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Scientific Output: Labor or Capital Intensive? An Analysis for Selected Countries

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Scientific output: labor or capital intensive? An analysis for selected countries.*

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Abstract

Scientific research contributes to sustainable economic growth environments. Hence, policy-makers should understand how the different inputs – namely labor and capital – are related to a country's scientific output. This paper addresses this issue by estimating output elasticities for labor and capital using a panel of 31 countries in nine years. Due to the nature of scientific output, we also use spatial econometric models to take into account the spillover effects from knowledge produced as well as labor and capital. The results show that capital elasticity is closer to the labor elasticity. The results suggest a decreasing return to scale production of scientific output. The spatial model points to negative spillovers from capital expenditure and no spillovers from labor or the scientific output.

Keywords: Scientific output; capital; labor; spillover effects
JEL Classification: O32, F01, O15

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1 Introduction

Research performance is a powerful indicator to assess the economic efficiency of a nation. For instance, nations with high productivity and economic output are also the leaders in patent and research output (Adams et al., 2013) Increasing scientific outcomes is necessary for technological changes, which may further develop the productivity and economic performance. Ultimately, it ends up increasing the national wealth and long-run sustainable economy growth.

In a globalization context, competitiveness is a common way to be an economic pioneer. Therefore, countries are striving to improve their scientific capacity (Adams et al., 2013). The authors emphasize that more than two-thirds of research published in 1973 occurred in well- established economies, whereas the trend has changed in recent years. Nowadays, only half of the journal publications have an author from G7 countries (Adams et al., 2013), indicating that developing countries are improving their scientific standing.

The aim of this study is to investigate the nature of research outcomes by answering the question of how the structure of scientific publication differs among nations. By answering this question, we are able to understand how countries use their available capital and labor to produce scientific outcome, and which of the inputs is more important in production. In turn, policymakers can use this information when deciding where to allocate resources; for example, investing in more education to develop researchers or investing in machinery for labs.

In general, there are two ways to increase the output of the economy: increase the volume of inputs entering the production cycle, or a more wisely alternative, increase productivity and efficiency of the production process (Rosenberg, 2014). Due to scarcity of resources, nations have focused on improving productivity. Investment on research and development is an important component of long-term economic growth as it is responsible for changes in productivity.

Research and development are mostly discussed in literature in three broader areas: the effectiveness of research and development (R&D) on economic growth, how R&D influences productivity, and the relative importance of the R&D investment on research outcomes. In section 2 we expand this discussion, concentrating on the effectiveness of research and development on research outcomes, which is the main focus of this paper.

To address the question of how nations produce their research outcome, we assume a simple production function and estimate the output elasticities for each input – labor and capital. We use a balanced panel of 31 countries from 2003 to 2011. Our results suggest that investing in researchers contributes more to the research outcomes than investing in research capital, especially because the number of researchers in higher education is the largest contributor to research outcomes. These results are not novel, but they are important because they corroborate previous studies. Also, the results help policymakers choose the appropriate pathway to enhance efficiency in resource allocation.

The remainder of the paper is as follows: section 2 discusses the R&D literature and how it is related to growth, productivity and spillovers; section 3 describes our econometric approach; section 4 presents the data used; section 5 discusses the results; and section 6 concludes.

2 Research and Development (R&D) and Economy Growth

Schumpeter (1942) and Solow (1957) are pioneers in the study of "innovation" and "technical changes" as engines to production and economic growth. King (2004) argues that "the ability to judge a nation's scientific standing is vital for both governments and society", as the result of scientific efforts may be seen in higher economic growth rates and more economic outputs. These eventually reflect the increase in social welfare.

Long-term economic growth needs a sustainable fuel, which could be provided by innovations. In long run, the ability of a nation to improve the standard of living passes through increasing the output-to-input ratio. A broad overview in productivity triggers is presented in the literature, most of them emphasizing technology and research. For instance, Guellec and van Pottelsberghe De La Potterie. (2001) analyzes 16 OECD countries and finds that R&D is an important factor for productivity and economic growth. Rouvinen (2002) studies four issues in R&D and productivity. His results suggest that R&D investment influences productivity — not vice versa. Bravo-Ortega and Marin (2010) provide evidence that corroborates Rouvinen (2002)'s results.

More recently, Eid (2012), using country-level data for 17 high-income OECD countries, measures the correlation between R&D and productivity growth and finds there is a lag between them. In the tradition of the knowledge-capital model of Griliches, Doraszelski and Jaumandreu (2013) develop a model to investigate the correlation between R&D and productivity. The authors find R&D expenditure has a key role in productivity across firms.

