \quad manhigh_i \quad manmedhigh_i \quad manmedlow_i \quad group_i \quad \exp_i \quad \hat{k}_i]$

and

$$\hat{k}_i = \begin{cases} \mathbf{z}_i\hat{\boldsymbol{\alpha}} + \dfrac{\phi(\mathbf{z}_i\hat{\boldsymbol{\alpha}})}{\Phi(\mathbf{z}_i\hat{\boldsymbol{\alpha}})}, & if \quad \sup\_inn_i = 1, \\ \mathbf{z}_i\hat{\boldsymbol{\alpha}} - \dfrac{\phi(\mathbf{z}_i\hat{\boldsymbol{\alpha}})}{1-\Phi(\mathbf{z}_i\hat{\boldsymbol{\alpha}})} & if \quad \sup\_inn_i = 0. \end{cases} \tag{2.4}$$

4.4 Results

Given the variety of methodological approaches employed in this report and the differences in data availability for Turkey and Poland, we present our results in four subsections. We start with two kinds of comparative analysis: first, the discussion of the outcome of the sequential ('CDM-based') model, and second, the presentation of the estimates of the model with endogenous support. Two subsections follow with extended national analyses for Turkey and Poland, respectively.

Comparative analysis: sequential ('CDM-based') model

How can government support be controlled for in a CDM-like model? One way is to follow the OECD methodology and to include a support dummy in the innovation expenditure equation. However, government support might be conducive for innovation in other ways than just monetary: it might facilitate co-operation with important actors in the innovation system (e.g. R&D institutes), help attract new talent[12], or mobilize the firm for a more efficient performance. To verify that, we estimate the sequential model including the government support variables also in the second step – the equation explaining the decision of the firm to include radical innovation.

The choice of the right hand side variables in the sequential model was an outcome of a longer process including several trial estimations. We first discuss the selection equation (whether the firm had innovation expenditure or not). The starting point was the model estimated for 18 countries in the OECD 2009 study, where the variables included in the selection were dummies for group membership, exporting activities, collaboration with other firms in innovation activities and the firm being large. Moreover, the authors included variables describing the role of the barriers to innovation faced by the firm (in a 0-3 Likert scale). We decided to exclude barriers to innovation activities, because this variable proved problematic in the OECD study (as in previous studies of ours). While the OECD model includes industry dummies as controls, we used industry categories defined by technology intensity. Although the OECD study is restricted to firms with positive innovation expenditure only, we did not want to lose the information, so our models are estimated on the entire sample of companies. Consequently, the collaboration dummy that is technically available only for innovating firms was extended so as to indicate zero in the case of non-innovators. The OECD model includes nearly the same variables in the 'outcome equation,' i.e. in the model explaining the amount of innovation expenditure, and in the dummy indicating public support for innovation. We roughly follow that methodology.

[12] A related effect was hypothesized by Lerner in his analysis of the American SBIR programme: government support could have been a kind of 'quality certificate' enabling the firm to raise funds from private sources.

Finally, the innovation performance equation is estimated only on the set of firms that declared positive innovation expenditure. The log of innovation expenditure per employee is the main vehicle of innovation in this equation. However, as explained above, we also consider a version of the model that includes support variables in this step. We had to give up on several other explanatory variables (e.g. group, firm size) because they proved to be strongly correlated with the inverse Mill's ratio we are including here and thus could be causing co-linearity.

The results of the basic model are presented in Table 19. Larger firms are more likely to have innovation expenditure both in Poland and in Turkey, as are firms from more advanced industries in terms of technology. Interestingly, group membership is associated with lower expenditure in Turkey but higher in Poland.

Table 19. Government support and innovation performance of firms (basic model)

	Turkey			Poland		
VARIABLES	(1) linexpemp	(2) innovator_OECD	(5) Radical_in	(1) linexpemp	(2) innovator_OECD	(5) radical_in
Manhigh	2.144***	0.542***		0.674***	0.820***	
	(0.449)	(0.171)		(0.162)	(0.0720)	
Manmedhigh	0.730***	0.480***		0.276***	0.558***	
	(0.197)	(0.0641)		(0.0952)	(0.0351)	
Group	-0.401**			0.416***		
	(0.195)			(0.0738)		
coll_othfirm	0.380**			0.432***		
	(0.188)			(0.113)		
support_gov	0.392**			0.518***		
	(0.168)			(0.129)		
support_loc	0.241			0.0971		
	(0.431)			(0.167)		
support_EU	1.097**			0.887***		
	(0.512)			(0.0932)		
Mediumlarge		0.640***			0.925***	
		(0.0509)			(0.0361)	
IMR			-0.167***			-0.583***
			(0.0617)			(0.0875)
Linexpemp			-0.00383			0.0321**
			(0.00724)			(0.0150)
Observations	2,687	2,687	876	9,858	9,858	2,350
Log Lik	-3563.90	-3563.90	-595.26	-9430.72	-9430.72	-1598.50

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Not surprisingly, government support has a statistically significant and positive impact on innovation expenditure. The probability of introducing radical product innovation increases with innovation expenditure (although it does not apply to all sources of support). For Poland, the bigger the innovation expenditure, the higher the probability to introduce radical product innovations. Meanwhile, for Turkey the coefficient was insignificant. When the support dummy is also included in the innovation performance equation, innovation expenditure becomes insignificant (Table 20). The support obtained from the central government is associated with a better innovation performance in Turkey, but not in Poland.

Table 20. Government support and innovation performance of firms (alternative model)

	Turkey				Poland			
VARIABLES	**(1) linexpemp**	**(2) innovator_OECD**	**(3) radical_in**	**(4) radical_in**	**(5) linexpemp**	**(6) innovator_ OECD**	**(7) radical_in**	**(8) radical_in**
Manhigh	2.230***	0.543***			0.658***	0.820***		
	-0.447	-0.171			-0.162	-0.072		
Manmedhigh	0.753***	0.481***			0.278***	0.558***		
	-0.197	-0.0641			-0.0952	-0.0351		
Group	-0.370*				0.432***			
	-0.195				-0.0738			
coll_othfirm	0.424**				0.432***			
	-0.187				-0.113			
sup_ino	0.454***		0.103***		0.958***		0.1674***	
	-0.165		(0.0343)		-0.0808		(	
Mediumlarge		0.640***				0.925***		
		-0.0509				-0.0361		
IMR			-0.149**	-0.146**				
			(0.0624)	(0.0627)				
Linexpemp			-0.00665	-0.00704				-0.563***
			(0.00745)	(0.00748)				(0.0883)
support_gov				0.0880**				0.285***
				(0.0352)				(0.0973)
support_loc				0.0938				0.0690
				(0.0901)				(0.127)
support_EU				0.0632				0.0703
				(0.109)				(0.0712)
Observations	2,687	2,687	876	876	9,858	9,858	2,350	2,350
Log Lik	-3566.4	-3566.4	-590.80	-590.80	.	.	-1586.87	-1592

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

While these results indicate the importance of government support, they are a bit puzzling (innovation expenditure is insignificant, mixed results with respect to the kinds of support). Therefore we turn to the model with endogenous support.

