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# Innovation policy and performance of Eastern European Countries

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## Abstract

This paper shows that EU and national innovation subsidy policies stimulated Central and Eastern Europe Countries (CEEC) productivity in the years after their entry to the EU. However, the average effectiveness of national funding was higher for the Western control group countries than for the CEEC sample. EU innovation subsidies partly compensated the CEEC for the greater innovation effectiveness and impact of western economies. Although they crowded out innovation projects or funding of local governments at the country level, the subsidies crowded in national and local projects at the firm level. Local/regional state innovation aid to enterprises encouraged no increase in labour productivity in all but one of sample CEEC countries. These impacts are assessed in a sequential structural econometric model estimated using Eurostat's collection of Community Innovation Surveys covering the years 2006-2014.

JEL Codes: L53 L21 H71 H25

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## 1 Introduction[1]

In 2005 Central and Eastern Europe Countries (CEEC), plus Cyprus, became members of the EU[2]. These countries' reorientation away from central planning towards market innovation-supporting policies presented them with special challenges, as the European Commission recognised (Kornai, 2010; Holscher et al., 2017; EC, 2003). The CEEC inherited structural weaknesses of their innovation systems and any beneficial legacy effects of central planning disappeared in the years leading up to the global financial crisis (Piech and Radosevic, 2006, p47; Carlin et al., 2013; Surubaru, 2021).

In compensation, the EU's early stimulus to innovation in CEECs has been judged highly positive, reorienting economic policies generally towards more sustainable growth (Suurna and Kattel, 2010). However, initiatives also supposedly exposed problems for innovation—inadequate networking, together with weak administrative capacity, coordination and cooperation. By 2016-17 none of the CEEC had developed system oriented innovation policy evaluation practices (Borrás and Laatsit, 2019). But there was a wide variety of experience among transition economies, some represented as successful 'transitioners' of North and Central Europe, others as the 'laggards' of South Eastern Europe (Uberti, 2018).

This paper assesses the productivity impact of enterprise innovation subsidies from the EU, national and local governments on some of the new EU members, both at the firm and the economy level. Economy-wide effects depend not only on firm level effects but also on how many national firms are subsidised. We compare CEEC performance to selected longer established Western economies of the EU with Eurostat's collection of Community Innovation Surveys covering the years 2006-2014. We quantify the extent to which public money for innovation has given rise to effective innovation by modelling the process, from the decision to subsidise research activities to the use of the resulting innovation in productive activities. The model structure realistically recognises that it is not innovation input (R&D) but innovation output that boosts enterprise productivity.

Previous research with this type of model has not usually linked innovation subsidy with the final outcome (Griffith et al., 2006; Hashi and Stojcic, 2013; Tevdovski et al., 2017). Researchers typically evaluate the impact of policy on innovation expenditure without integrating this finding with the influence of the innovation spending on productivity at the firm level. We

[1] The anonymised data used in the analysis of this paper were obtained on CDROM from Eurostat as part of the research proposal 'European National Innovation Systems'. The results and the conclusions are those of the authors. They represent their opinion and not necessarily those of Eurostat, the European Commission or any of the statistical authorities whose data have been used. We thank Serena Trucchi and Howard Gospel for helpful comments on an earlier draft,

[2] On 1 May 2004 Estonia, Latvia, Lithuania, Czech Republic, Slovakia, Poland, Hungary, and Slovenia entered the EU. On the same date Cyprus became a full EU Member State. Romania and Bulgaria joined the EU on 1 January 2007.

quantify the cumulative impact on the sample countries of subsidies on firms' labour productivity over 2006-2014.

We find that EU funded marginal effects on productivity were on average greater for new members than for the old members' control group, which can be attributed to proportionately greater resources allocated to the East[3]. This was so for both firm-level and economy-wide effects. But central and local government funded policy innovation marginal effects were generally larger for old members. Lithuania and Slovakia were extreme cases of firm-level large EU marginal effects and small central or national government policy impacts. Given the administrative and other resources of the new members, the pattern is consistent with EU funded innovation initiatives crowding out locally supported innovation at the country level. By contrast at the enterprise level EU innovation projects encouraged the awarding of national and local innovation funding.

Our estimates show considerable heterogeneity among the 2005 new members' innovation policy effectiveness that does not permit a clear division between flagging economies in the South and successful 'transitioners' in the North. The Czech Republic and Romania implemented the two most effective new member national innovation firm-level policies. These were more effective than national innovation policy effectiveness of Portugal, one of the older member sample countries, though this was not true for the economy-wide impact. In extensions we show that our baseline estimates of innovation policy marginal effects are credible because they are higher than obtained with less complete innovation specifications but lower than provided by a model version ignoring feedback.

The paper contributes to the transition innovation policy literature by quantifying the impact of innovation subsidies on formerly centrally planned economies. It identifies more recent persistent subsidy-induced innovation performance differences between East and West Europe. The research employs a common framework for eleven countries. Using firm-level data allows the appropriate identification of key firm-level relations.

The following section 1 briefly surveys key concepts, data sources and some of the previous model-based research on innovation support in Eastern Europe. Section 2 discusses our model, section 3 describes the data and the estimation procedures, section 4 presents the results, section 5 offers some extensions and section 6 concludes.

[3] For the period 2007-2015 EU funds allocated to the eleven CEEC averaged 14.8% of GDP and 1848 EUR per capita. KPMG (2016) p10.

## 2 Background

Innovation policy is intended to stimulate productive innovations, but some innovations can be harmful, some beneficial, and others may be of only minor use. How do we measure the value of the average innovation? One approach is to use patents as a proxy for the value of innovations (Griliches, 1990). But in services and for small firms, patents are rarely used so that this indicator will understate innovation in these sectors (Jaumotte and Pain, 2005, p25). Another method has been to identify and count 'significant' innovations (Tether et al., 1997). However, there is no obvious way of comparing the relative importance of the innovations and therefore the count measure of innovation output may be misleading. Increasingly common is the measurement of innovation by asking firms about their behaviour. For instance, the Community Innovation Survey (CIS) of enterprises offers self-assessed innovation indices—primarily binary measures of process and product innovation—though these in themselves provide no indication of value or effect. The impact of an innovation depends on how widely it is spread, within an enterprise as well as without. CIS also supplies an enterprise level measure of the diffusion of innovation—the (self-assessed) proportion of new product revenue in total sales.

Many innovation measures are included in the EU's European Innovation Scoreboard (EIS)[4]. The EIS measurement framework distinguished in 2020 between four main types of activities, capturing ten innovation dimensions and using in total 27 different indicators. The resulting EIS innovation index is the unweighted average of normalised scores for all these indicators[5]. The appropriateness of some of the indicators is questionable when used in this way. For instance, proportion of employment in high tech industries might be a misleading indicator where one country has a larger proportion of less efficient workers in these industries than another country. In view of the finding that CEE countries had lower levels of productivity than might be expected given their research and development (R&D), innovation and production capabilities (Kravtsova and Radosevic, 2012), simple aggregation of inputs and outputs for innovation indices could be misleading.

Linking the innovation measure at the enterprise level to enterprise performance is the most appropriate measure of the value or impact of innovations. The CIS definition of innovations does not require them to be profitable or accepted by the market; quality enhancement or cost reduction could come at the expense of each other, change can be damaging. So, in principle it is possible that innovations, as measured, impact adversely on business performance.

[4] https://ec.europa.eu/commission/presscorner/detail/en/QANDA_20_1150

[5] For the calculation of normalised scores, first the lowest value of an indicator across all countries and all years is deducted from the value in a specific year for each country. This re-calculated value is then divided by the difference between the highest and lowest value across all countries and all years.