For scientometrics, scientific publication is the engine of economic growth. Therefore, the knowledge spillover discussion becomes relatively more important. This discussion started Alfred Marshall (Carlino et. al, 2001), and it still gets the attention of many economists. Some of the researches on knowledge spillovers are summarized below.

Griliches (1986) finds that after controlling for industry-specific fixed effects, the effects of research on productivity growth is cut by about fifty percent. The author explains this is because of spillovers within the industry. Jaffe (1989) and Jaffe et al. (1993) show that spillovers are industry and geographically localized. Varga (2000) applies the Griliches-Jaffe knowledge production function and expands it to a hierarchical version to test the knowledge spillovers in U.S. metropolitan areas, finding that research universities can increase the regional production. More recently, Elhorst and Zigova (2014) find no evidence of cross-fertilization effects across nearby universities, which corroborates the Bonaccorsi and Daraio's (2005) results. However, the authors argue that collaboration has a positive effect on research productivity.

2.1 R&D and Research Outcomes

In an oversimplification scenario, research and development (R&D) has two major inputs and two major outputs, capital and labor for the former, and patents and publications for the latter. In this work, we focus only on the publication output. McAllister and Wagner (1981) examine the relationship between R&D expenditure and the number of papers published in a sample of 500 universities and colleges in the United States. For each of 11 fields of science that the authors consider, there is a strong positive relationship between R&D expenditure and the number of publications. Focusing only on late industrial countries, Amsden and Mourshed. (1997) examine the scientific publication, patent and technological capabilities. While the authors expect a high growth rate of GDP and scientific publications to be positively correlated, they find the high correlation in countries like South Korea, China and Singapore rather than in countries such as Turkey, Argentina, Brazil, Chile and Mexico.

Shelton (2008) compares American and European publications and finds that the effectiveness of research investment is more significant than the number of scientists for scientific outcomes. Sharma and Thomas. (2008) finds that the number of efficient countries in the R&D sector varies based on the assumption the authors made. Crespi and Geuna. (2008) find a strongly positive long-run relationship between R&D expenditure and the number of publications with an optimum lag of 6 years. Adams et al. (2013) look at Brazil, Russia, India, China and South Korea, known together as the BRICK nations. They find Brazil stands out as different from the others. While a natural knowledge economy is a leading area in Brazil, research policy, physics, chemistry, engineering and materials are the leading areas in Russia, India, China, and South Korea.

Akhmat (2014) the relationship between educational indicators and research outcomes in the top twenty countries. The results indicate that education expenditures and the number of publications have a one-to-one relationship. In a series of papers, Meo and Usmani (2014) and Meo et al. (2013b, 2013a found among Asian countries, Middle East, and European countries a positive correlation between spending on R&D and the number of research publications, while in all the sub-samples the results show no correlation between GDP per capita and the total number of publications. They also conclude that the research outcome depends on the ratio of R&D expenditure to the total GDP— not the absolute R&D expenditure.

3 Model and Econometric Approach

Assume countries produce scientific research following a Cobb-Douglas production function in which there are two main inputs: capital and labor.

$$Y = K^{\alpha} L^{\beta} \tag{1}$$

By assuming a Cobb-Douglas, we implicitly assume that there is no heterogeneity between countries. At first this may seem unreasonable; however, given the easy access to internationally produced research through the Internet, and globalization, which allows more trade and movement between countries of both goods and people, it is possible to assume that scientific research is a homogenous produced good.

In order to estimate the model, we can transform equation 1 by taking the natural logarithm on both sides. After some manipulation we have

$$ln(Y) = \alpha ln(K) + \beta ln(L) \quad (2)$$

We do not make any assumptions on the parameters such that, the production function can be constant, increasing, or decreasing returns to scale. Parameters α and β are the share of each input used in the production of one unit of output; hence, the bigger the parameter, the more it is used in the production. Thus, the estimated model is

$$ln(SO) = \beta_0 + \beta_1 ln(CO) + \beta_2 ln(Res) + \mu_c + \delta_t + \epsilon \quad (3)$$

where SO is the scientific output measured as the number of scientific and technical journal articles, CO is capital outlay, Res is the number of researchers in R&D, μ_c is the country fixed effect and δ_t is year fixed effect. Notice that introducing country fixed effect we are able to control for institutional differences among countries.

