OECD Regional Development Working Papers 2013/11

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https://dx.doi.org/10.1787/5k451mplq9lw-en

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THE IMPACT OF STRUCTURAL AND MACROECONOMIC FACTORS ON REGIONAL GROWTH[1]

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This papers aims to understand the impact of nation-wide structural policies such as product market regulation in six upstream sectors and employment protection legislation and that of macroeconomic factors on the productivity growth of OECD regions. In particular we explore how this effect varies with the productivity gap of regions with their country's frontier region. We use a policy-augmented growth model that allows us to simultaneously estimate the effects of macroeconomic and structural policies on regional productivity growth controlling for region-specific determinants of growth. We estimate our model with an unbalanced panel dataset consisting of 217 regions from 22 OECD countries covering the period 1995 to 2007. We find a strong statistical negative effect of product market regulation on regional productivity growth in five of the six upstream sectors considered and the effects are differentiated with respect to the productivity gap. Our estimates also reveal that dispersion of policies hurts regional productivity growth suggesting that policy complementarity can boost productivity growth. The effects of employment protection legislation are negative overall and are especially detrimental to productivity growth in lagging regions. The three macroeconomic factors we consider also influence regional performance: inflation has a negative effect on regional growth and government debt has a positive effect on average. When differentiating the effects by the distance to the frontier, trade-openness is more beneficial to lagging regions and the negative effects of inflation are less negative in lagging regions. These results reveal a strong link between nation-wide policies and the productivity of regions, which carries important policy implications, mainly that these effects should be taken into account in the policy design.

JEL Classification: R12, E66

Keywords: regional productivity growth, regional impact of structural policies, spatial impact of national policies

1. We would like to acknowledge very valuable comments and suggestions by Bill Tompson and John Morrow as well as participants at the ERSA Congress 2012. The views expressed are those of the authors and do not reflect those of the OECD or its Member countries.

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I. Introduction, review of literature and conceptual framework

Introduction

This paper aims at understanding the impact of nation-wide factors on regional performance. By doing this we aim to bridge the gap between the national and the regional dimensions in the study of economic growth as well as in economic policy. There is a growing body of literature investigating economic growth dynamics at the regional level including work on regional convergence (Sala i Martin, 1996) and more recently models of regional growth using frameworks from the New Economic Geography, the endogenous growth theory and the neoclassical theory[2] . Most of the empirical literature on regional growth explains regional growth based on regional factors. At the country level, the neoclassical literature investigating economic growth based on Cobb-Douglas production functions (Solow, 1956 and Swan, 1956) evolved towards the endogenous growth theoretical framework focusing on understanding the country-level drivers of national growth, including country-level policies.

In our opinion there is a disconnect between these two bodies of literature and the link between macroeconomic factors and structural policies and regional economic growth needs to be explored. Recent work has advanced our understanding on how the regional dimension maps and contributes to aggregate growth (see OECD, 2011), however the study of how country-wide factors influence performance at the regional level is still nascent. This paper aims at improving our understanding in this domain. This work carries important policy conclusions given that nation-wide policies typically do not take into account the role of geography and space, mainly due to a lack of understanding of their effects. At the same time regional policy has evolved over the past decades from a previous policy dominated by temporary subsidies and short term corrections in regional imbalances to the current approach focusing on competitiveness and growth with an aim to boost the overall performance of countries.

The paper is structured around five sections. In the remainder of this section we provide an overview of the literature and our conceptual framework. The next section describes the model specification and Section 3 is dedicated to the data. Section four presents the results of our estimates and the final section presents our conclusions.

Review of the literature and conceptual framework:

The nation-wide factors we examine are both structural policies including product market regulation and labour market legislation and macroeconomic factors such as trade exposure, the level of inflation and government debt. With regard to regional performance we consider the productivity growth of OECD regions, which we measure as growth in GDP per employee. In particular we seek to explore how this impact might vary across regions depending on their productivity gap with the most productive region in their country representing the frontier. We also examine the effects of technological pass-through by estimating the improvements at the frontier on regional productivity growth.