In a multi-equation context, evaluations of subsidies are sometimes only partial; they only measure the policy impact on an intermediate variable such as R&D or innovation. An innovation policy may be fully additional at one stage but totally ineffective if later stages lack additionality. A full evaluation assesses the ultimate consequences of the policy intervention for the policy objective, be it employment, output or productivity. The multi-equation approach is more convincing in the sense that it attempts to identify structural parameters of the innovation process. But it renders more challenging the assessment of policy statistical significance (which we address in this paper).

The EU's Community Innovation Surveys (CIS) has been the most widely used firm level data source for innovation effectiveness and related studies for groups of countries (Mairesse and Mohnen, 2010). The CIS data consists of enterprises employing over 10 persons in a survey of the innovation activities of enterprises across Europe. The survey is undertaken by national statistical authorities using a harmonised questionnaire developed by Eurostat to ensure comparability across countries. Comparative studies including the CEEC are rarer than single country analyses or comparisons of western European economies. More recently Orbis, an alternative business data base has been used for cross-country firm-level analysis ((Bureau van Dijk, Bachtrögler and Hammer, 2018). The firm-level Business Environment and Enterprise Performance Survey (BEEPS), a joint initiative of the European Bank for Reconstruction and Development and the World Bank, does not cover the wealthier economies of the EU and so cannot be used for the comparisons possible with CIS and Orbis.

More aggregated data sets have recently been employed such as Tunali et al. (2015) using a panel data set covering 27 European Union countries over the period 1992-2011, to estimate macroeconomic effects of industrial policy for these countries on economic growth and investment. Their results suggest that state aid policy is not an effective tool to achieve higher economic growth and investment rates. But possibly this result could be a consequence of the high level of aggregation of the data. Alternatively, as maintained in another NUTS2 aggregated study (Rodriguez-Pose and Ketterer, 2020) without explicit policy variables, it was government quality that mattered for European regional growth. However, not all state aid can be classified as support for innovation and merely because aid is classified as say 'regional' it cannot be assumed that none subsidised innovation. Lithuania in 2008 recorded spending no state aid on R&D but 73 percent on regional development, (of a total amounting to 0.82 percent of GDP) Yet 13 percent of Lithuanian CIS respondents recorded goods product innovation.

Especially for users of the CIS the CDM model has been very influential (Crépon, et al., 1998; Loof et al., 2017). The CDM framework introduced a structural model that explains productivity by innovation output and innovation output by research investment. It indicated a method of correcting for the endogeneity inherent in the model. Janz et al. (2003) explored the comparability and pooling of CIS data sets between Germany and Sweden. Using a slightly modified CDM model to examine the innovation- productivity link they found that innovation strongly affected productivity and that knowledge intensive manufacturing firms were rather similar in the two countries. Griffith et al. (2006) compared innovation in France, Germany, Spain and the UK also with the CDM model. They concluded that the drivers of innovation and productivity were similar across these four countries, and government funding was important in all countries.

There have been many studies of the contribution of public funding to innovation in the EU but CEEC studies and comparisons are still in a minority[6]. For Eastern Europe, Masso and Vahter (2008) found a positive effect of government funding on innovation expenditure and inferred that the funds had been used efficiently in Estonia. Like our paper, Hashi and Stojcic (2013) compare firm level determinants of the innovation process in mature market economies of Western Europe and in the transition economies from Central and Eastern Europe that recently joined the EU. But they aggregate countries between CEEC and Western European blocs and use the Community Innovation Survey for 2006-8, in contrast to our country level analysis and later sample. They highlight the role of national and EU subsidies facilitating the transformation of innovation input into innovation output, but not into the final productivity stage. Their local subsidies variable has a significant negative sign with the old EU sample and is statistically insignificant for the new EU countries. The authors suggest this result may reflect local decisions targeting political objectives.

Tevdovski et al. (2017) found no impact of any public innovation funding on Romanian companies' R&D intensity. For Bulgaria, there was very little effect of national funding on R&D intensity, EU funding had no impact and local funding had a slightly negative influence. Using an Orbis data set Bachtrögler and Hammer (2018) detected that firm-level innovation and RTD and other EU business projects contributed to the additional positive impact of financial assistance in some cases but not others. Net job creation in Portugal gained, along with the growth of the capital stock in the Czech Republic, Spain, Italy and Portugal. Nevertheless, innovation and business projects were correlated with negative TFP growth in policy-supported firms in the Czech Republic and Spain. Also using Orbis, Fattorini et al. (2020) evaluating the impact of ERDF spending on productivity across EU Nuts 2 areas, found more targeted support for product and process innovation under RTD funding was significantly associated with an increase in Total Factor Productivity. The impact was higher for the least productive firms in the first quartile of the TFP distribution. Utilising the 2009 BEEPS, Mateut (2018) established a positive relation between public subsidies and the innovative activities of many firms in 30 Eastern Europe and Central Asian countries. The stronger positive association found for

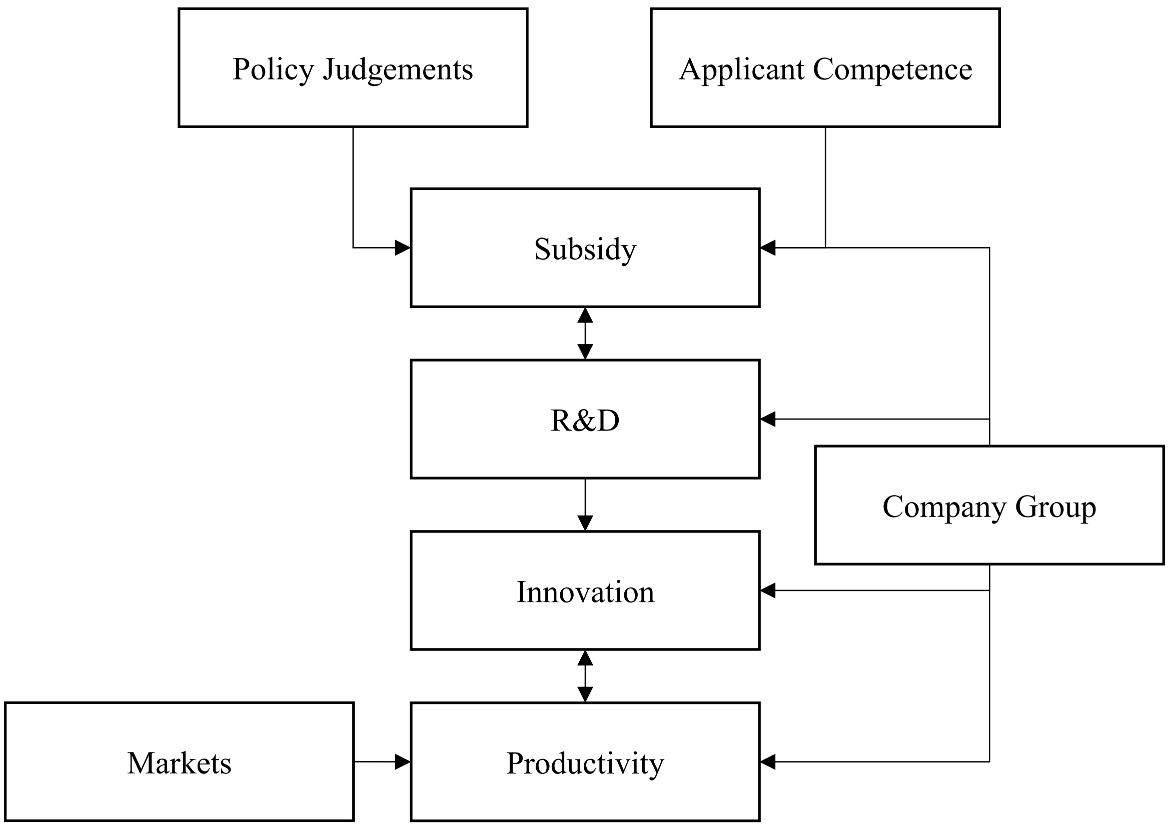
[6] The final list of studies discussed by Dvouletý et al (2020) included nine of CEEC out of a total of 30.

enterprises more likely to be financially constrained provides support for the EU market failure justification for state intervention (although none of the EU's wealthiest economies could be covered in the study).