One important feature of the labor input, which is even more important in the case of scientific output, is the knowledge from the worker. As argued by Griliches (1986), knowledge spillovers are expected to exist. Therefore, we incorporate this feature into our model by using a spatial model that follows the general formulation:

$$Y = \rho W_1 Y + X\beta + W_1 X\tau + \xi \quad (4)$$

$$\xi = \lambda W_2 \xi + \varepsilon \quad (5)$$

such that $\varepsilon \sim (0, \sigma^2 I)$.

In order to capture the knowledge spillover, we will focus on four models: the Spatial Durbin model (SDM) in which we include and on the right-hand side; the Spatial Durbin error model (SDEM) that expands the SDM model by introducing in the right-hand side; the Spatial Autoregressive Lag model (SAR) in which we include only ; and, the Spatial Lag of X model (SLX) in which we include only .

4 Data

Data for constructing the model come from two different sources: The World Bank (WB) dataset[1] and the Organization for Economic Cooperation and Development (OECD) dataset[2]. The list of countries in each set of analysis is provided in Appendix I. Because the number of countries in each dataset differs, we estimate two different sets of models, one for each source.

[1]Available at: http://data.worldbank.org/indicator

[2]Available at: http://stats.oecd.org/

The World Bank provides the number of scientific and technical journal articles for all the countries around the world. The dependent variable for all the specifications is based on the World Bank. Explanatory variables for scientific inputs in the World Bank model includes the number of researchers in R&D and gross capital formation. This dataset includes 31 countries in a panel of nine years from 2003 to 2011.

The OECD explanatory variables include the full-time equivalent researchers in total, and we further break it down to business enterprise, government, and higher education sectors. The total labor cost and the total capital expenditure in research are the capital related input in OECD countries analysis This dataset contains 22 countries from 2003 to 2011.

The scientific output information is available for 46 countries from 1996 to 2011 in an unbalanced set up. Because we believe the use of spatial econometrics techniques are very important in this study, we created a balanced panel of countries that maximized the number of observations. Moreover, we chose to use of both World Bank and OECD datasets because one may argue that gross formation of capital is not the best measure for R&D capital investment and the measure for researchers should be disaggregated. Therefore, we attempt to deal with these possible concerns, but to have a balanced panel, we have to drop 9 other countries that were in the World Bank sample. Table 1 provides the summary statistics for the data.

<INSERT TABLE 1 >

5 Results

The results are divided into two parts. First we present the results without any spatial spillovers and then we introduce such results. As explained in the previous sections, we believe that the spatial spillovers are important both theoretically and empirically. Tables 2 to 5 present the results with no spatial dependence. The analysis will focus on model (4), our preferred specification.

Table 2 presents the results using the number of researchers provided by the World Bank (WB) and the gross capital formation, also provided by the World Bank. The results show no influence of capital on the scientific output, while the elasticity of labor is positive and statistically significant. To further investigate[3] this relationship, we look at another data source. Tables 3 presents results using labor cost as a proxy for the number of researchers in R&D and capital cost, Table 4 uses the total number of researchers, and Table 5 disaggregates the researchers into three categories: business enterprise, government and higher education. The dependent variable remains the number of articles produced reported by the World Bank.

The results for the preferred model (4) from tables 3 to 5 show a positive and statistically significant result for both capital and labor. According to the elasticity values, there is decreasing returns to scale relation, as the sum of both elasticities

[3]Another robustness check performed was the analysis for unbalanced panels in all scenarios discussed. The results remain similar in terms of sign and significance of the estimated coefficients. These results are available upon request.

are less than one in every case. It is interesting to note when using the number of researchers instead of the labor cost (tables 4 and 5) the results suggest the capital and labor elasticities have similar magnitude.

<INSERT TABLES 2 TO 5>

5.1 Spatial Models

As discussed in the previous sections, it is important to consider the spillover effects of knowledge both theoretically and empirically. Therefore, we present in tables 6 to 9 the spatial results for the regressions presented in tables 2 to 5. We present four spatial models: SAR, SDM, SDEM and SLX; however, we will focus the analysis on the SDM model as we believe it is the best model because it considers spillovers from the dependent variables (articles) and the explanatory variables (inputs). In terms of the weight matrix, we used the k-nearest neighbors weight matrix with k equals to 1. This was the weight matrix that captured the most spatial dependence.