Our framework is inspired by Bourlès *et al.* (2010). This is a version of the neo-Schumpeterian endogenous growth model by Aghion *et al.* (1997), which highlights the costs of market imperfections in upstream sectors. The paper examines whether competition and policies affecting competition have an impact on the productivity growth of sectors. The broad conclusion of their model is that lack of competition in upstream sectors leads to lower productivity growth in downstream sectors. Moreover, when estimating the impact of competition in upstream sectors on productivity growth in downstream sectors, Bourlès *et al.* (2010) also introduce two factors that have been identified in the literature as influencing positively sector productivity growth. First, growth at the international technological frontier

2. See OECD (2009) for a review.

for a given sector has a positive effect on growth in lagging country-sectors: this is called *technological pass-through*. Second, by a *catching-up effect*, the efficiency gap between this frontier and the follower sectors also enhances growth in the follower sectors.

We transpose this framework at the regional level, examining the impact of nation-wide policies (*e.g.* structural policies) and macroeconomic factors on regional productivity growth, while simultaneously examining the *pass-through* and the *catching-up* effects. For the former effect we determine whether regional productivity growth increases with the growth of the country's frontier region and for the latter we determine whether regional growth increases in distance to the frontier.

Our framework examining the effects of nation-wide level on regional productivity growth necessitates controlling for region-specific drivers of growth. The literature in this regards is quite extensive, particularly since recent studies apply the classical economic growth literature at the regional level, such as the neoclassical theory and the endogenous growth theory in addition to the region-specific factors identified in the New Economic Geography.

The region-specific factors identified in the neoclassical and the endogenous growth theories are similar to those identified at the country level. At the country level both the neoclassical theory of growth (starting with Solow, 1956 and Swan, 1956) and endogenous growth models (Romer, 1986 and 1990, Lucas, 1988 and Aghion and Howitt, 1998) emphasise the role of physical and human capital accumulation on economic growth. Physical capital accumulation can take the form of private sector investment or public sector investment (in infrastructure for example). There is empirical evidence showing that transport improvements enhance economic growth. Chandra and Thompson (2000) and Michaels (2008) find that improved access to interstate highways in rural US counties increased firm earnings. And Duranton and Turner (2011) find that population growth in US Metropolitan Statistical Areas responds positively to increases in the road network. Human capital is usually seen as formal education and skills (and evaluated in years of education or formal training). Sianesi and Van Reenen (2003) provide a summary of the empirical evidence on the effects of education on economic growth: increasing school enrolment rates by one percentage point increases GDP growth between 1 and 3 percentage points per annum. New evidence in Acemoglu and Dell (2010) indicates that differences in human capital account for half of between-municipality differences in output, and Gennaioli *et al.* (2011) also find that education is the most important determinant of regional income and productivity. Finally, investment in research and development or innovation is also considered to be a determinant of growth, as it favours new technology adoption and the better use of existing capital. Empirical evidence can be found in Jorgenson (1991) and Geroski (1989). Following recent studies that have applied the framework of both growth theories at the regional level, Roberts (2010) explores the regional applications of endogenous growth theory and the corresponding empirical literature. He identifies the geographical dimension of knowledge spillovers as the main reason why endogenous growth models can explain regional growth: According to this review it is mainly regional differences in human capital investment and the ability to transmit knowledge that explain regional differences in growth rates: Empirical evidence on the importance of human capital for regional growth can be found in Henderson et al. (1995), Rauch (1993), Glaeser et al. (1995) and OECD (2009).

The growth literature and the urban economics literature have also looked for evidence on the role of agglomeration effects on economic performance. We know from the urban economics literature that economic density enhances productivity levels (Ciccone and Hall, 1996). Density indicates the extent of agglomeration economies, which can take the form of labour market pooling, industrial linkages or technological and knowledge spillovers. As reviewed in Glaeser (1994), density, and in particular urban density, favours intellectual and technological spillovers, as well as the accumulation of human capital. There is empirical evidence on the impact of economic density on innovation (Sedgley and Elmslie, 2004; Knudsen *et al.*, 2008), and innovation itself is a determinant of growth (Romer, 1990). Contrary to the

other factors mentioned above, there is no direct econometric evidence on the effect of economic density on regional growth[3].