## 3 Model

Governments attempt to subsidise innovating firms believing that there are substantial benefits to society. Firms invest in research to develop innovations that in turn may contribute to their economic performance. The achievements of innovation policy are the extent to which subsidies boost performance. This process, as modelled, is summarised in Figure 1.

Figure 1 Simplified Representation of the Enterprise Innovation Subsidy Model




The state innovation aid or subsidy measure in our model is the binary response to the CIS question 'During the three years …. did your enterprise receive any public financial support for innovation activities from … levels of government?' (CIS 2008 q5.3) The three sources of subsidy funding that we can measure are the EU[7], national government and local government. Funding allocators might assume some industries have greater innovative potential than other

[7] The CIS also distinguishes participation in the EU RTD programme. We aggregate this with all other EU programmes, even though a substantial number of German firms in the sample admitted to participation in the RTD programme but not to funding by the EU.

or that some types of firms face greater handicaps. Regardless of what officials think, some types of firms might be more capable of completing formal funding applications. In any of these cases funding would be selectively allocated, not randomly as econometric modelling requires. This implies that firms successful at being awarded one type of grant are more likely to be awarded another type of grant. We therefore would expect to see EU funding crowding in innovation projects financed by other means. To capture this process we estimate a probit equation explaining innovation subsidies with strictly exogenous variables such as industry, market and size. If the selection equation is statistically significant and plausible then the hypothesis of endogeneity is not rejected.

Subsidies may encourage firms to increase the effort they put into innovation; state innovation aid influences whether firms undertake intra-mural R&D. The R&D measure in our model is the same binary variable used by Harris et al (2020) from the 2012 CIS in estimating the effect of absorptive capacity on innovative potential. The measure is defined broadly as 'Creative work undertaken within [the] enterprise to increase the stock of knowledge for developing new and improved products and processes (include software development in-house that meets this requirement'. We do not attempt to model the intensity with which the firm undertakes R&D but we do need to estimate endogeneity bias affecting R&D (Dimos and Pugh, 2016). We do not restrict the modelling to manufacturing enterprise as does some of the previous literature (Crepon et al., 1998; Griffith et al., 2006).

The output of this innovation effort is knowledge that leads to innovation. Innovations here are broadly defined as new or improved goods or services or production methods or delivery or supporting activities. For any sample the coefficient on the innovation index in principle might be negative, zero or positive depending on average innovative success.

Innovation feeds into the firms' production function, potentially raising sales per employee (our proxy for labour productivity), in logs. A possible complication is the endogeneity of the innovation index. More productive firms may be more innovative. We control for this endogeneity with the inclusion of an Inverse Mills Ratio derived from the innovation equation.

The proximity, nature and size of the market is likely to influence productivity on the demand side. In our model we attempt to control for the major European macroeconomic shocks—the 2008 financial crisis and the 2010 debt crisis—to isolate an average policy effect. The economies in the sample are very heterogeneous, so it is important to distinguish individual country effects. The Czech Republic had almost three times Bulgaria's GDP per capita and Cypriot GDP per head was higher than Portugal's in 2014. The Czech Republic GDP per capita was only about 6 percent less than Portugal's. However, the poorer economies tended to expand; the post-communist economies were converging more rapidly than other European countries to German levels of GDP per capita (Zoega and Phelps, 2019).

On the supply side, subsidiary or enterprise group member enterprises may benefit from the R&D and marketing of a larger group of which they are a member, boosting their innovation, R&D and productivity. We allow all innovation subsidy coefficients to vary across countries and country intercepts to differ, but otherwise we impose a common model for the eleven sample countries. In all equations we control for unobserved industry characteristics. We also control for firm size in all equations.

## 3. Data and Estimation

The model is estimated with GSEM on four pooled Community Innovation Surveys covering three-year periods ending in 2008, 2010, 2012 and 2014[8], including eleven countries. Among the 'new arrivals' these are Estonia, Lithuania, Czech Republic, Slovakia, Hungary, Cyprus, Romania and Bulgaria. The Western reference group is Germany, Spain and Portugal.

Table 1 Descriptive statistics for model variables 2006-2014

| **Variables** | **Old** | **New** | **Total** |
|---|---|---|---|
| R&D internal (rrdin2) | 0.2532 | 0.1016 | 0.1805 |
| Innovation (inn) | 0.3995 | 0.2375 | 0.3218 |
| Process Innovation | 0.2016 | 0.1219 | 0.1634 |
| Product Innovation | 0.2119 | 0.1271 | 0.1712 |
| % of turnover from product inn (turnmar) | 0.036 | 0.0218 | 0.0292 |
| log Labour productivity | 11.3396 | 10.3876 | 10.8842 |
| EU funding inc. RTD (xfunrtd) | 0.0324 | 0.0392 | 0.0356 |
| National government funding (xfungmt) | 0.1005 | 0.0379 | 0.0705 |
| Regional government funding (xfunloc) | 0.078 | 0.0065 | 0.0437 |
| Enterprise group member (gp) | 0.3042 | 0.2337 | 0.2704 |
| 10-49 employees | 0.6012 | 0.6015 | 0.6013 |
| 50-249 employees | 0.284 | 0.3035 | 0.2933 |
| 250+ employees | 0.1148 | 0.0951 | 0.1053 |
| Sales to other European markets (mareur) | 0.4438 | 0.4513 | 0.4474 |
| Sales to national market (marnat) | 0.7511 | 0.6535 | 0.7041 |
| Sales to local/regional markets (marloc) | 0.9013 | 0.7327 | 0.82 |

Source: Eurostat CIS. Note: German data for 2010 multiplied up for consistency with other years. 'New' refers to the group Estonia, Lithuania, Czech Republic, Slovakia, Hungary, Cyprus, Romania and Bulgaria. 'Old' refers to Germany, Spain, and Portugal.

In addition to providing the necessary data on subsidies and R&D, information on enterprise employments size, whether the enterprise is part of a wider group, industry, proportion of turnover from new products and on principal markets, are utilised. Descriptive statistics of the data

[8] We cannot use for example the approach of Roper et al (2017) to create a pseudo-panel from the CIS surveys. Not all EU countries make their disaggregated CIS data available to Eurostat. Each survey covers three years.

divided between western members, ‘Old’, and CEEC plus Cyprus, ‘New’, are in Table **Error! Reference source not found.**1. The chances of an enterprise engaging in R&D or innovation are considerably lower for those in the New countries. Labour productivity is also lower but the chances of receiving EU innovation funding slightly higher. This contrasts with New members’ lower chances of central government and local government innovation funding. Firms employing more than 250 are less likely to be in the New members economies, as are members of a larger corporate group.