Comparative analysis: endogenous support model

The results of the endogenous support model are quite similar for both countries (Table 21). Firms that are larger, operate in more advanced industries, are group members and are exporters have a better chance of obtaining government support. Yet even when this fact is controlled for, the recipients of public aid are more likely to introduce product innovations new to the market, as indicated by the positive and statistically significant coefficient for the *sup_IMR* variable, i.e. the respective inverse Mill's ratio.

Table 21. Determinants of government support and the relationship of support and innovation performance

	Turkey		**Poland**	
	(1)	**(2)**	**(1)**	**(2)**
VARIABLES	**sup_ino**	**radical_in**	**sup_ino**	**radical_in**
Medium	0.00254	0.119	0.496***	0.556***
	(0.0855)	(0.0811)	(0.0528)	(0.0487)
Large	0.451***	0.502***	0.727***	1.035***
	(0.0672)	(0.0806)	(0.0638)	(0.0609)
Manhigh	0.807***	0.330*	0.486***	0.802***
	(0.178)	(0.192)	(0.0967)	(0.0845)
Manmedhigh	0.666***	0.357***	0.374***	0.554***
	(0.0774)	(0.0750)	(0.0493)	(0.0434)
Manmedlow	0.276***	-0.0183	0.253***	0.182***
	(0.0716)	(0.0673)	(0.0451)	(0.0410)
Export		0.244***		0.255***
		(0.0669)		(0.0452)
Group		0.190**		0.226***
		(0.0845)		(0.0428)
sup_IMR		0.605***		0.569***
		(0.0397)		(0.0265)
Observations	2,687	2,687	9,858	9,858
Log Lik	-1090.00	-1258.60		

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note that the variable *sup_ino* used in the above model is the most general definition of support: it stands for public aid obtained from *any* source. In Turkey it is almost identical with *support_gov*. On the other hand, for Poland, an estimation of the model for *support_EU* and *support_gov* brought nearly the same results.

Extension: analysis for Turkey

As mentioned previously, we matched the Turkish innovation survey with two other data bases containing firm-level data for Turkey. This enabled us to replicate the CDM model estimated for 18 countries in the OECD Microdata project as examined in the OECD 2009 study. We extended the OECD model by using three different types of innovation support in addition to *any* innovation. These include support granted by central government, by local authorities and through funds coming from EU. Secondly, we used the methodology suggested in Griffith et al. (2006) which allows us to estimate the innovation output and productivity equations for *all* the firms present in the sample, not only for innovators – which significantly increased the number of observations used in the regressions.

In the sequel, we first present the CDM model used in the OCD Microdata project (OECD 2009). We then estimate it on Turkish data which is based on a sample of firms covering all the sectors – not solely the manufacturing sector. We then estimate and discuss *different* extensions of the OECD model with the emphasis being each time on the possible impact of innovation support granted to firms on their innovation expenditures and innovation output.

CDM model used in the OECD Microdata Project[13] The CDM model used in the OECD 2009 study for a number of countries that agreed to participate in the project has the following characteristics.

First, the model is estimated only for innovative firms, defined as those firms having both positive innovation expenditures and innovative sales. Secondly, endogeneity and selectivity issues are addressed within the model. Third, a core model containing variables available to all the countries participating in the project was specified in order for the countries to be able to estimate the same equations. Finally, only variables obtained from innovation surveys are used in the project.

The CDM model used in the OECD project involves three stages and consists of four equations. We analyze them below by putting the emphasis on the dependent and explanatory variables included in different equations of the model on the one hand, and on the methods used to alleviate selectivity and endogeneity. The *first stage* of the CDM model explains the innovation propensity (decision) of firms and the volume of innovation expenditure through a generalized Tobit model. As mentioned in OECD (2009: 128), the limited availability of data on non-innovative firms in innovation surveys leads to the selection of these variables in the first stage.

[13] See also chapter 3 (*Innovation and productivity: estimating the core model across 18 OECD countries*) in OECD 2009

Box 1. Methodology of the OECD model

Innovation decision

Dependent variable: a binary variable if a firm innovates, zero otherwise
Explanatory variables: firm size, group dummy, exporter dummy,
importance of obstacles to innovation dummies (due to knowledge, costs, and market),
industry dummies

Innovation expenditures

Dependent variable: innovation expenditure per employee
Explanatory variables: group dummy, exporter dummy, cooperation dummy
(clients, suppliers, other agents), public financial support dummy

Recall that the first equation is called the decision equation while the second one is called the outcome equation. In order to correctly identify the coefficients of the model, some exclusion criteria must be satisfied: certain coefficients included in the decision equation must be excluded from the outcome equation. In our case, these variables are firm size and obstacles to innovation dummy variables.

The second stage of the CDM model consists in the specification and estimation of a knowledge production function. As the model is estimated only on innovative firms, the inverse Mill's ratio, estimated in the aforementioned first stage, is used here as an explanatory variable to correct for a possible selection bias. Predicted innovation expenditures obtained from the first stage, rather than actual expenditures, are used here to correct for the endogeneity of innovation expenditures in the knowledge production function.

Box 2. Methodology of the OECD model (continued)

Knowledge production function

Dependent variable: innovative sales per employee (logarithm)

Explanatory variables: firm size, group dummy, process innovation dummy,
importance of obstacles to innovation dummies (due to knowledge, costs, and market),
industry dummies, inverse Mill's ratio, innovation expenditures per employee (or their predicted
value to correct a possible endogeneity problem)

Exclusions required for the identification of the coefficients of the knowledge production function relate to two variables: public financial support and the exporter dummy, which are supposed to influence innovation output only through increased innovation expenditures.

In the third and final step of the model, the link between innovation output (knowledge) and productivity is investigated through an augmented Cobb Douglas function.

Box 3. Methodology of the OECD model (continued)

Productivity function

Dependent variable: sales per employee (logarithm)

Explanatory variables: firm size, group dummy, process innovation dummy, inverse Mill's ratio, exporter dummy, innovative sales per employee (logarithm)

Since innovative sales per employee present in the augmented Cobb Douglas production function might be a potentially endogenous variable, this equation is estimated using instrumental variables two-stage least squares.

Estimation of the basic CDM model used in the OECD Microdata Project Estimation results for the basic OECD model for Turkey are presented in Table 22-Table 25. These tables report coefficients for the innovation decision variable, not the marginal effects of the explanatory variables. Most of the explanatory variables included in these tables were presented previously while discussing the OECD project.

In Table 22, we present estimation results for the basic OECD model where any innovation support variable (*sup_ino*) is included only in the innovation expenditures equation.