In this paper, we explore the links between both macro-economic and structural policies and regional performance based on theoretical literature carried at the national level. Our approach is related to that of Bassanini and Scarpetta (2001), who build a "policy-augmented" growth model analysing the effects of macroeconomic policies such as inflation targeting, fiscal policy or international trade on growth at the country level. Their findings suggest high inflation hinders output growth due to their negative effect on investment and capital accumulation. In terms of government deficit, it can affect growth by reducing private sector investment, and by resorting to a level of taxation that changes the efficient allocation of resources in the economy. In spite of the positive effects of public spending, medium to high levels of deficit tend to curb economic growth. The magnitude of the effect depends on the type of financing of the deficit (i.e. how distortionary the taxes are) and the type of public investment undertaken (how productive it is). The evidence in Bassanini and Scarpetta (2001) indicates a negative effect of the size of government on growth. At the regional level in contrast, Kim (1997) estimates the effect of local taxes and public expenditures on regional economic growth in Korea and finds that overall the positive effect of local government investment on regional growth outweighs the negative effect of local taxes. Rodriguez Pose and Fratesi (2003) find a small positive impact of European structural funds on regional growth in the EU.

International trade can also enhance economic growth, by reinforcing the efficient allocation of resources according to patterns of comparative advantage, by increasing the scale of production, facilitating the flow of technologies and knowledge, and increasing levels of competition. The New Economic Geography and growth literature, in particular Martin and Ottaviano (1999) suggest there is a permanent effect of trade integration on economic growth. In contrast, Minniti and Parello (2011), using a spatial model of endogenous growth, predict that trade integration has only a short term impact on growth, which is positive when there are positive R&D spillovers. In terms of empirical evidence, Bassanini and Scarpetta (2001) find that trade exposure is positively associated with output growth at the country level. Sachs *et al.* (2002), aiming to explain the differences in economic performance across Indian states, find that after the reforms of 1991 the surge in international trade has been a positive factor of growth.

We also examine the effects of policy complementarites based on work carried by Braga and Oliveira Martins (2008). The authors argue that the complementarity in structural reforms is a critical pillar affecting economic growth: Using the case of CEECs during the transition period, they establish that both a high level of reforms and positive changes in their complementarity enhance growth.

A very small number of studies have combined the notions of macroeconomic policies, regional economic growth and convergence. Birthal *et al.* (2011) consider income levels and growth across Indian states and find that the nation-wide economic reforms after 1991-92 have no significant effect on growth or convergence. Also studying the case of Indian states, Ahluwalia (2000) analyses the reasons for inter-state differences in economic growth in India in the 1990s. He finds that variations in growth are best explained by variations in the private investment ratio, the provision of infrastructure and literacy. He also highlights how nation-wide structural reforms can have different impacts on states as these differ in their characteristics. He argues that as a result of trade or licensing reforms there is a reallocation of resources, notably capital investment, according to states' natural advantage or initial conditions (infrastructure, rule of law, policy environment), which leads to differences in regional growth. More recently, related work by Che and Spilimbergo (2012) has estimated the effect of structural reforms on the speed of convergence between regions concluding that financial development, trade openness, sound institutions and some labour market reforms favour regional convergence.

3. Henderson (2003) tackles the question directly and finds no econometric evidence in favour of the effects of urbanisation on economic growth. Henderson (2005) provides a review.

II. Description of the model:

As previously discussed our model is based on a modified version of Bourlès *et al.* (2012) adapted to the regional context. We use a policy-augmented growth model that allows us to estimate the effects of macroeconomic and structural policies on regional productivity growth controlling for region-specific determinants of growth and simultaneously measure how this effect varies with respect to a region's distance to the frontier (*e.g.* the catching-up effect) and the impact of the leading region on productivity growth (*e.g.* the pass-through effect). Our hypothesis is that regional productivity growth is positively related to the productivity growth of the leading region within the country and positively related to the productivity gap with the region that has the highest level of productivity in the country (in other words productivity growth increases with distance to the productivity frontier as lagging regions catch up).

For our structural policies we consider regulation in six upstream sectors and labour market legislation (EPL) and for our macroeconomic variables our model considers inflation, trade exposure, and government deficit. In the former we also compute the average level of regulation in each country based on the regulatory measure from the six up-stream sectors as well as the complementarity of regulations.

We interact our structural and macroeconomic variables with the productivity gap or catching up effect allowing us to capture whether the impact of these factors differs in regions close and far from the frontier. Our regional determinants of productivity growth according to the literature include measures of physical and human capital as well as innovation. We also include the density of the regional labour market in order to determine its relation with productivity growth.