Labour productivity is calculated following Tedvovski et al (2017). For the innovation variable of the baseline model (‘inn’) any one of the five categories of innovation available in the CIS is sufficient to achieve a positive score. For the sensitivity tests of the model, the novel turnover variable is the answers to the question ‘Please give the percentage of your total turnover in [last year] from new or significantly improved goods and services introduced during [years of CIS] that were new to your market.’ From necessity to achieve consistent data over all country and period surveys, we utilize a small number of variables compared with many CIS studies, but we have detailed industry (24) and country (11) breakdowns.

In the recursive structure, our model is similar to the classic CDM model (Crépon et al., 1998; Loof et al., 2017**)**. But we utilise the control function approach exclusively to correct for endogeneity[9]. We allow for possible selection of innovative firms for funding by policy makers according to previously earned reputation or application skill. We fit a probit selection equation for funding (S). If $S_i^*$ is an unobserved decision variable for whether a firm $i$ receives state aid and $R_i^*$ the unobserved firm’s investment in R&D, with $S_i$ and $R_i$ being their observable counterparts, the first two stages can be represented as follows:

$$\Pr(S_i = 1) = \Phi(S_i^*), \text{ where } S_i^* = \boldsymbol{\beta}_0'\mathbf{x}_{0i} + u_{0i} \text{ and } \Phi(\cdot) \text{ is the normal CDF.} \quad [1]$$

$$\Pr(R_i = 1) = \Phi(R_i^*), \text{ where } R_i^* = \alpha_S S_i + \boldsymbol{\beta}_1'\mathbf{x}_{1i} + u_{1i}. \quad [2]$$

In [1] and [2] $\mathbf{x}_{0i}$, $\mathbf{x}_{1i}$, $\boldsymbol{\beta}_0$, $\boldsymbol{\beta}_1$ are vectors of independent variables and their corresponding parameters. They reflect the impact of influences on firms’ decisions to receive and be awarded state aid and on the actual probability of undertaking R&D. $\alpha_S$ is a state aid effect parameter. $u_{0i}$ and $u_{1i}$ are random error terms with zero mean, constant variances and not correlated with the explanatory variables. Specifically, $\mathbf{x}_{1i}$ includes among others an Inverse Mills Ratio (IMR1 which is a function of $S_i^*$) predicted from equation [1] to correct for endogeneity bias.

[9] For example, Heckman and Robb (1985). Previous literature uses a combination of both instrumenting and control functions -Heckman for the R&D intensity stage and IV for productivity stage. The control function is especially appropriate here because it is suitable for non-invertible models (such as discrete choice models) and allows for heterogeneous effects.

Wooldridge (2002 p568) shows that inclusion of the IMR in these circumstances controls for endogeneity.

The binary R&D equation has explanatory variables including 24 industry categories, employment size (larger firms are more likely to engage in R&D, according to Cohen and Klepper's (1996) stylised facts), government and EU support, CIS year, whether part of an enterprise group and 11 countries. The selection equation [1] for policy uses similar variables to those of the R&D equation [2] (see Table3).

The R&D outcome of equation [2] feeds into the innovation output equation [3] that explains whether the firm innovates. We do not restrict the sample to non-zero R&D performers because lags or high R&D reporting thresholds may explain positive innovation sales despite the absence of recorded R&D for some firms. Equation 3 includes other explanatory variables: industry, country, size, and whether part of an enterprise group[10]. This third stage of the estimation is represented by:

$$\Pr(N_i = 1) = \Phi(N_i^*), \text{ where } N_i^* = \alpha_R R_i + \boldsymbol{\beta}_2 \mathbf{x}_{2i} + u_{2i} \qquad [3]$$

where $N_i$ represents the observed innovating and non-innovating enterprises, $R_i$ is R&D from equation [2] and $\alpha_R$ its corresponding parameter, $\mathbf{x}_{2i}$ is the vector of other explanatory variables. $\boldsymbol{\beta}_2$ is the vector of corresponding unknown parameters while $u_{2i}$ is the random error term with mean zero and constant variance, not correlated with explanatory variables.

The final equation explains the labour productivity of the firm (performance) by whether it is innovative, by their country, market, size and whether part of an enterprise group.

$$Q_i = \alpha_N N_i + \boldsymbol{\beta}_3 \mathbf{x}_{3i} + u_{3i} \qquad [4]$$

where $Q_i$ is labour productivity, $N_i$ is actual values of innovation from the knowledge production function equation [3], $x_{3i}$ is a vector of other determinants of labour productivity including an Inverse Mills Ratio derived from [3][11], $a_N$ and $\beta_3$ are associated coefficient vectors, and $u_{3i}$ is a random error. Therefore, the effect of state aid on the turnover growth can be written as a partial derivative using the chain rule:

[10] State funding to boost innovation is likely also to raise R&D. So, including the funding in both stages would be double counting.

[11] By the same control function logic as for the IMR in the R&D equation [2].

$$\frac{\partial Q_i}{\partial S_i} \approx \frac{\partial Q_i}{\partial N_i} \times \frac{1}{N}\sum_{i=1}^{N}[\Pr(N_i = 1|R_i = 1) - \Pr(N_i = 1|R_i = 0)] \times \frac{1}{N}\sum_{i=1}^{N}[\Pr(R_i = 1|S_i = 1) - \Pr(R_i = 1|S_i = 0)] \quad [5]$$

In the baseline model equations [1]-[3] are probits and equation [4] is a linear regression.

The model provides measures of policy effectiveness that can be compared between CEEC and the Western sample countries. The coefficient size of this measure could reflect either, or all, of the efficiency with which the innovation funding is used, the amount, or the type, of funding given to each firm. The country level impact also depends on the proportion of enterprises in the country receiving support and the timing of that support.

## 4 Results

In Table 2 we give parameters of the core model run with data for 2006-14 and with selection for funding, feedback from R&D to the subsidy process and feedback from productivity to innovation. A change in funding will first affect the dependent variable of the R&D equation [2] (rrdin), will then be transmitted to the innovation equation and finally to the productivity equation. This effect takes place over the CIS period of up to three years. The coefficients linking the equations and capturing this transmission are highly significant (top section Table 2). The Inverse Mills Ratios to control for selection and feedback were also highly significant.

The year controls show the impact of the financial crisis followed by the debt crisis; innovation subsidy chances increased but the chances of undertaking R&D were reduced in the period after 2010 compared to 2008 and fell strongly to 2014. Innovation chances were markedly reduced after 2008 and so was labour productivity. Like Biagi et al. (2016) we found that firms in the ICT sector tend to innovate more than those in other sectors, (we include electronic and electric manufactures in ICT along with telecoms and programming). In our case we identified this precocity from the industry contribution to R&D chances (Appendix).

The size coefficients indicate that larger firms were more likely to receive innovation subsidies and to undertake R&D. They also show that larger firms (over 250 employees) were generally more productive and, across the whole range above 49 employees, more likely to innovate. Membership of an enterprise group boosted all three dependent variables. Enterprises selling to a local market were less productive than those selling nationally and even less productive than those selling in other EU economies (the base case was 'markets other'). International sales may measure the firm's exposure to international competition which might boosts productivity. Because the three funding effects interact with the 11 country effects across three equations to generate the reduced form coefficients of Table 3, in the interest of clarity we do not report all these policy structural parameters in Table 2.