Linexemp is the logarithm of the innovation expenditures per employee, *innovator* is a dummy variable taking the value 1 if a firm has positive innovation expenditures, zero otherwise. *Linsalemp* is the logarithm of the innovative sales per employee. *Lvalademp* stands for the logarithm of firm-level labour productivity, measured as value added divided by the number of employees. *Lemp* represents the logarithm of the number of employees (firm size). *Coll_othfirm* is a dummy variable taking the value of 1 if a firm collaborates with any other company in order to innovate, zero otherwise. Sector-level dummies introduced in regressions are: *manhigh* (hi-tech manufacturing industries), *manmedhigh* (high-medium tech manufacturing industries) *manmedlow* (medium-low technology manufacturing industries), *kis* (knowledge-intensive service industries) and *lkis* (low knowledge intensive service industries). The omitted category is low-tech manufacturing industries. *Barknow* stands for barriers to innovation related to knowledge factors (such as lack of qualified personnel, lack of technological/market information or lack of cooperation partners), *barmark* stands for barriers to innovation related to the market (such as a market dominated by large enterprises or/and uncertain demand for innovative products) while *barcost* stands for barriers to innovation related to cost factors (such as lack of internal funds or external finance, high cost of innovation). *Amills* is the inverse Mill's ratio retrieved from the Heckman selection equation and used in the innovation expenditure in order to mitigate a possible selection bias since this equation is estimated only on *Linexpemp_hat* is *linexpemp* variable, which is instrumented. This instrumented variable is used in the innovation output equation (*linsalemp)* in an attempt to mitigate a possible reverse causality problem between innovation input and innovation output variables. This instrumented variable is used as an explanatory variable alternatively with the actual innovation expenditure variable (*linexpemp*) in the innovation output equation.

Findings reported in Table 22 indicate that use by firms of direct innovation support of any kind granted by public authorities is associated with a positive and statistically significant effect on the innovation expenditures of Turkish firms. This *might* point to the existence of input additionality, indicating that on average, firms would have spent less on innovation in the absence of direct support. However, note that this finding is conditional on the innovation support being exogenous.

Besides, innovation expenditures, whether measured by actual expenditures or by the instrumented ones, are associated with a positive and significant effect on innovation output, as is innovation output, measured by the actual innovative sales per employee, with the productivity of firms.

Table 22. The OECD Model for Turkey – Basic Specification with any innovation support variable (sup_ino) included only in the innovation expenditures equation

	linexpemp (1)	innovator (2)	lvalademp (3a)	linsalemp (3b)	lvalademp (4a)	linsalemp (4b)
Group	-0.164	0.332***	0.546***	0.246	0.555***	0.448
	(0.270)	(0.0567)	(0.0740)	(0.340)	(0.0705)	(0.340)
Export	0.764**	0.418***				
	(0.300)	(0.0458)				
Lemp		0.123***	0.190***	-0.135	0.186***	-0.104
		(0.0174)	(0.0246)	(0.114)	(0.0236)	(0.113)
barknow		0.362***				
		(0.0587)				
barmark		-0.120**				
		(0.0565)				
barcost		0.192***				
		(0.0498)				
manhigh	2.187***	0.468**	0.411**	0.536	0.445**	-0.678
	(0.710)	(0.182)	(0.183)	(0.798)	(0.173)	(0.853)
manmedhigh	0.760**	0.458***	0.234***	0.318	0.245***	-0.0216
	(0.371)	(0.0763)	(0.0869)	(0.450)	(0.0806)	(0.463)
manmedlow	0.247	0.250***	0.210***	-0.152	0.201***	-0.240
	(0.304)	(0.0629)	(0.0751)	(0.399)	(0.0699)	(0.399)
kis	1.207***	0.425***	0.438***	-0.450	0.433***	-0.868**
	(0.337)	(0.0660)	(0.0910)	(0.422)	(0.0872)	(0.440)
lkis	-0.360	0.153***	0.135	-0.559	0.116	-0.192
	(0.286)	(0.0582)	(0.0828)	(0.381)	(0.0796)	(0.392)
coll_othfirm	1.063***					
	(0.223)					
sup_ino	1.667***					
	(0.211)					
linsalemp			0.101***		0.0694***	
			(0.0263)		(0.0243)	
process_inno			0.255**	-2.832***	0.177*	-2.714***
			(0.1000)	(0.291)	(0.0934)	(0.285)
amills			0.250	-1.340*	0.184	-0.564
			(0.157)	(0.717)	(0.148)	(0.739)
coopk_supplier				-0.896		-1.107**
				(0.549)		(0.549)
coopk_customer				1.329**		1.258**
				(0.544)		(0.543)
coopk_public				0.736		0.336
				(0.467)		(0.477)
coopk_priv				0.788		0.633
				(0.536)		(0.539)
linexpemp				0.142***		
				(0.0336)		
linexpemp_hat						0.668***
						(0.143)
Observations	3,888	3,888	1,620	1,620	1,620	1,620
R2	---	---	0.01	0.08	0.12	0.08
Log Likelihood	-6,874	-6,874	---	---	---	---

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 23 replicates the estimation of the model presented in Table 22 but with a major difference: any innovation support variable (*sup_ino*) is replaced by the three support variables: (i) a dummy variable taking the value of 1 if a firm receives innovation support from an organization associated with the central government (*support_gov)*, zero otherwise (ii) a dummy variable taking the value of 1 if a firm receives innovation support granted by a local authority (*support_loc),* zero otherwise and (iii) a dummy variable taking the value of 1 if a firm receives innovation support from EU funds (*support_EU*), zero otherwise.

Coefficients estimated with these three different types of support among explanatory variables are reported in Table 23. Innovation support provided by the central government (the most common type of support) has a positive and significant effect at the 1% level on the innovation expenditures of firms, indicating the presence of an input additionality effect. Such an additionality also concerns innovation support originating from EU funds but it is significant only at the 10% level. There is no statistical evidence as to any positive impact of support granted by local authorities on innovation expenditures of firms (note that it's coefficient is negative).

Besides, variables measuring innovation expenditures exert a positive and significant effect on innovation output (innovative sales per employee) while the innovation output variable itself also has a positive and significant effect on labor productivity.

Next, we will introduce different innovation support variables not only in the innovation expenditure equation to test for the input additionality but also in the innovation output model to test for the output additionality of innovation support in Turkey.