As in Bourlès *et al.* (2010), we model region-year productivity as an auto-regressive distributed lag (ARDL) process:

$$\ln prod_{r,t} = \alpha_0 \ln prod_{r,t-1} + \alpha_1 \ln prod_{F^C t} + \alpha_2 \ln prod_{F^C t-1} + \alpha_3 X_{r,t-1} + \gamma_r + \zeta_t + \varepsilon_{r,t} \quad (1)$$

$prod_{F^C t}$ is the growth of the country frontier region's productivity in year t, $X_{r,t-1}$ are the determinants of regional productivity (in logs), and γ_r and ζ_t are region and year effects respectively.

We can rewrite equation (1) as:

$$\Delta \ln prod_{r,t} = (\alpha_0 - 1) \ln prod_{r,t-1} + \alpha_1 \ln prod_{F^C t} + \alpha_2 \ln prod_{F^C t-1} + \alpha_3 X_{r,t-1} + \gamma_r + \zeta_t + \varepsilon_{r,t}$$
$$= (\alpha_0 - 1) \ln prod_{r,t-1} + \alpha_1 \Delta \ln prod_{F^C t} + (\alpha_2 + \alpha_1) \ln prod_{F^C t-1} + \alpha_3 X_{r,t-1} + \gamma_r + \zeta_t + \varepsilon_{r,t}$$

Under the long-run homogeneity assumption ($\alpha_0 + \alpha_1 + \alpha_2 = 1$), we obtain:

$$\Delta \ln prod_{r,t} = \alpha_1 \Delta \ln prod_{F^C t} + (1 - \alpha_0) \ln \frac{prod_{F^C t-1}}{prod_{r,t-1}} + \alpha_3 X_{r,t-1} + \gamma_r + \zeta_t + \varepsilon_{r,t}$$

Our baseline estimable model is therefore specified in equation (2) and is estimated with ordinary least squares:

$$\Delta \ln prod_{r,t} = \beta_1 \Delta \ln prod_{F^C t} + \beta_2 countrygap_{r,t-1} + \beta_3 X_{r,t-1} + \gamma_r + \zeta_t + \varepsilon_{r,t} \quad (2)$$

Regional productivity growth between *t-1* and *t* is therefore regressed on the growth of the country frontier productivity $prod_{F^C t}$ (thus if β_1>0 regional growth is positively associated with growth in the frontier region), the lagged productivity gap with the country frontier region $countrygap_{r,t-1}$ (thus testing

for convergence or divergence between leading and lagging regions at the national level), and a vector $X_{r,t-1}$ capturing regional determinants of productivity growth. These include physical capital (motorway kilometres per inhabitant), human capital (share of working age population with tertiary education), innovation (patents per inhabitant), and employment density (the number of employees per square km). We lag the determinants of growth by one year in order to take into account the time it takes for investment to capitalise into growth. In all specifications we include year dummies ζ_t and after estimating the equation with pooled OLS we later include a region fixed effect γ_r in order to account for time-invariant regional factors that influence regional productivity growth.

The productivity gap variable $countrygap_{r,t-1}$ is defined as $\ln\left(\frac{Prod_{rt}}{Prod_{F^C{}_t}}\right)$. The gap is equal to zero at the frontier and becomes increasingly negative as we move farther away from the frontier.

We expect β_1 to be positive as the growth of the country frontier region has a positive effect on that of other regions in the same country. We expect β_2 to be negative: as $countrygap_{r,t}$ takes on negative values, increasing $countrygap_{r,t}$ is equivalent to decreasing the distance to the frontier, which we expect to have the effect of reducing regional growth.

When estimating this type of growth model, a common issue that arises comes from the fact that human capital is endogenously determined. So far no satisfactory solution to this issue has been proposed. However our main goal is to focus on the effect of regulation and how this effect varies with distance to the frontier, and we can assume that regulation is exogenous. We then augment this base model to include measures of nation-wide policies: the level of regulation in upstream sectors, employment protection legislation (EPL), and macroeconomic factors such as trade exposure, government debt and inflation. We are interested in the impact of nation-wide variables on different types of regions, and in particular on regions depending on their distance to the frontier. We therefore interact each nation-wide variable with the productivity gap variable and estimate the model specified in equation (2):

$$\Delta \ln prod_{rt} = \beta_1 \Delta \ln prod_{F^C,t} + \beta_2\, countrygap_{r,t-1} + \beta_3 X_{r,t-1} + \beta_4 Pol_{C,t-1} + \beta_5 Pol_{C,t-1}\,.\,countrygap_{r,t-1} + \gamma_r + \zeta_t + \varepsilon_{rt} \quad (3)$$

Where $Pol_{C,t}$ is the level of the policy variable (regulation, EPL, trade exposure, government debt or inflation) in region *r* in year *t*. If we expect the policy to have a negative effect on the regional growth of lagging regions (compared to the effect on the frontier region), we would expect to obtain a positive estimate of β_5.