Table 2. Baseline estimation results of the model

| | (1) Funding | (2) R&D | (3) Inn. | (4) Prod. |
|---|---|---|---|---|
| Funding: EU | | 0.4374*** | | |
| Funding: Central Gov | | 1.2909*** | | |
| Funding: Local Gov | | 0.22 | | |
| (1) R&D | | | 1.6650*** | |
| (2) Innovation (Inn.) | | | | 0.1651*** |
| Inverse Mills ratio | | 0.8322*** | | -0.1236*** |
| Part of enterprise group | 0.1093*** | 0.3424*** | 0.1715*** | 0.7055*** |
| Size 50-249 | 0.2273*** | 0.3733*** | 0.2508*** | -0.3214*** |
| Size 250+ | 0.4494*** | 0.8777*** | 0.3723*** | 0.7728*** |
| Period ending 2010 | 0.0436*** | 0.0605*** | -0.0409*** | -0.0440*** |
| Period ending 2012 | 0.0066 | -0.0600*** | -0.2588*** | 0.0304*** |
| Period ending 2014 | 0.0466*** | -0.0623*** | -0.2810*** | 0.0338*** |
| Sales to other EU or EFTA | | | | 0.4366*** |
| Sales to national market | | | | 0.3167*** |
| Sales to local market | | | | -0.0410*** |
| Industry | yes | yes | yes | yes |
| Country | yes | yes | yes | yes |
| Funding*Country | no | yes | no | no |
| No. of obs. | 356032 | 356032 | 356032 | 356032 |

Note: * p<0.05; ** p<0.01; *** p<0.001. 'Funding' is a selection equation with dependent variable equal to 1 if the firm receives any funding. Bulgaria is the country base case, 'All other countries' is base case for Sales markets. 'Prod' is log of labour productivity. 'Inn' is unity if enterprise records any one of five types of innovation, otherwise zero. Size refers to employees, base case is 10-49.

The three policy coefficients in Table 3 are the effect of funding from local, national and EU sources on labour productivity (of each average firm in each country). All EU, national and local innovation funding responses are significantly greater than zero except for Bulgaria's. The largest EU coefficient, Lithuania's, means that if a Lithuanian firm was innovation funded by EU, then the labour productivity of this enterprise on average would have been 3.6 percent higher than those that did not receive the support over up to three years. The (unweighted average) marginal effect for the CEEC group is 2.32% and while that for the Western three was less, at just over 2 percent, reflecting stronger EU support for the new members.

National funding was more effective for both groups on average, though this not so for Hungary, Lithuania and Slovakia. The average effectiveness of national funding was higher for the Western group than for the CEEC, in contrast to EU funding. This implies that the long-term technological gap based on continuous innovation between West and East is likely to persist unless compensated by EU funding. Alternatively, the high level of EU funding was displacing CEEC national innovation policy effectiveness. We address these possibilities below.

For local funding the coefficients of the CEEC are much smaller. But for the Western economies of Germany, Portugal and Spain they were comparable on average to the EU marginal effects. This may be because a local government in CEEC and Cyprus was typically smaller than in Spain or Germany. Portugal has a similar population size to Hungary and the Czech Republic and its marginal local innovation policy effect is much smaller than those of Spain and Germany. But unlike Hungary, Portugal's local policy effectiveness was statistically significant.

Table 3 Marginal effects of subsidy by funding on productivity at firm level

| | **Membership** | **EU** | **Central Gov** | **Local Gov** |
|---|---|---|---|---|
| BG | New | 0.0025 | 0.0149* | 0.0011 |
| CY | New | 0.0169*** | 0.0171*** | 0.0028** |
| CZ | New | 0.0205*** | 0.0350*** | 0.0101*** |
| EE | New | 0.0319*** | 0.0315*** | -0.000*** |
| HU | New | 0.0309*** | 0.0299*** | 0.0023 |
| LT | New | 0.0361*** | 0.0118** | -0.001* |
| RO | New | 0.0180** | 0.0344*** | 0.0076 |
| SK | New | 0.0288*** | 0.0229** | 0.0009 |
| DE | Old | 0.0249*** | 0.0413*** | 0.0225*** |
| ES | Old | 0.0200*** | 0.0438*** | 0.0298*** |
| PT | Old | 0.0168*** | 0.0329*** | 0.0066*** |
| | **New** | **0.0232** | **0.0247** | **0.0030** |
| | **Old** | **0.0206** | **0.0393** | **0.0196** |

Note: Derived from regressions of Table 2 using expression [5].

All three of the marginal effect rankings are not significantly different from that of the EU Innovation Scoreboard values for 2014[12]. Although the scoreboard indices are constructed with different data and for different purposes, they are measuring the innovation environment which is in key respects similar to our innovation policy concerns. However, our ranking of policy marginal effects does differ in some respects from the Scoreboard's. Romanian innovation policy is always stronger than Bulgaria's in Table 2 but in the 2020 Scoreboard 2012 and 2014 Bulgaria is more innovative than Romania. The Scoreboard has the Czech Republic behind Estonia 2008-2014 whereas our national and local marginal effects place the Czech Republic ahead. In 2019 the Czech Republic GDP per capita was higher than Estonia's and Romania's

[12] Using the 2016 Scoreboard and the Wilcoxon matched-pairs signed-rank test (Wilcoxon, 1945). However, the ranking of the Innovation Scoreboard has a different metric from our marginal effects. We therefore standardise both by Z = (Z-mean(Z))/SD(Z) before applying the test. The null hypothesis is that "The two series are not significantly different from each other in ranks." For EU marginal effects, the p-value of the null is 84.88%. For central government marginal effects, the p-value is 84.66%. For local government marginal effects, the p-value is 90.35%. The first two p-values are the same because the sum ranks of the marginal effects for EU and central are the same.

were greater than Bulgaria's. If innovation effectiveness is a predictor of future GDP per capita then our policy ranking is superior where these economies are concerned.

Table 4 Cumulative marginal effects of innovation funding on productivity at country level

| | Membership | EU | Central Gov | Local Gov |
|---|---|---|---|---|
| BG | New | 0.02% | 0.11% | 0.00% |
| CY | New | 0.20% | 0.73% | 0.02% |
| CZ | New | 0.66% | 1.27% | 0.07% |
| EE | New | 0.70% | 1.00% | 0.00% |
| HU | New | 0.69% | 0.65% | 0.00% |
| LT | New | 1.55% | 0.21% | 0.00% |
| RO | New | 0.10% | 0.18% | 0.02% |
| SK | New | 0.27% | 0.16% | 0.00% |
| DE | Old | 0.59% | 2.15% | 0.70% |
| ES | Old | 0.19% | 1.63% | 1.07% |
| PT | Old | 0.36% | 1.49% | 0.04% |
| | **New** | 0.52% | 0.53% | 0.01% |
| | **Old** | 0.37% | 1.75% | 0.60% |

Note: Table 3 firm-level and period innovation policy effectiveness times proportion subsidised and cumulated.

Table 4 shows the cumulative impact of these innovation subsidies over 2006-2014 on the national economies. It does so by multiplying the policy effectiveness measure by the proportion of enterprises subsidised over each of the four periods of the CIS. The result is a different ranking. Lithuania, with a 1.55 percent increase in labour productivity is by far the top beneficiary of EU innovation funding in our sample. Among the new members the Czech Republic holds this position for central government innovation funding, with 1.27 percent, though this is far behind Germany's impact of 2.15 percent. Local subsidies have minimal impact for new members while Spain is the top performer in the whole sample. Bulgaria shows by far the weakest impact across all three sources of innovation funding, with Romania and Slovakia close behind. In the West, Portugal the weakest of the three, has a larger central government impact than any of the new members. The comparison is the opposite for EU funding: the old members experience a smaller impact than the new. The two possibilities discussed for the firm level effectiveness estimates are also pertinent for the economy wide impact.