Table 23. The OECD Model for Turkey – Basic Specification with different types of innovation support (support_gov, support_loc, support_EU) included only in the innovation expenditures equation

	linexpemp (1)	innovator (2)	lvalademp (3a)	linsalemp (3b)	lvalademp (4a)	linsalemp (4b)
Group	-0.603**	0.346***	0.545***	0.222	0.557***	0.494
	(0.274)	(0.0562)	(0.0752)	(0.345)	(0.0703)	(0.352)
Export	0.0261	0.424***				
	(0.287)	(0.0454)				
Lemp		0.102***	0.186***	-0.123	0.182***	-0.130
		(0.0185)	(0.0239)	(0.111)	(0.0225)	(0.110)
Barknow		0.331***				
		(0.0572)				
Barmark		-0.107**				
		(0.0533)				
Barcost		0.181***				
		(0.0469)				
manhigh		0.557***	0.418**	0.455	0.459***	0.476
		(0.165)	(0.184)	(0.810)	(0.171)	(0.794)
manmedhigh		0.449***	0.227***	0.311	0.242***	0.266
		(0.0737)	(0.0871)	(0.453)	(0.0795)	(0.454)
manmedlow		0.229***	0.203***	-0.142	0.192***	-0.179
		(0.0603)	(0.0746)	(0.397)	(0.0681)	(0.397)
kis		0.462***	0.440***	-0.490	0.430***	-0.419
		(0.0616)	(0.0924)	(0.430)	(0.0877)	(0.431)
lkis		0.111**	0.126	-0.522	0.104	-0.539
		(0.0561)	(0.0825)	(0.379)	(0.0778)	(0.380)
coll_othfirm	1.013***					
	(0.224)					
support_gov	1.741***					
	(0.223)					
support_loc	-0.374					
	(0.527)					
support_EU	1.110*					
	(0.645)					
linsalemp			0.1000***		0.0575**	
			(0.0263)		(0.0257)	
process_inno			0.253**	-2.831***	0.148	-2.720***
			(0.0999)	(0.291)	(0.0954)	(0.286)
amills			0.234	-1.382*	0.141	-1.486**
			(0.162)	(0.739)	(0.152)	(0.736)
coopk_supplier				-0.897		-1.018*
				(0.549)		(0.546)
coopk_customer				1.331**		1.315**
				(0.544)		(0.540)
coopk_public				0.738		0.363
				(0.467)		(0.482)
coopk_priv				0.785		0.696
				(0.536)		(0.539)
linexpemp				0.142***		
				(0.0336)		
linexpemp_hat						0.534***
						(0.139)
Observations	3,888	3,888	1,620	1,620	1,620	1,620
R2	---	---	0.012	0.083	0.153	0.079
Log Likelihood	-6,882	-6,882	---	---	---	---

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

In Table 24, any innovation support variable (*sup_ino*) is included both in the innovation expenditure and innovation output equations. Although its positive and significant effect on innovation expenditures observed in Table 23 is conserved, no such significant impact is observed on innovative sales per employee, pointing to the absence of output additionality of supports. Another possible explanation is that we are using cross-section data but the materialization of a possible effect of innovation support on innovation output may need a long period of time – longer than what is needed for input additionality.

In Table 25, we introduced the three types of innovation support instead of the *sup_ino* variable in the model. The positive and significant effect of government and EU supports on innovation expenditure is confirmed here. EU support for innovation seems to exert a positive and significant effect on innovative sales per employee, but it is significant only at the 10% level. Meanwhile government support has a negative effect which is, however, only significant at the 10% level.

In both Table 24 and Table 25, the positive and significant relationship of innovation expenditure and innovation output is conserved as well as the positive impact of innovation output on firm-level productivity in Turkey.

Finally, the results presented in Table 26 and Table 27 are based on the methodology discussed in Griffith et al. (2006). This methodology uses innovation probabilities computed after the Heckman procedure to estimate the innovation input (expenditure) and output (innovative sales) on all sample firms, innovators and non-innovators all together. This procedure considerably increases the number of observations hence degrees of freedom for the estimation of the CDM model.

The results reported in Table 26 confirm those obtained previously: innovation support by government and EU funds both seem to have a positive and significant impact on innovation expenditures, confirming the previously found input additionality effect for these two types of support. The absence of a significant effect of local innovation support on innovation expenditures is also confirmed.

Table 24. The OECD Model for Turkey – Basic Specification with any innovation support (sup_ino) included in both innovation expenditure and innovation output equations

	linexpemp (1)	innovator (2)	lvalademp (3a)	Linsalemp (3b)	lvalademp (4a)	linsalemp (4b)
group	-0.164	0.332***	0.308***	0.381	0.317***	0.441
	(0.270)	(0.0567)	(0.0577)	(0.326)	(0.0572)	(0.324)
export	0.764**	0.418***				
	(0.300)	(0.0458)				
lemp		0.123***	0.0982***	-0.0703	0.0972***	-0.0720
		(0.0174)	(0.0176)	(0.109)	(0.0168)	(0.108)
barknow		0.362***				
		(0.0587)				
barmark		-0.120**				
		(0.0565)				
barcost		0.192***				
		(0.0498)				
manhigh	2.187***	0.468**	0.420***	0.713	0.447***	-0.827
	(0.710)	(0.182)	(0.147)	(0.774)	(0.140)	(1.052)
manmedhigh	0.760**	0.458***	0.164***	0.506	0.176***	-0.0378
	(0.371)	(0.0763)	(0.0634)	(0.393)	(0.0612)	(0.475)
manmedlow	0.247	0.250***	0.143**	-0.0367	0.141**	-0.240
	(0.304)	(0.0629)	(0.0603)	(0.383)	(0.0575)	(0.395)
kis	1.207***	0.425***	0.405***	-0.268	0.406***	-0.899*
	(0.337)	(0.0660)	(0.0717)	(0.403)	(0.0696)	(0.496)
lkis	-0.360	0.153***	0.119*	-0.445	0.111	-0.144
	(0.286)	(0.0582)	(0.0697)	(0.383)	(0.0685)	(0.408)
coll_othfirm	1.063***					
	(0.223)					
sup_ino	1.667***			0.0606		-0.186
	(0.211)			(0.784)		(0.799)
linsalemp			0.0698***		0.0495*	
			(0.0260)		(0.0287)	
lcapint			0.147***		0.148***	
			(0.00829)		(0.00807)	
process_inno			0.138	-2.856***	0.0861	-2.706***
			(0.0943)	(0.291)	(0.0949)	(0.285)
amills			0.0761	-0.916	0.0462	0.0662
			(0.0599)	(0.811)	(0.0608)	(0.899)
linexpemp				0.127***		
				(0.0342)		
linexpemp_hat						0.745***
						(0.287)
coopk_supplier				-0.869		-1.156**
				(0.547)		(0.564)
coopk_customer				1.333**		1.260**
				(0.543)		(0.543)
coopk_public				0.507		0.345
				(0.476)		(0.482)
coopk_priv				0.801		0.592
				(0.536)		(0.548)
Observations	3,888	3,888	1,620	1,620	1,620	1,620
R2	---	---	0.299	0.087	0.350	0.082
Log Likelihood	-6,874	-6,874	---	---	---	---