III. Description of the data

Our data consists of a panel of 217 regions from 22 OECD countries[4] defined at Territorial Level 2 (TL2), taken from the OECD Regional Database covering the period 1995 and 2007. We observe regional productivity since 1995, defined as GDP per employee, deflated with base year 2000 and PPP adjusted in US dollars. We use this measure to compute yearly regional productivity growth in percentages. Using the regional productivity data we are able to identify the regions which are at the productivity frontier in their country in each year allowing us to compute the productivity growth of the frontier region, and the distance from the country frontier region ($countrygap$).

4. We do not use the full set of OECD countries and regions due to restrictions on data availability.

The indicators measuring the regional effects - human and physical capital agglomeration and innovation - are also taken from the OECD Regional Database. We employ the following indicators to proxy the regional factors:

- *Physical capital* is measured by motorway density (total kilometres of motorway to population)
- *Human capital* is captured by the percentage of the working age population with tertiary attainments
- Our measure of *density* is captured by the ratio of employment at place of work to total aerial land
- *Patent intensity* measured by total number of patent applications per thousand inhabitant captures the innovation effect.

The policy and macroeconomic variables are country-year level measures. For the structural indicators, our measures of sectoral regulation are drawn from the OECDs Product-Market Regulation (PMR) Database. [5] The OECD PMR indicators are a comprehensive and internationally comparable set of indicators that measure the degree to which policies promote or inhibit competition in areas of the product market where competition is viable. They measure the economy-wide regulatory and market environments in 34 OECD countries as well as in Brazil, China, India, Indonesia, Russia and South Africa. They are consistent across time and countries. The values for each indicator vary between zero and one, with higher values indicating more regulatory impediments to competition. Data are gathered and the indicators calculated according to a common method, so as to ensure consistency across time and comparability across space and across sectors.

Our regulatory indicators cover the following six upstream sectors on a yearly basis:

1. electricity, gas and water supply
2. wholesale and retail trade; repairs
3. transport and storage
4. post and telecommunications
5. financial intermediation
6. renting of machinery and equipment and other business activities

The overall regulation index used here is a simple average of the six sectors covered rather than the OECD's headline PMR indicator, which has even broader coverage.

It is likely that the regulatory framework across the six sectors displays positive interactions, i.e. reforms enhancing competition in one sector enhance the returns from reforming in another sector. In this context, a more balanced system of regulations across the six upstream sectors will generate a higher positive impact on productivity than a less coherent one, even if both systems could display the same average represented by the overall regulation index. In order to capture this complementarity effect among

5. See Wolfl et al. (2009) for a detailed description of the PMR data.

policies we employ the reciprocal of the Hirshmann-Herfindhal indicator as suggested by Braga and Oliveira Martins (2006) and defined in equation (4):

$$RC = 1/\sum_i \left(\frac{Ri}{RL*N}\right)^2 \quad (4)$$

where RL is the simple average year by year of the six sector indicators and N is the number of reform areas. The maximum value for *RC* is *N* (=6) when all six individual reform indicators are at the same level.

Our second structural policy area focuses on labour market restrictions and is captured by the employment protection legislation (EPL) indicator constructed by the OECD's Directorate for Labour and Social Affairs, which varies from 0 to 6 and increases with the level of labour market restrictions. It measures the procedures and costs involved in dismissing or hiring workers, based on information provided by officials in the OECD member countries and expert opinions from the International Labour Organization (ILO).

In terms of macroeconomic variables, we consider trade openness captured by total trade flows as a percentage of GDP, government debt to GDP ratio, and the inflation variable specified as the rise in the consumer price index for the year in question. All macroeconomic data are drawn from OECD sources.