## 5 Extensions

We test the robustness of the model and the outputs in ways that show the baseline estimates of policy marginal effects are higher than obtained by less complete innovation specifications but lower than a model version ignoring feedback. Abandoning the two endogeneity corrections has little effect on the structural coefficients except for the innovation variable in the productivity equation, which is increased ('No Selection', Table 5). The overall effect is to boost the size of the innovation policy marginal effect (Table 6). Since the Inverse Mills Ratio coefficients were statistically significant, indicating that there was endogeneity, the baseline marginal effects estimates are more acceptable.

We replace the aggregated innovation variable (Inn) by the proportion of turnover accounted for by innovative products ('Turnmar' Table 5)– following the original CDM model (Crepon et al 1998) and Hashi and Stojcic (2013). This replacement variable captures the extent of diffusion of the product innovation within the firm's product range. However, it is unlikely to be an adequate measure of process innovation as well. As table 6 shows, the implied innovation policy multipliers, as expected, are smaller than the baseline model.

The final model ('Separate' Table 5) modification is to introduce separate variables and equations for product and process innovations (for example following Griffith et al., 2006)[13]. The sum of the product and process innovation coefficients in the productivity equation, 0.2 or 20%, is somewhat higher than the composite innovation coefficient of baseline, 0.16 or 16%. But because of a smaller coverage of innovations, the specification results in lower policy marginal effects (Table 6). The relatively small product innovation coefficient is consistent with the small policy effects of the Turnmar equation model.

Table 5 Selected coefficients for the baseline innovation model and variants

| Dep. Var. | Indep. Var. | Baseline | No Selection | Turnmar | Separate |
|---|---|---|---|---|---|
| R&D | Funding: EU | 0.9360*** | 0.9353*** | 0.9360*** | 0.9360*** |
| | Funding: central gov | 1.1784*** | 1.1764*** | 1.1784*** | 1.1784*** |
| | Funding: local gov | 0.3355*** | 0.3353*** | 0.3355*** | 0.3355*** |
| Inn | R&D | 1.6650*** | 1.6650*** | - | - |
| Process inn | | - | - | - | 1.1267*** |
| Product inn | | - | - | - | 1.4300*** |
| Turnmar | | - | - | 0.0922*** | - |
| Log productivity | Inn | 0.1651*** | 0.2069*** | - | - |
| | Process inn | - | - | - | 0.1351*** |
| | Product inn | - | - | - | 0.0671*** |
| | Turnmar | - | - | 0.0975*** | - |
| | No. of obs. | 356032 | 356032 | 37509 | 356032 |

Note: The coefficients of funding are based on averages of the coefficients of all countries, hence the baseline parameters differ from those of Table 2 which are for Bulgaria (base group) only. ***= p<0.001. The R&D equation is the same for all variants except for the no selection specification. 'Baseline' from Table 2, 'No Selection' abandoning control function terms. 'Turnmar' use proportion of innovative products in turnover as replacement innovation variable, 'Separate' distinguishes separate product and process innovations.

[13] Tevdovski et al. (2017) estimate equations for four binary innovation variables but use only two in the productivity equation.

To summarise, the baseline results still hold: the average innovation policy subsidy generated around a one percent cumulative increase in labour productivity over the years 2006-2014 (country level), old members had more effective central and local government innovation policies than new EU members, EU subsidies to some extent compensated, with greater effectiveness and impact in CEECs than in the Western group.

Table 6 Innovation policy marginal effects on productivity

| Funding | Membership | Baseline | No Selection | Turnmar | Separate |
|---|---|---|---|---|---|
| EU | New | 0.0232 | 0.0289 | 0.0022 | 0.0178 |
| | Old | 0.0206 | 0.0258 | 0.0020 | 0.0169 |
| Central Gov | New | 0.0247 | 0.0307 | 0.0024 | 0.0187 |
| | Old | 0.0393 | 0.0494 | 0.0038 | 0.0318 |
| Local Gov | New | 0.0030 | 0.0036 | 0.0003 | 0.0023 |
| | Old | 0.0196 | 0.0246 | 0.0019 | 0.0154 |

Note: Derived from equations estimated in Table 5.

Crowding out may occur at the country level, where administrative and other resources are largely fixed. But, at the same time, there may be crowding in at the firm level. That is, an enterprise awarded an EU subsidy might have a greater chance of gaining a national subsidy. The correlations between subsidies granted are consistent with this interpretation (Table 7). Using country-level data (average percentages funded for each country each period) shows that EU and local funding are negatively correlated (crowding out), whereas the firm-level correlation coefficients among the three funding sources are all positive and significant (crowding in).

Table 7 Crowding out and in: correlation coefficient matrices at firm and country levels

| | | **EU** | **Central Gov.** | **Local Gov.** |
|---|---|---|---|---|
| **Firm Level** | **EU** | 1 | | |
| | **Central Gov.** | 0.3043* | 1 | |
| | **Local Gov.** | 0.1500* | 0.2581* | 1 |
| **Country Level** | **EU** | 1 | | |
| | **Central Gov.** | 0.2333 | 1 | |
| | **Local Gov.** | -0.3205* | 0.1431 | 1 |

Note: * indicates 5% significance level. A negative coefficient indicates subsidy displacement or crowding out. Positive coefficients indicate crowding in.

## 6 Conclusion

Recognising the importance of innovation for economic development, we have focussed not on explicit policies but on subsidies intended to trigger it. We have estimated innovation subsidy policy effectiveness, at the level of the firm and the economy, for eight members of the

EU that joined in the first decade of the 21st century and for three western European economies. We find effectiveness within each group varied substantially, with the Bulgarian EU subsidy effectiveness being minimal (as Tevdovski et al (2017) also discovered) especially compared with those of Hungarian, Lithuanian and Estonian firms. Hungary's effectiveness contrasts with the Maroshegyi and Nagy (2010) evaluation for an earlier period.

For nationally funded policies, again there was considerable heterogeneity within the groups, with Estonia, the Czech Republic and Romania having bigger firm-level innovation policy effects among new members. For EU and central government policy effectiveness jointly Estonia was prominent, as implied by the earlier Hartsenko and Sauga (2012) and Masso and Vahter (2008) evaluations. On average the Western three have greater innovation policy effectiveness (both at the individual enterprise and the economy levels) than the new members for central and local government. All new members have lower economy-wide effectiveness than Portugal, the poorest western sample nations. The Czech Republic was the most local innovation policy effective among the new members, contrary to Bachtrögler and Hammer (2018), though the marginal effect was nonetheless very small.

The limited administrative and other resources of the new members imply that the substantial external EU funded innovation initiatives crowded out locally supported innovation. This interpretation is supported not only by the pattern of policy effectiveness but also by the subsidy correlation at the country level. By contrast, the subsidy correlation at the enterprise level indicates that the grant of an EU innovation project encouraged the awarding of national and local innovation funding.

Our evaluation of innovation policy analysis complements the EU Innovation Scoreboard, which utilises a wider range of innovation data in a less theoretically structured manner. If our innovation effectiveness (at both levels) and the Scoreboard are compared as predictors of future GDP per capita then our non-EU rankings are more accurate where the relative positions of Romania and Bulgaria, and Estonia and the Czech Republic, economies are concerned.