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 25. The OECD Model for Turkey – Basic Specification with different types of innovation support (support_gov, support_loc, support_EU) included in the innovation expenditure and innovation output equations

	linexpemp (1)	innovator (2)	lvalademp (3a)	linsalemp (3b)	lvalademp (4a)	linsalemp (4b)
Group	-0.603**	0.346***	0.308***	0.305	0.317***	0.358
	(0.274)	(0.0562)	(0.0577)	(0.322)	(0.0569)	(0.321)
Export	0.0261	0.424***				
	(0.287)	(0.0454)				
Lemp		0.102***	0.0982***	-0.117	0.0973***	-0.133
		(0.0185)	(0.0176)	(0.107)	(0.0168)	(0.106)
Barknow		0.331***				
		(0.0572)				
Barmark		-0.107**				
		(0.0533)				
Barcost		0.181***				
		(0.0469)				
manhigh		0.557***	0.421***	0.681	0.449***	-0.609
		(0.165)	(0.147)	(0.775)	(0.140)	(1.043)
manmedhigh		0.449***	0.164***	0.446	0.177***	-0.0511
		(0.0737)	(0.0635)	(0.388)	(0.0617)	(0.481)
manmedlow		0.229***	0.143**	-0.0853	0.141**	-0.279
		(0.0603)	(0.0604)	(0.382)	(0.0575)	(0.395)
kis		0.462***	0.406***	-0.374	0.407***	-0.945*
		(0.0616)	(0.0718)	(0.402)	(0.0696)	(0.503)
lkis		0.111**	0.119*	-0.491	0.111	-0.240
		(0.0561)	(0.0697)	(0.379)	(0.0680)	(0.405)
coll_othfirm	1.013***					
	(0.224)					
support_gov	1.741***			-0.752		-1.205*
	(0.223)			(0.671)		(0.730)
support_loc	-0.374			0.550		1.142
	(0.527)			(0.600)		(0.713)
support_EU	1.110*			1.130*		0.469
	(0.645)			(0.676)		(0.765)
linsalemp			0.0701***		0.0486	
			(0.0259)		(0.0297)	
Lcapint			0.147***		0.148***	
			(0.00829)		(0.00806)	
process_inno			0.139	-2.864***	0.0840	-2.714***
			(0.0941)	(0.291)	(0.0978)	(0.285)
amills			0.0777	-1.497**	0.0467	-0.909
			(0.0599)	(0.714)	(0.0612)	(0.772)
coopk_supplier				-0.917*		-1.174**
				(0.552)		(0.570)
coopk_customer				1.384**		1.325**
				(0.547)		(0.548)
coopk_public				0.521		0.391
				(0.475)		(0.480)
coopk_priv				0.776		0.592
				(0.537)		(0.548)
linexpemp				0.130***		
				(0.0342)		
linexpemp_hat						0.688**
						(0.306)
Observations	3,888	3,888	1,620	1,620	1,620	1,620
R2	---	---	0.299	0.089	0.352	0.083
Log Likelihood	-6,882	-6,882	0.300	0.09	0.350	0.080

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 26. The OECD Model for Turkey – Extended Specification (for all firms) with innovation support included only in the innovation expenditure equation

	linexpemp (1a)	innovator (1b)	linexpemp (2a)	innovator (2b)	linsalemp (1c)	lvalademp (1d)	linsalemp (2c)	lvalademp (2d)
Group	-0.168	0.386***	-0.156	0.384***	0.475**	0.544***	0.427**	0.541***
	(0.326)	(0.0562)	(0.300)	(0.0560)	(0.187)	(0.0410)	(0.188)	(0.0412)
Export	0.637*	0.450***	0.641*	0.450***				
	(0.382)	(0.0442)	(0.340)	(0.0442)				
Lemp		0.103***		0.104***	-0.0228	0.0331***	-0.0184	0.0326***
		(0.0177)		(0.0174)	(0.0488)	(0.0108)	(0.0492)	(0.0109)
Barknow		0.379***		0.379***				
		(0.0580)		(0.0581)				
Barmark		-0.134**		-0.135**				
		(0.0558)		(0.0560)				
Barcost		0.191***		0.191***				
		(0.0490)		(0.0492)				
coll_othfirm	1.144***		1.121***					
	(0.224)		(0.224)					
sup_ino	1.871***							
	(0.211)							
support_pub			1.910***					
			(0.217)					
support_loc			-0.522					
			(0.529)					
support_EUall			1.319**					
			(0.637)					
process_inno					4.997***	-0.217***	5.117***	-0.244***
					(0.196)	(0.0799)	(0.195)	(0.0860)
coopk_supplier					-1.139*		-1.003*	
					(0.590)		(0.590)	
coopk_customer					1.448**		1.593***	
					(0.569)		(0.570)	
coopk_public					-0.154		-0.0929	
					(0.498)		(0.502)	
coopk_priv					0.764		0.780	
					(0.600)		(0.604)	
linexpemp1_hat					1.164***			
					(0.115)			
linexpemp2_hat							0.979***	
							(0.109)	
Lcapint						0.133***		0.133***
						(0.00438)		(0.00438)
linsalemp1_hat						0.0373***		
						(0.0121)		
linsalemp2_hat								0.0417***
								(0.0132)
Observations	3,888	3,888	3,888	3,888	3,888	3,888	3,888	3,888
R2					0.428	0.368	0.423	0.368
Log Likelihood	-6929	-6929	-6925	-6925				
R2					0.43	0.37	0.42	0.37

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

The results in Table 27 indicate that receiving innovation support increases not only innovation expenditures but also innovation output (innovative sales per employee), which points to an output additionality effect of innovation support in Turkey. When we look at the different types of support, we see that support based on government and EU funds is again positive and statistically significant. Only support originating from local authorities seems to have an output additionality effect.

Table 27. The OECD Model for Turkey – Extended Specification (for all firms) with innovation support included both in the innovation expenditure and innoıvation output equations