For the World Bank sample (table 6) we observe that the results remain similar to those of table 2, but there is an extra weight on the labor elasticity. Also, there is no evidence of articles or input spillover, which suggests countries have access to the same information regardless if they are neighbors. As for the OECD sample (tables 7 to 9), there is statistically significant negative spillover of capital expenditure on R&D. This suggests that investing in R&D has a negative effect on knowledge output in close-by countries. There is no spillover of labor inputs nor of scientific outputs. Also, the countries own labor and capital inputs have positive and statistically significant results.

One possible concern is the use of the geographical matrix to do the spatial analysis. We would argue that this matrix is good for several reasons. Firstly, we need the weight matrix to be exogenous to our estimation, and the geographic matrix fits this requirement. Secondly, it is well established in the literature that distance has an inverse relation to economic outcomes. Lastly, several authors (Jaffe, 1989; Jaffe el al., 1993; Varga, 2000) show that geographical proximity is important for spillovers.

<INSERT TABLES 6 TO 9>

6 Conclusions and Implications

The objective of this paper is to understand the production of scientific output for several countries. More specifically, we wanted to investigate the relation of capital and labor employed in research to its output. We used a balanced panel of 31 countries and 9 years to estimate the capital and labor elasticities and then employed spatial models in order to capture possible spillovers. The main results can be divided into two: firstly, capital and labor seems to have similar importance in terms of producing scientific output; and when disaggregated, researchers in the business enterprise have zero output elasticity. Secondly, in terms of spillovers, there seems to be a negative spillover in R&D capital expenditure. Also, there is no spillovers of scientific output (articles) in all spatial specifications.

In terms of policy implication, governments should not choose between labor and capital because the results point to similar importance in the production of scientific outputs. Moreover, the results suggest that research should be conducted by government agencies and workers in higher education. This is important, especially in developing countries, as government offers better careers in terms of stability and income even though it offers little incentive in the production of new scientific output.

Future research should focus on improving the data availability in order to incorporate different countries in the analysis. Other possible extensions are: the estimation of the elasticities assuming heterogeneous production functions for each country and the use of "economic" weight matrix, which would capture the closest economic relations between the countries. As discussed previously, the challenge in this last part is to guarantee the weight matrix is exogenous to the estimations.

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Tables

Table 1: Descriptive Statistics

Statistic	Source	N	Mean	St. Dev.	Min	Max
World Bank Sample						
# of Articles	World Bank	279	20,521.3	37,990.1	354.6	212,883.0
Total # of Researchers WB	World Bank	279	3,126.4	1,812.8	301.5	8,003.5
Gross Capital Formation	World Bank	279	23.1	5.8	11.2	47.6
OECD Sample						
# of Articles	World Bank	198	12,465.8	16,306.8	874.9	89,894.4
Total # of Researchers OECD	OECD	198	152,079.0	283,872.4	3,775.0	1,592,420.0
Researchers in Business Enterprises	OECD	198	89,770.3	186,084.8	1,516.0	1,092,213.0
Researchers in Government	OECD	198	24,570.3	52,255.5	1,044.0	250,250.0
Researchers in Higher Education	OECD	198	36,604.6	53,214.3	1,178.0	261,237.0
Labor cost on R&D	OECD	198	8,915.4	14,101.0	190.5	64,252.0
Capital Expenditure on R&D	OECD	198	2,632.6	5,979.1	44.6	34,867.9

Table 2: World Bank Sample Results

	Dependent variable:			
	Articles			
	OLS	*Fixed Effects*		
	(1)	(2)	(3)	(4)
Gross Capital Formation	−0.500	0.100*	−0.553	0.081
	(0.361)	(0.052)	(0.384)	(0.059)
Total # of Researchers WB	0.398***	0.570***	0.390***	0.293***
	(0.103)	(0.045)	(0.106)	(0.058)
Constant	7.413***			
	(1.467)			
Year FE			*X*	*X*
Country FE		*X*		*X*
Observations	279	279	279	279
R^2	0.063	0.995	0.064	0.996
Adjusted R^2	0.056	0.994	0.030	0.995

Note: *p<0.1; **p<0.05; ***p<0.01 In parenthesis, we present the standard deviation. The variables in the regression are in log form, so the coefficients can be interpreted as the output elasticities of capital and labor.For the fixed effects model we used the package "lfe" in R

Table 3: OECD Sample Results

	Dependent variable:			
	Articles			
	OLS	*Fixed Effects*		
	(1)	(2)	(3)	(4)
Capital Expenditure on R&D	0.305***	0.224***	0.307***	0.129***
	(0.031)	(0.032)	(0.031)	(0.034)
Labor cost on R&D	0.475***	0.102***	0.477***	0.047*
	(0.032)	(0.027)	(0.033)	(0.027)
Constant	2.918***			
	(0.122)			
Year FE			*X*	*X*
Country FE		*X*		*X*
Observations	198	198	198	198
R^2	0.936	0.992	0.938	0.993
Adjusted R^2	0.936	0.990	0.934	0.992