A qualification to the innovation marginal policy effectiveness reported here is that some firms exerting innovative effort may not report this effort (as R&D). Their workers may spend some of their time considering improvements in the process or products on which they are working but their allocation of time may be a small proportion of the total. Then innovation may take place without recorded R&D. Hence, the chain of actions from subsidy to productivity could be incomplete and the impact of (non-R&D) innovation subsidies understated. This implies that our policy effectiveness measure could be downward biased.

Another qualification is that the economies analysed do not include all those joining the EU between 2004 and 2007, nor are all the older members covered. Widening the coverage could increase the heterogeneity of policy results. We were unable to quantify the return to innovation subsidies because the Community Innovation Surveys do not contain sufficient information. Additions to future Surveys could provide opportunities to remedy this omission.

## References

Aerts K and Schmidt T (2008) Two for the price of one? Additionality effects of R&D subsidies: A comparison between Flanders and Germany, Research Policy 37 806–822

Bachtrögler, J. and C. Hammer (2018), Who are the beneficiaries of the structural funds and the cohesion fund and how does the cohesion policy impact firm-level performance? OECD Economics Department Working Papers, No. 1499, OECD Publishing, Paris.

Biagi, F, Pesole A and Stancik J (2016) Modes of Innovation: Evidence from the Community Innovation Survey; Joint Research Centre EU

Borrás S and Laatsit M (2019) Towards system oriented innovation policy evaluation? Evidence from EU28 member states. Research Policy 48, 1, 312-321

Čadil, J., Mirošník, K., and Rehák, J. (2017). The lack of short-term impact of cohesion policy on the competitiveness of SMEs. International Small Business Journal, 35(8), 991-1009.

Carlin, W.. Schaffer M E , and Seabright P (2013) Soviet power plus electrification: what is the long-run legacy of communism? Explorations in Economic History 50(1) 116-147.

Cohen, W and Klepper, S. (1996). A reprise of size and R&D. Economic Journal 437, 925–951.

Crépon, B., E. Duguet and J. Mairesse, (1998), Research, Innovation and Productivity: An Econometric Analysis at the Firm Level, Economics of Innovation and New Technology 7, 115-158.

Czarnitzki, D and Delanote, J (2015) R&D policies for young SMEs: input and output effects, Small Business Economics; 45, 3,

Decramer, S and Vanormelingen, S (2016) .The effectiveness of investment subsidies: evidence from a regression discontinuity design, Small Business Economics 47,. 4, 1007-1032

Dekker R and Kleinknecht A H (2008) The EU Framework Programs: Are they worth doing? Paper for the CAED Conference on 22-24 May in Budapest

Derenne J and Merola M ((2007) Economic analysis of state aid rules – contributions and limits – Proceedings of the third annual conference of the Global Competition Law Centre, College of Europe 21–22 September 2006

Dimos C and Pugh G (2016) The effectiveness of R&D subsidies: A meta-regression analysis of the evaluation literature, Research Policy 45 4, 797–815

Dvouletý, O., Srhoj, S., and Pantea, S. (2020). Public SME grants and firm performance in European Union: A systematic review of empirical evidence. Small Business Economics, 1-21.

European Commission (2003) Innovation policy: updating the Union's approach in the context of the Lisbon strategy Brussels, COM(2003) 112 final

European Commission (2005) 'State Aid Action Plan - Less and better targeted state aid: a roadmap for state aid reform 2005–2009' (Consultation document), COM (2005) 107 final, 7 June.

European Commission (2014) Innovation Union Scoreboard 2014

European Commission (2016) Ex post evaluation of the ERDF and Cohesion Fund 2007-13, Brussels, SWD(2016) 318

Fattorini, L., Ghodsi, M. and Rungi, A., (2020). Cohesion Policy Meets Heterogenous Firms, Journal of Common Market Studies. 58, 4 803-817

Foreman-Peck J (2013) Effectiveness and efficiency of SME innovation policy, Small Business Economics 41:55–70

Frontier Economics (2014) Rates of return to investment in science and innovation, a report prepared for the Department for Business, Innovation and Skills (BIS) July

Griffith R, Huergo E Mairesse J and Peters B (2006) Innovation and productivity across four European countries, Oxford Review of Economic Policy 22 4 483-498

Harris R Krenz A and Moffat J (2020) The Effects of Absorptive Capacity on Innovation Performance: A Cross-Country Perspective, Journal of Common Market Studies

Hartsenko, J. and Sauga, A., (2012). Does financial support from the EU structural funds have an impact on the firms' performance: evidence from Estonia. Proceedings of 30th International Conference on Mathematical Methods in Economics

Hashi, I and Stojcic N (2013) The impact of innovation activities on firm performance using a multi-stage model: Evidence from the Community Innovation Survey 4, Research Policy 42 353– 366

Heckman, J.J. (1979) 'Sample Selection Bias as a Specification Error'. *Econometrica*, 47 (1). 153–61

Heckman, J J and Robb, R (1985). Alternative methods for evaluating the impact of interventions. *Journal of Econometrics*. 30 (1–2 ) 239–267

Hölscher J, Nulsch N and Stephan J (2017) State Aid in the New EU Member States, Journal of Common Market Studies, 55(4). 779–797

Janz N, Lööf H and Peters B (2003) Firm Level Innovation and Productivity - Is there a Common Story Across Countries? ZEW Discussion Paper No. 03-26

Jaumotte, F., & Pain, N. (2005). Innovation in the business sector OECD Economics Department Working Papers no. 459.

Kornai, J. (2010). 'Innovation and dynamism', Economics of Transition and Institutional Change, 18(4) 629–670.

Koski, H and Pajarinen, M (2013) The role of business subsidies in job creation of start-ups, gazelles and incumbents. Small Business Economics; 41(1) 195-214.

KPMG (2016) EU Funds in Central and Eastern Europe: Progress Report 2007-2015,

Kravtsova V and Radosevic S (2012) Are systems of innovation in Eastern Europe efficient? Economic Systems 36 109-126

Lööf H, Mairesse J and Mohnen P (2017) CDM 20 years after, Economics of Innovation and New Technology, 26:1-2, 1-5

Mairesse J and Mohnen P (2010) Using innovation surveys for econometric analysis, NBER Working Paper 15857

Maroshegyi, C and Nagy, S G (2010) Out of credit: Evaluating the impact of the EU structural funds on Hungarian small business growth and access to finance. Köz-gazdaság, 5 (3). 113-127.

Masso J and Vahter P (2008) Technological innovation and productivity in late-transition Estonia: econometric evidence from innovation surveys, European Journal of Development Research, 20 (2), 240-261

Mateut, S (2018) Subsidies, financial constraints and firm innovative activities in emerging economies. Small Business Economics; 50,(1,) 131-162.

Piech, K.and Radosevic, S. (2006). The Knowledge-based Economy in Central and Eastern Europe. Countries and Industries in a Process of Change. London: Palgrave Macmillan

Rodríguez-Pose A and Ketterer T (2020) Institutional change and the development of lagging regions in Europe, Regional Studies, 54:7, 974-986

Roper S, Love, J H, and Bonner K (2017) Firms' knowledge search and local knowledge externalities in innovation performance, Research Policy 46(1) 43–56

Surubaru, N-C (2021) European funds in Central and Eastern Europe: drivers of change or mere funding transfers? European Politics and Society, 22:2, 203-221,

Suurna M and Kattel R (2010) Europeanization of innovation policy in Central and Eastern Europe, Science and Public Policy, 37(9), 646–664

Tether, B. S., Smith, I. J., & Thwaites, A. T. (1997). Smaller enterprises and innovation in the UK: The SPRU innovations database revisited. Research Policy, 2, 19–32.