	linexpemp (1a)	innovator (1b)	linexpemp (2a)	innovator (2b)	linsalemp (1c)	lvalademp (1d)	linsalemp (2c)	Lvalademp (2d)
group	0.0793	0.338***	-0.0106	0.334***	0.245	0.544***	0.296	0.545***
	(0.237)	(0.0601)	(0.235)	(0.0600)	(0.190)	(0.0411)	(0.189)	(0.0411)
export	0.974***	0.347***	0.844***	0.348***				
	(0.223)	(0.0475)	(0.221)	(0.0475)				
sup_ino	1.934***				0.913**			
	(0.460)				(0.404)			
lemp		0.107***		0.107***	-0.0160	0.0331***	-0.0157	0.0332***
		(0.0182)		(0.0182)	(0.0497)	(0.0108)	(0.0499)	(0.0108)
barknow		0.301***		0.301***				
		(0.0640)		(0.0637)				
barmark		-0.0423		-0.0432				
		(0.0605)		(0.0605)				
barcost		0.0969*		0.0946*				
		(0.0539)		(0.0538)				
coll_othfirm	1.170***		1.140***					
	(0.223)		(0.223)					
support_pub			1.734***				0.470	
			(0.432)				(0.421)	
support_loc			-0.634				2.532***	
			(0.560)				(0.659)	
support_EUall			1.361**				-0.715	
			(0.636)				(0.786)	
process_inno					5.017***	-0.217***	5.066***	-0.207**
					(0.196)	(0.0802)	(0.196)	(0.0824)
coopk_supplier					-0.895		-0.987*	
					(0.591)		(0.597)	
coopk_customer					1.531***		1.582***	
					(0.569)		(0.574)	
coopk_public					-0.0901		-0.0730	
					(0.499)		(0.502)	
coopk_priv					0.909		0.846	
					(0.602)		(0.604)	
linexpemp2_hat							0.822***	
							(0.161)	
linexpemp1_hat					0.695***			
					(0.139)			
Lcapint						0.133***		0.133***
						(0.00438)		(0.00438)
linsalemp1_hat						0.0373***		
						(0.0121)		
linsalemp2_hat								0.0358***
								(0.0126)
Observations	3,888	3,888	3,888	3,888	3,888	3,888	3,888	
R2	---	---	---	---	0.428	0.368	0.426	
Log Likelihood	-6560	-6560	-6560	-6560	---	---	---	

Extension: analysis for Poland

Our extension for Poland consists of two quite different parts. One involves a verification of the sequential model in a panel dataset, while another seeks to answer the question about the kind of help that is most effective in terms of inducing innovation.

We start with the extended sequential model. In order to verify whether panel effects are present in the equation of innovation expenditures, we compare two competitive Heckman models for innovation expenditures. A pooled model is given by equations (3.1)-(3.3)

$$linemp_{it} = \alpha_0 + \alpha_1 \sup\_gov_{it} + \alpha_2 \sup\_eu_{it} + \varepsilon_{it} \quad (3.1)$$

if $innovator\_OECD_{it} = 1$

and $linemp_{it}$ is unobservable if $innovator\_OECD_{it} = 0$.

$$innovator\_OECD^*_{it} = \beta_0 + \beta_1 mediumlarge_{it} + \beta_2 manmedhigh_{it} + \beta_3 manmedlow_{it} + \xi_{it} \quad (3.2)$$

$$innovator\_OECD_{it} = 1\{innovator\_OECD^*_{it} \geq 0\} \quad (3.3)$$

In order to distinguish fixed time effects, we shall estimate the parameters of the following competitive model:

$$linemp_{it} = \alpha^*_0 U2008_{it} + \alpha^{**}_0 U2010_{it} + \alpha_1 \sup\_gov_{it} + \alpha_2 \sup\_eu_{it} + \varepsilon_{it} \quad (3.4)$$

if $innovator\_OECD_{it} = 1$

and $linemp_{it}$ is unobservable if $innovator\_OECD_{it} = 0$.

$$innovator\_OECD^*_{it} = \beta^*_0 U2008_{it} + \beta^{**}_0 U2010_{it} + \beta_1 mediumlarge_{it} + \\ + \beta_2 manmedhigh_{it} + \beta_3 manmedlow_{it} + \xi_{it} \quad (3.5)$$

$$innovator\_OECD_{it} = 1\{innovator\_OECD^*_{it} \geq 0\} \quad (3.6)$$

It can easily be seen that models (3.1)-(3.3) and (3.4)-(3.6) are equivalent, if the following two restrictions for model (3.4)-(3.6) are valid:

$$\alpha^*_0 = \alpha^{**}_0, \quad (3.7a)$$

$$\beta^*_0 = \beta^{**}_0. \quad (3.7b)$$

In order to verify the validity of restrictions (3.7a) and (3.7b), we propose applying the likelihood ratio test. The results of the test are shown in Table 28.

Table 28. Results of testing fixed time effects with likelihood ratio test for the equation of public support in Poland

Loglikelihood for model (3.1)-(3.3) (restricted model)	Loglikelihood for model (3.4)-(3.6) (unrestricted model)	LR	p-value
-20291.79	-20273.59	36.4	0.000

According to the results from Table 28, we reject the hypothesis that the restriction is valid. By implication, time fixed effects are present in the Heckman model. Therefore we present estimates of parameters for the Heckman model with fixed time effects.

By analogy, we can verify whether panel effects are present in the equation of radical innovation. In order to do this, we compare the pooled probit model:

$$radical_{it}^{*} = \alpha_0 + \mathbf{z}_{it}\boldsymbol{\beta} + \varepsilon_{it}, \quad \varepsilon_{it} \sim N(0,1), \tag{3.8a}$$

$$radical_{it} = 1\{radical_{it}^{*} \geq 0\}, \tag{3.8b}$$

with the following panel probit model with fixed time effects:

$$radical_{it}^{*} = \alpha_0^{*} U2008_{it} + \alpha_0^{**} U2010_{it} + \mathbf{z}_{it}\boldsymbol{\beta} + \varepsilon_{it}, \quad \varepsilon_{it} \sim N(0,1) \tag{3.9a}$$

$$radical_{it} = 1\{radical_{it}^{*} \geq 0\} \tag{3.9b}$$

where:

$$z_{it} = \left[\sup\_gov_{it} \quad \sup\_eu_{it} \quad \sup\_loc_{it} \quad \frac{\phi(\mathbf{x}_{it}\hat{\boldsymbol{\alpha}})}{\Phi(\mathbf{x}_{it}\hat{\boldsymbol{\alpha}})} \quad linemp_{it} \right].$$

It can easily be seen that model (3.8a)-(3.8b) is a restricted version of model (3.9a)-(3.9b) with the condition:

$$\alpha_0^{*} = \alpha_0^{**} \tag{3.11}$$

Therefore we propose to estimate the parameters of both models by maximum likelihood and carry out a likelihood ratio test. The results of the likelihood ratio test are presented in Table 29.