Note: *p<0.1; **p<0.05; ***p<0.01 In parenthesis, we present the standard deviation. The variables in the regression are in log form, so the coefficients can be interpreted as the output elasticities of capital and labor.For the fixed effects model we used the package "lfe" in R

Table 4: OECD Sample Results, Researchers

	Dependent variable:			
	Articles			
	OLS	*Fixed Effects*		
	(1)	(2)	(3)	(4)
Capital Expenditure on R&D	0.439***	0.161***	0.444***	0.124***
	(0.040)	(0.032)	(0.041)	(0.034)
Total # of Researchers OECD	0.348***	0.351***	0.345***	0.178**
	(0.045)	(0.055)	(0.046)	(0.069)
Constant	2.100***			
	(0.284)			
Year FE			*X*	*X*
Country FE		*X*		*X*
Observations	198	198	198	198
R^2	0.896	0.993	0.897	0.993
Adjusted R^2	0.895	0.992	0.891	0.992

Note: *p<0.1; **p<0.05; ***p<0.01 In parenthesis, we present the standard deviation.
The variables in the regression are in log form, so the coefficients can be interpreted as the output elasticities of capital and labor.For the fixed effects model we used the package "lfe" in R

Table 5: OECD Results, disaggregate researchers

	Dependent variable:			
	l.articles			
	OLS	*Fixed Effects*		
	(1)	(2)	(3)	(4)
Capital Expenditure on R&D	0.311***	0.143***	0.314***	0.114***
	(0.045)	(0.031)	(0.046)	(0.033)
Researchers in Business Enterprises	0.201***	−0.034	0.200***	−0.061
	(0.039)	(0.038)	(0.040)	(0.038)
Researchers in Government	−0.083**	0.148***	−0.087**	0.116**
	(0.037)	(0.054)	(0.038)	(0.054)
Researchers in Higher Education	0.393***	0.371***	0.398***	0.281***
	(0.060)	(0.054)	(0.062)	(0.062)
Constant	1.609***			
	(0.286)			
Year FE			*X*	*X*
Country FE		*X*		*X*
Observations	198	198	198	198
R^2	0.910	0.994	0.911	0.994
Adjusted R^2	0.908	0.993	0.905	0.993

Note: *p<0.1; **p<0.05; ***p<0.01 In parenthesis, we present the standard deviation.
The variables in the regression are in log form, so the coefficients can be interpreted as the output elasticities of capital and labor.For the fixed effects model we used the package "lfe" in R

Table 6: World Bank Sample Spatial Results

	Dependent variable:			
	Article			
	SAR	*SDM*	*SDEM*	*SLX*
Gross Capital Formation	0.079	0.085	0.055	0.087
	(0.054)	(0.055)	(0.054)	(0.060)
Total # of Researchers WB	0.296***	0.300***	0.304***	0.296***
	(0.053)	(0.053)	(0.053)	(0.058)
W*Articles	0.066	0.072		
	(0.048)	(0.047)		
W*Gross Capital Formation		-0.023	-0.03	-0.022
		(0.064)	(0.063)	(0.070)
W*Total # of Researchers WB		0.048	0.062	0.041
		(0.052)	(0.051)	(0.057)
W*Error Term			0.100**	
			(0.049)	
Year FE	X	X	X	X
Country FE	X	X	X	X
R squared				0.996
Number of observations	279	279	279	279

Note: *p<0.1; **p<0.05; ***p<0.01 In parenthesis, we present the standard deviation. The variables in the regression are in log form, so the coefficients can be interpreted as the output elasticities of capital and labor. For the spatial models SAR, SDM and SDEM we used the package "splm" in R,and for the SLX the package "lfe".