Tevdovski D, Kosevska-Trpcevska K and Makrevska Disoska E (2017) What is the role of innovation in productivity growth in Central and Eastern European countries? Economics of Transition and Institutional Change, 25(3) , 527–551

Transparency International (various), Corruption Perceptions Index.

Tunali C B and Fidrmuc J (2015) State Aid Policy in the European Union, Journal of Common Market Studies, 53 (5) 1143–1162

Uberti L J (2018) Corruption in transition economies: Socialist, Ottoman or structural? Economic Systems 42 2018 533-555

World Bank (various) Doing Business, Washington

Wooldridge J. (2002), Econometric Analysis of Cross Section and Panel Data, MIT Press

Zoega G and Phelps E S (2019) Values, Institutions and the Rise of Eastern Europe, Economics of Transition and Institutional Change, 27(1), 247–265

**Appendix**

Table A1: Descriptive ratios of R&D and innovation across industries

| **Industry** | **R&D** | **Inn** |
|---|---|---|
| Agriculture, forestry, and fishing | 0.147 | 0.248 |
| Mining and quarrying | 0.088 | 0.207 |
| Manufacture of food, beverages, tobacco | 0.173 | 0.358 |
| Manufacture of textiles, apparel, leather | 0.092 | 0.224 |
| Manufacture of wood, paper, media | 0.110 | 0.308 |
| Manufacture of fuel, chemical, pharmaceuticals | 0.311 | 0.461 |
| Manufacture of metals | 0.203 | 0.371 |
| Manufacture of electronic, electric, etc. | 0.396 | 0.522 |
| Manufacture of furniture and others | 0.159 | 0.332 |
| Electricity, gas, steam, and AC | 0.128 | 0.279 |
| Water, sewerage, waste | 0.113 | 0.253 |
| Construction | 0.110 | 0.197 |
| Wholesale and retail | 0.067 | 0.201 |
| Transport | 0.039 | 0.162 |
| Warehousing and courier | 0.081 | 0.242 |
| Accommodation | 0.021 | 0.127 |
| Publishing, motion picture, TV | 0.164 | 0.346 |
| Telecom, programming | 0.393 | 0.495 |
| Financial and insurance | 0.180 | 0.402 |
| Real estate | 0.058 | 0.207 |
| Legal, accounting, consulting | 0.163 | 0.324 |
| Research | 0.386 | 0.420 |
| Design, photographic, translation, veteran | 0.260 | 0.410 |
| Administrative | 0.091 | 0.223 |

Table A2 Non-SME marginal effects of state aid (baseline specification)

| | **EU** | **Central Gov** | **Local Gov** |
|---|---|---|---|
| Bulgaria | 0.0035*** | 0.0103*** | 0.0024*** |
| Cyprus | 0.0104*** | 0.0059*** | 0.0086*** |
| Czech | 0.0076*** | 0.0133*** | 0.0000*** |
| Germany | 0.0055** | 0.0082** | 0.0038** |
| Estonia | 0.0082** | 0.0063** | 0.0107* |
| Spain | 0.0156** | 0.0168*** | 0.0125*** |
| Hungary | 0.0150*** | 0.0139*** | -0.000*** |
| Lithuania | 0.0118*** | 0.0059*** | -0.001*** |
| Portugal | 0.0061* | 0.0080* | 0.0051* |
| Romania | 0.0118*** | 0.0152*** | 0.0099*** |
| Slovakia | 0.0158*** | 0.0097*** | -0.007*** |

Table A3 Marginal effects of state aid on labour productivity

| | Country | Membership | Baseline | No Selection | Turnmar | Separate |
|---|---|---|---|---|---|---|
| **EU Funding** | BG | New | 0.0025 | 0.0031 | 0.0002 | 0.0019 |
| | CY | New | 0.0169*** | 0.0213*** | 0.0016*** | 0.0149** |
| | CZ | New | 0.0205*** | 0.0256*** | 0.0019*** | 0.0167** |
| | DE | Old | 0.0249*** | 0.0313*** | 0.0023*** | 0.0191** |
| | EE | New | 0.0319*** | 0.0399*** | 0.0031*** | 0.0271*** |
| | ES | Old | 0.0200*** | 0.0252*** | 0.0019*** | 0.0150* |
| | HU | New | 0.0309*** | 0.0385*** | 0.0029*** | 0.0199* |
| | LT | New | 0.0361*** | 0.0449*** | 0.0034*** | 0.0293*** |
| | PT | Old | 0.0168*** | 0.0210*** | 0.0017*** | 0.0166*** |
| | RO | New | 0.0180** | 0.0222* | 0.0017** | 0.0129 |
| | SK | New | 0.0288*** | 0.0356*** | 0.0027*** | 0.0196* |
| | | **New** | 0.0232 | 0.0289 | 0.0022 | 0.0178 |
| | | **Old** | 0.0206 | 0.0258 | 0.0020 | 0.0169 |
| | **Country** | **Membership** | **Baseline** | **No Selection** | **Turnmar** | **Separate** |
| **Central Government** | BG | New | 0.0149* | 0.0184 | 0.0014* | 0.0107 |
| | CY | New | 0.0171*** | 0.0216*** | 0.0017*** | 0.0152** |
| | CZ | New | 0.0350*** | 0.0437*** | 0.0033*** | 0.0283*** |
| | DE | Old | 0.0413*** | 0.0518*** | 0.0039*** | 0.0312*** |
| | EE | New | 0.0315*** | 0.0394*** | 0.0030*** | 0.0268*** |
| | ES | Old | 0.0438*** | 0.0551*** | 0.0041*** | 0.0320** |
| | HU | New | 0.0299*** | 0.0373*** | 0.0028*** | 0.0193* |
| | LT | New | 0.0118** | 0.0147** | 0.0011** | 0.0097** |
| | PT | Old | 0.0329*** | 0.0413*** | 0.0034*** | 0.0322*** |
| | RO | New | 0.0344*** | 0.0425*** | 0.0033*** | 0.0242* |
| | SK | New | 0.0229** | 0.0280** | 0.0022*** | 0.0157* |
| | | **New** | 0.0247 | 0.0307 | 0.0024 | 0.0187 |
| | | **Old** | 0.0393 | 0.0494 | 0.0038 | 0.0318 |
| | **Country** | **Membership** | **Baseline** | **No Selection** | **Turnmar** | **Separate** |
| **Local Government** | BG | New | 0.0011 | 0.0013 | 0.0001 | 0.0008 |
| | CY | New | 0.0028** | 0.0035** | 0.0002* | 0.0025 |
| | CZ | New | 0.0101*** | 0.0127*** | 0.0009*** | 0.0084** |
| | DE | Old | 0.0225*** | 0.0282*** | 0.0021*** | 0.0173** |
| | EE | New | -0.000*** | -0.000*** | -0.000*** | -0.000** |
| | ES | Old | 0.0298*** | 0.0374*** | 0.0028*** | 0.0222** |
| | HU | New | 0.0023 | 0.0029 | 0.0002 | 0.0015 |
| | LT | New | -0.001* | -0.002* | -0.000* | -0.001 |
| | PT | Old | 0.0066*** | 0.0083*** | 0.0007*** | 0.0066*** |
| | RO | New | 0.0076 | 0.0097 | 0.0007* | 0.0055 |
| | SK | New | 0.0009 | 0.0009 | 0.0000 | 0.0006 |
| | | **New** | 0.0030 | 0.0036 | 0.0003 | 0.0023 |
| | | **Old** | 0.0196 | 0.0246 | 0.0019 | 0.0154 |