Table 29. Results of testing fixed time effects with likelihood ratio test for the equation of radical innovation

Loglikelihood for model (1a)-(1b) (restricted model)	Loglikelihood for model (2a)-(2b) (unrestricted model)	LR	p-value
-3467.13	-3465.26	3.74	0.053

By analogy, we apply the same procedure to the model with endogenous support. We consider two competitive models:

$$\sup\_ino^{*}_{it} = \alpha_0 + \mathbf{v}_{it}\boldsymbol{\gamma} + \varepsilon_{it}, \quad \varepsilon_{it} \sim N(0,1) \qquad (3.12a)$$

$$\sup\_ino_{it} = 1\{\sup\_ino^{*}_{it} \geq 0\} \qquad (3.12b)$$

and

$$\sup\_ino^{*}_{it} = \alpha^{*}_0 U2008_{it} + \alpha^{**}_0 U2010_{it} + \mathbf{v}_{it}\boldsymbol{\gamma} + \varepsilon_{it}, \quad \varepsilon_{it} \sim N(0,1) \qquad (3.13a)$$

$$\sup\_ino_{it} = 1\{\sup\_ino^{*}_{it} \geq 0\} \qquad (3.13b)$$

In this case $\mathbf{v}_{it} = [medium_i \quad large_i \quad manhigh_i \quad manmedhigh_i \quad manmedlow_i]$

Similarly as in previous cases, we verify hypothesis (3.11) in order to check whether fixed time effects are present. Table 30 shows the results of testing fixed time effects with the likelihood ratio test for the equation of support. Again, the model with fixed time effects is preferred.

Table 30. Results of testing fixed time effects with likelihood ratio test for the equation of support

Loglikelihood for model (4a)-(4b) (restricted model)	Loglikelihood for model (5a)-(5b) (unrestricted model)	LR	p-value
-5051.14	-5044.40	13.48	0.000

Finally we test the presence of fixed time effects in the equation of radical innovation with endogenous support. We consider two alternative models:

$$radical^{*}_{it} = \alpha_0 + \mathbf{q}_{it}\boldsymbol{\delta} + \varepsilon_{it}, \quad \varepsilon_{it} \sim N(0,1) \qquad (3.14a)$$

$$radical_{it} = 1\{radical^{*}_{it} \geq 0\} \qquad (3.14b)$$

and

$$radical^{*}_{it} = \alpha^{*}_0 U2008_{it} + \alpha^{**}_0 U2010_{it} + \mathbf{q}_{it}\boldsymbol{\delta} + \varepsilon_{it}, \quad \varepsilon_{it} \sim N(0,1) \qquad (3.15a)$$

$$radical_{it} = 1\{radical^{*}_{it} \geq 0\} \qquad (3.15b)$$

where:

$$\mathbf{q}_{it} = [medium_{it} \quad large_{it} \quad manhigh_{it} \quad manmedhigh_{it} \quad manmedlow_{it} \quad export_{it}].$$

In order to check whether time fixed effects are present, we verify hypothesis (3) using the likelihood ratio test. The result in Table 31 suggests that also in this case, time fixed effects should be included.

Table 31. Results of testing fixed time effects with likelihood ratio test for the equation of support

Loglikelihood for model (6a)-(6b) (restricted model)	Loglikelihood for model (7a)-(7b) (unrestricted model)	LR	p-value
-6903.87	-6895.63	16.48	0.000

The results of the panel version of the core model presented in Table 32 are stronger than the findings from the cross-section model (cf. Table 19 and Table 20). Both government support and the aid from EU funds provide input additionality *and* output additionality. The only kind of public support for which a significant influence for innovation performance cannot be confirmed is aid from local government.

Table 32. Panel model of the role of government support (Poland)

VARIABLES	(1) linexpemp	(2) innovator_OECD	(3) radical_in
U2008	1.325***	-1.360***	0.367***
	(0.102)	(0.025)	(0.080)
U2010	1.176***	-1.466***	0.298***
	(0.106)	(0.025)	(0.083)
manhigh	0.267***		
	(0.100)		
support_gov	0.505***		0.353***
	(0.082)		(0.064)
support_eu	0.702***		0.080*
	(0.063)		(0.048)
support_loc	-0.021		-0.023
	(0.116)		(0.088)
mediumlarge		0.783***	
		(0.024)	
manmedhigh		0.550***	
		(0.025)	
manmedlow		0.183***	
		(0.022)	
amills			-0.398***
			(0.065)
linexpemp			0.026**
			(0.011)
Observations	20,186	20,186	5,075
ll	-20274	-20274	-3465

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The panel version of the endogenous support model confirms that receiving public support was conducive to innovation, even if possible selectivity of government intervention is controlled for (Table 33). The only result different from the cross-section model, in terms of statistical significance, is the insignificant coefficient of the *manmedlow* variable.

Table 33. Endogenous panel model (Poland)

VARIABLES	(1) sup_ino	(2) radical_in
U2008	-2.000***	-0.737***
	(0.037)	(0.048)
U2010	-2.100***	-0.835***
	(0.038)	(0.051)
medium	0.530***	0.138***
	(0.036)	(0.033)
large	0.710***	0.493***
	(0.044)	(0.042)
manhigh	0.445***	0.434***
	(0.067)	(0.057)
manmedhigh	0.348***	0.330***
	(0.034)	(0.030)
manmedlow	0.225***	0.039
	(0.031)	(0.028)
export		0.233***
		(0.030)
group		0.214***
		(0.030)
sup_mills		0.569***
		(0.018)
Observations	20,186	20,186
r2	.	.
ll	-5044	-6896
nocons	.	.

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The second major extension in the Polish part is the assessment of the relative importance of public aid aimed at supporting different innovation activities. To address this issue we estimate another model with endogenous support. This time, however, we do not estimate the probability of receiving just *any* kind of public aid. Instead we estimate a multinomial logit model with three possible outcomes:

1. Firm receives support for human resources development or capital upgrading but not for R&D
2. Firm receives support for RD but not for the other two goals
3. Firm does not receive support for these sources

We exclude from the analysis firms that benefited from R&D *and* any of the other schemes (0.9% of the sample) which is a convenient, if non-eligible, simplification. While estimating the multinomial logit, we take group 1 as base category. This is important in the next step of the analysis, wherein we estimate the probability of introducing a radical product innovation.

Here we include in the analysis the inverse Mills ratios of the logit model, *mills_RD and mills_nosupp*[14], the IMRs responsible for options (2) and (3) in the above list respectively.

The results of the estimation in Table 34 make it evident that various kinds of support have a dissimilar influence. The positive and significant coefficient for *mills_RD* indicates that grants dedicated to covering the R&D expenditure of firms are more likely to introduce radical product innovations than aiding firms in buying equipment or training staff. Equally important, the latter kind of help did not prove to be superior to no-support (coefficient for *mills_nosupp* insignificant). This result is extremely important given the huge role played by this kind of government support in the Polish innovation system (cf. Section 3). It is important to note, finally, that the negative coefficients in column (1) are consistent with our previous findings that firms from technologically more advanced industries are more likely to obtain public support for innovation.

Table 34. Multinomial logit of the kind of innovation support (base category: support for investment in equipment or human resources upgrade)

VARIABLES	(1) Kind of support = no support	(2) Kind of support = R&D	(3) radical_in
export			0.343***
			(0.0438)
group			0.340***
			(0.0387)
mills_nosupp			-0.125
			(0.522)
mills_RD			0.138***
			(0.0349)
mediumlarge	-1.072***	0.909**	
	(0.148)	(0.394)	
manmedhigh	-0.298**	1.206***	
	(0.134)	(0.242)	
manmedlow	-0.290**	0.507**	
	(0.116)	(0.237)	
Constant	4.182***	-2.516***	-0.107
	(0.146)	(0.409)	(0.525)
Observations	9,767	9,767	9,767
Ll	-2149	-2149	-3335

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

[14] While exact formulae are not reported, they are available from authors upon request.