Table 1 provides summary statistics of the variables. Annual productivity growth has an average value of 1.5% and ranges from -44% to +65%. The productivity gap takes on negative values. It is equal to zero for regions at the productivity frontier of their country, and becomes increasingly negative for regions further away from the frontier. Given our hypothesis that regional growth is greater for regions far away from the country productivity frontier, we expect the coefficient on the productivity gap variable to be negative.

Table 1. Summary statistics

	Mean	Std Dev	Min	Max
Productivity	58,616	17,224	15,694	161,259
Productivity growth	1.53	3.38	-16.31	25.37
Productivity gr of country frontier	3.06	4.99	-6.79	25.71
Country productivity gap	-0.39	0.232	-1.06	0
Motorway density	2.26	2.94	0.063	31.68
Tertiary education	24.04	8.26	5.73	54.66
Patents	91.13	97.93	0.08	741.05
Density	130.16	372.36	0.19	4197.4
Regulation	0.26	0.06	0.16	0.44
Complementarity	5.63	0.23	4.79	5.92
EPL	1.75	0.98	0.21	3.67
Trade	35.17	17.73	11.49	92.37
Debt	64.87	20.74	15.79	119.87
Inflation	2.42	1.45	0.018	12.04

Source: Own calculations using data from OECD Regional Database, OECD PMR Database, OECD EPL Database and OECD Economic Outlook Database.

IV. Results of the model:

In this section first report the estimates for our base model (equation 2), and then report the results of the augmented model (equation 3) capturing both the effects of structural policies and macroeconomic policies on regional productivity growth. In terms of the structural factors we report the effects of regulation on regional productivity growth for each of the six upstream sectors, the compounded effect through an average value and the effects of complementarities. We also report the effects of labour market regulation captured through the employment protection legislation. In terms of the three macroeconomic effects we capture the impact of inflation, trade and debt on regional productivity growth. For both the structural and macroeconomic nation-wide variables we capture effects between nation-wide levels on regional productivity growth and though an interaction term with the productivity gap we are able to disentangle the effects according to region's distance to the production possibility frontier.

Baseline model

We first report the estimates for our base model in Table 2 using eight different model specifications. All the specifications include year dummies.

Table 2. Productivity growth: the baseline regression

	(1) pooled OLS	(2) pooled OLS	(3) pooled OLS	(4) pooled OLS	(5) pooled OLS	(6) pooled OLS	(7) FE	(8) FE robust s.e.
Frontier growth (t-1)	0.13***	0.13***	0.13***	0.13***	0.13***	0.13***	0.09***	0.09**
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.039)
Productivity gap (t-1)	-0.15	-0.20	0.05	-0.02	-0.03	-0.15	-9.23***	-9.23***
	(0.409)	(0.409)	(0.426)	(0.426)	(0.428)	(0.437)	(1.678)	(3.238)
Physical capital (t-1)		-0.23**		-0.22**	-0.22**	-0.17*	-0.55	-0.55
		(0.089)		(0.089)	(0.093)	(0.101)	(0.730)	(0.886)
Human capital (t-1)			-0.46*	-0.39	-0.43	-0.47	-2.54	-2.54
			(0.265)	(0.266)	(0.295)	(0.298)	(1.561)	(2.047)
Patents (t-1)					0.02	0.01	-0.16	-0.16
					(0.081)	(0.082)	(0.385)	(0.416)
Density (t-1)						0.00	0.03***	0.03***
						(0.000)	(0.012)	(0.012)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region effects							Yes	Yes
N	1,234	1,234	1,234	1,234	1,234	1,234	1,234	1,234
R^2	0.081	0.086	0.083	0.088	0.088	0.089	0.118	0.118
Number of regions							217	217

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

The first column reports the estimates from a pooled OLS regression. In this model specification productivity growth of the country frontier region has a positive effect on regional growth, as expected. The coefficient on *productivity gap* is also negative as expected suggesting that regional growth increases with distance to the frontier, but statistically insignificant. In columns 3-6 we introduce progressively physical capital, tertiary education and density. Once we include regional fixed effects (columns 7-8) we obtain the expected signs and statistical significance on the coefficients of frontier growth and productivity gap. In the full model with robust standard errors (column 8), a 1 percentage point increase in the annual productivity growth of the country frontier region is associated with a 0.1 percentage point increase in regional productivity growth. The negative coefficient on *productivity gap* captures the catching up effect suggesting that regions further away from the productivity frontier tend to have higher growth rates. The coefficients on physical and human capital are insignificant in models 7 and 8, suggesting that the effects

of changes in human and physical capital on productivity growth might take longer than one year. The sign on density is positive and significant capturing agglomeration forces, while the coefficient on patents is not significant. Again the relationship between patents and growth might take a longer time to appear.