Table 7: OECD Sample Spatial Results

	Dependent variable:			
	Articles			
	SAR	*SDM*	*SDEM*	*SLX*
Capital Expenditure on R&D	0.129***	0.139***	0.138***	0.140***
	(0.031)	(0.030)	(0.031)	(0.033)
Labor cost on R&D	0.048*	0.051**	0. 051**	0.051*
	(0.024)	(0.024)	(0.024)	(0.026)
W*Articles	-0.023	-0.023		
	(0.059)	(0.059)		
W* Capital Expenditure on R&D		-0.109***	-0.110***	-0.109***
		(0.034)	(0.033)	(0.037)
W* Labor cost on R&D		0.011	0.001	0.011
		(0.019)	(0.019)	(0.021)
W*Error Term			-0.030	
			(0.063)	
Year FE	X	X	X	X
Country FE	X	X	X	X
R squared				0.993
Number of observations	198	198	198	198

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$ In parenthesis, we present the standard deviation.
The variables in the regression are in log form, so the coefficients can be interpreted as the output elasticities of capital and labor. For the spatial models SAR, SDM and SDEM we used the package "splm" in R,and for the SLX the package "lfe".

Table 8: OECD Expenditures Spatial Results

	Dependent variable:			
	l.articles			
	SAR	*SDM*	*SDEM*	*SLX*
Capital Expenditure on R&D	0.120***	0.130***	0.131***	0.133***
	(0.031)	(0.030)	(0.030)	(0.033)
Total # of Researchers OECD	0.189***	0.206***	0.209***	0.201***
	(0.062)	(0.064)	(0.063)	(0.070)
W*Articles	-0.055	-0.044		
	(0.059)	(0.058)		
W* Capital Expenditure on R&D		-0.077***	-0.114***	-0.111
		(0.075)	(0.032)	(0.033)
W* Total # of Researchers OECD		0.064	0.079	0.08
		(0.076)	(0.076)	(0.084)
W*Error Term			-0.059	
			(0.063)	
Year FE	X	X	X	X
Country FE	X	X	X	X
R squared				0.993
Number of observations	198	198	198	198

Note: *p<0.1; **p<0.05; ***p<0.01 In parenthesis, we present the standard deviation.
The variables in the regression are in log form, so the coefficients can be interpreted as the output elasticities of capital and labor. For the spatial models SAR, SDM and SDEM we used the package "splm" in R,and for the SLX the package "lfe".

Table 9: OECD Sample Spatial Results, Disaggregated Researchers

	Dependent variable:			
	l.articles			
	SAR	*SDM*	*SDEM*	*SLX*
Capital Expenditure on R&D	0.111***	0.107***	0.107***	0.112***
	(0.030)	(0.029)	(0.030)	(0.033)
Researchers in Business Enterprises	-0.056	0.001	0.003	-0.006
	(0.034)	(0.039)	(0.040)	(0.044)
Researchers in Government	0.118**	0.115**	0.111**	0.111**
	(0.049)	(0.047)	(0.048)	(0.053)
Researchers in Higher Education	0.282***	0.212***	0.205***	0.217***
	(0.056)	-0.059	(0.060)	(0.066)
W*Articles	-0.036	-0.063		
	(0.056)	(0.055)		
W*Capital Expenditure on R&D		-0.069**	-0.075**	-0.070*
		(0.034)	(0.034)	(0.038)
W* Researchers in Business Enterprises		0.053	0.062*	0.057
		(0.036)	(0.037)	(0.040)
W* Researchers in Government		-0.025	-0.020	-0.020
		(0.054)	(0.054)	(0.060)
W* Researchers in Higher Education		-0.12	-0.120	-0.098
		(0.075)	(0.075)	(0.083)
W*Error Term			-0.069	
			(0.063)	
Year FE	X	X	X	X
Country FE	X	X	X	X
R squared				0.994
Number of observations	198	198	198	198

Note: *p<0.1; **p<0.05; ***p<0.01 In parenthesis, we present the standard deviation. The variables in the regression are in log form, so the coefficients can be interpreted as the output elasticities of capital and labor. For the spatial models SAR, SDM and SDEM we used the package "splm" in R,and for the SLX the package "lfe".

Table 10: *

Appendix 1 - Counties in World Bank and OECD Samples

Countries	World Bank	OECD
Argentina	X	X
Belgium	X	X
Canada	X	
China	X	X
Czech Republic	X	X
Denmark	X	X
Estonia	X	
Finland	X	X
France	X	X
Germany	X	
Hungary	X	X
Ireland	X	
Italy	X	X
Japan	X	X
Korea	X	X
Mexico	X	
Netherland	X	X
Norway	X	X
Poland	X	X
Portugal	X	X
Romania	X	X
Russia	X	X
Singapore	X	X
Slovak Republic	X	X
Slovenia	X	X
South Africa	X	X
Spain	X	
Sweden	X	
Turkey	X	X
United Kingdom	X	
United States	X	

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