5. Conclusions and policy implications

In this study, we offer a comparative analysis of the policies aimed at enhancing the innovation performance of firms in Turkey and Poland. Both institutional and quantitative analysis was conducted.

A detailed discussion of innovation support systems revealed considerable differences between the two countries. In Turkey, one can observe the growing popularity and the generous practices of public incentives in industrial R&D and innovation, in addition to the recent trends in public policies that support technological entrepreneurship and the commercialization of research output. Since 2004, the significant changes and improvements that have taken place in Turkey concerning science and technology policy schemes have actually influenced the national innovation system in a number of ways, including an important increase in public support provided to private R&D, the diversification of direct support programmes for private R&D and innovation (which was tailored to the needs of potential innovators), the widening of the scope of existing fiscal incentives for private R&D activities and the implementation of new ones, and the implementation of new call-based grant programmes targeted at technology areas and industries based on national priorities.

In contrast, in Poland, science, technology and innovation (STI) policy has been seen as less important than other reforms during economic transition. The STI policy has lacked funding, co-ordination and vision. The institutional architecture has been changing, implying a lack of continuity and a short institutional memory. A major breakthrough occurred after 2004 when considerable funds for innovation were released from the EU structural funds. However out of the three principle areas of support, the creation of technologies, technology absorption, and indirect support, the absorption of technologies by investing in new machinery and equipment has been allocated the most funds. This stands in sharp contrast to Turkey, where government support for innovation is focused on R&D and the development of truly new product and production processes.

To assess the efficiency of public support, the same econometric methodology has been applied to the Turkish and Polish 2008-2010 editions of the Community Innovation Survey for manufacturing firms. Two models were estimated: one following the now classical CDM model and assessing the role of innovation spending, but assuming government support to be exogenous and another controlling for the endogeneity of support but assuming a simplified version of the innovation performance equation. Depending on data availability, extensions of the analysis for both countries were offered: For Turkey, the estimation of a full-fledged CDM model both for manufacturing and services firms and for Poland the analysis of panel data for 2006-2010 and an assessment of the efficiency of specific kinds of public support.

The evidence indicates that government support seems to contribute to higher innovation spending by firms (*input additionality*) and this in turn seems to improve their chances to introduce product innovations (*output additionality*). The positive impact remains valid even when a possibly non-random selection of firms for government support programmes is controlled for. The extended analysis for Turkey proved there is a positive relationship between innovation and firm productivity.

On the other hand, substantial differences between various kinds of public aid were identified. In particular, the support from local government proved inefficient or less efficient than the support from central government or the European Union. Moreover, in Poland, grants for investment in new machinery and equipment and human resources upgrading proved to contribute significantly less to innovation performance than support for R&D activities in firms.

Several recommendations both for policy and for further research can be formulated. In Turkey, while the general assessment of innovation support policy is positive, the puzzling element is the that the EU-related support (mainly from the 7th Framework Programme) was a significant incentive to increase firms' innovation activities, despite constituting less than 2% of the total public support in Turkey. Since in Turkey all the EU supported R&D projects are based on international collaboration, only 1.5 % of R&D and innovation projects that are supported by national programs are collaborative. Therefore, existing mechanisms should be strengthened and new policy instruments should be developed both for universities and the private sector. Further research is necessary to investigate the success of EU-funded programmes on the one hand and the apparent failure of the schemes organized on the local (subnational) level, on the other.

While public support for innovation seems to be generally successful in Poland too, the results from our study indicate that this policy could be designed more efficiently. In particular, the support schemes for investments in new machinery and equipment and human resources development (which constitute a majority of the EU-funded programmes and hence of innovation policy in Poland) proved less efficient than measures aimed at supporting R&D activities and the development of truly new products and technologies. Therefore, a revision of this part of Poland's science, technology and innovation policy is recommended, especially now, in view of the new Financial Perspective of the European Union. Moreover, just as in Turkey, supported provided by local government proved inefficient, suggesting a need for a more in-depth assessment and possible policy change.

Table 35. Summary of results

Research questions	Methodology applied in the current study	Main literature	Results for Turkey	Results for Poland	Conclusions and policy implications
Does government support provide input additionality?	Estimation of different versions of a CDM model aimed at testing for input and output additionality of innovation support Panel data analysis for Poland	(Aerts, Czarnitzki 2004; Lööf 2005),(Özçelik, Taymaz 2008), (OECD 2009)	Input additionality confirmed for innovation support in general, government and EU-based support. Output additionality confirmed for innovation support in general and local support.	Input additionality confirmed for all kinds of support except support from local government. Output additionality confirmed only for support from the national government	Turkey: increase in the volume of innovation support and in the number of instruments used. Findings in this study point to the effectiveness of these instruments in Turkey. This finding should be verified by using panel data and appropriate econometric techniques. Poland: see next row.
Is it efficient in triggering innovation?	CDM model Endogenous support model Panel data analysis for Poland	(Mohnen, Therrien 2002), (Cerulli 2008), (Ebersberger 2005)), {Ali-Yrkkö 2004 #55, (Lach et al. 2008), (González, Pazó 2008), (Czarnitzki, Lopes-Bento 2013), (Aerts, Schmidt 2008)	Confirmed both under the exogeneity assumption of innovation support, and when controlling for endogeneity of support.	Confirmed under the exogeneity assumption of innovation support (but only via increased expenditure), and when controlling for endogeneity of support.	Poland: moderately positive assessment of the EU-funded innovation policy, however serious reservations to grants for new equipment.
Does it contribute to productivity?	Cross section data not appropriate for answering this question	(Levy, Terleckyj 1983), (Klette, Møen 1999), De Negri, Lemos and De Negri (2006),	Not tested for Turkey but this effect is extremely hard to detect on cross-section data	N/A	-
Are all kinds of support equally efficient?	CDM models For Poland a version of endogenous	(Lhuillery 2005), (Mohnen, Lokshin 2009), (Negri 2006)	No. Only innovation support originating from central government and EU-based funds are	No. Substantial differences between public support for R&D activities and for	Ineffectiveness of local support to innovation should be investigated. Turkey: reasons for the

Research questions	Methodology applied in the current study	Main literature	Results for Turkey	Results for Poland	Conclusions and policy implications
	support model with mul		effective.	investment and HR development (the latter significantly less effective)	effectiveness of EU support – used by a low percentage of firms – should be examined. Poland: a redesign of EU-funded innovation policy seems necessary

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