Augmenting the model to structural factors

Table 3 reports the results of augmenting the model allowing for the regulatory effects of each of the six sectors on regional productivity growth and the effects interacted with the productivity gap. The reported results include region fixed effects and year dummies and the coefficients are estimated using a robust standard error specification.

Table 3. Impact of sector-specific regulation on regional productivity growth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Frontier growth (t-1)	0.12***	0.12***	0.07*	0.09**	0.09**	0.09**	0.10**	0.10**	0.09**	0.04	0.07*	0.05
	(0.034)	(0.035)	(0.034)	(0.034)	(0.038)	(0.038)	(0.040)	(0.040)	(0.036)	(0.032)	(0.035)	(0.035)
Productivity gap (t-1)	-16.52***	-19.39***	-9.28***	-70.08***	-9.89***	-13.00**	-9.40***	-12.96**	-9.63***	51.50***	-9.22***	26.06**
	(3.139)	(4.173)	(3.178)	(10.744)	(3.312)	(5.941)	(3.267)	(6.169)	(3.193)	(8.607)	(3.134)	(10.946)
Physical capital (t-1)	-1.08	-1.10	-1.02	-1.33	-0.56	-0.58	-0.71	-0.71	-1.17	-0.84	-0.88	-0.86
	(0.799)	(0.809)	(0.881)	(0.872)	(0.881)	(0.901)	(0.867)	(0.870)	(0.886)	(0.784)	(0.852)	(0.793)
Human capital (t-1)	-6.77***	-6.71***	-5.30**	-5.17**	-3.63*	-3.60*	-2.58	-2.35	-5.03**	-6.42***	-6.19***	-5.73***
	(2.034)	(2.048)	(2.092)	(2.082)	(2.112)	(2.118)	(2.039)	(2.062)	(2.024)	(1.910)	(2.125)	(2.055)
Patents (t-1)	-0.68*	-0.66	-0.46	-0.42	-0.33	-0.33	-0.18	-0.21	-0.38	-0.24	-0.56	-0.59
	(0.402)	(0.408)	(0.412)	(0.397)	(0.423)	(0.425)	(0.413)	(0.406)	(0.413)	(0.376)	(0.410)	(0.397)
Density (t-1)	0.03***	0.04***	0.04***	0.04***	0.03***	0.03***	0.03***	0.04***	0.03***	0.03***	0.03***	0.03***
	(0.012)	(0.011)	(0.012)	(0.012)	(0.012)	(0.013)	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Reg utilities (t-1)	-33.84***	-30.36***										
	(4.067)	(5.829)										
Reg utilities x prod gap (t-1)		7.41										
		(8.561)										
Reg retail-wholesale trade (t-1)			-201.07***	-110.34**								
			(44.348)	(45.068)								
Reg RWT x prod gap (t-1)				165.16***								
				(28.064)								
Reg transport (t-1)					-12.35***	-9.73*						
					(3.801)	(5.664)						
Reg transport x prod gap (t-1)						9.11						
						(15.312)						
Reg comm. (t-1)							-8.07	-2.95				
							(5.910)	(10.267)				
Reg comm x prod gap (t-1)								12.30				
								(16.930)				
Reg fin interm (t-1)									-331.59***	-237.82***		
									(75.446)	(57.954)		
Reg FI x prod gap (t-1)										-267.41***		
										(36.169)		
Reg business services (t-1)											-323.61***	-329.83***
											(57.343)	(54.389)
Reg bus serv x prod gap (t-1)												-149.31***
												(44.642)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,234	1,234	1,234	1,234	1,234	1,234	1,234	1,234	1,234	1,234	1,234	1,234
R^2	0.240	0.241	0.150	0.225	0.126	0.127	0.120	0.121	0.150	0.258	0.163	0.193
Number of regions	217	217	217	217	217	217	217	217	217	217	217	217

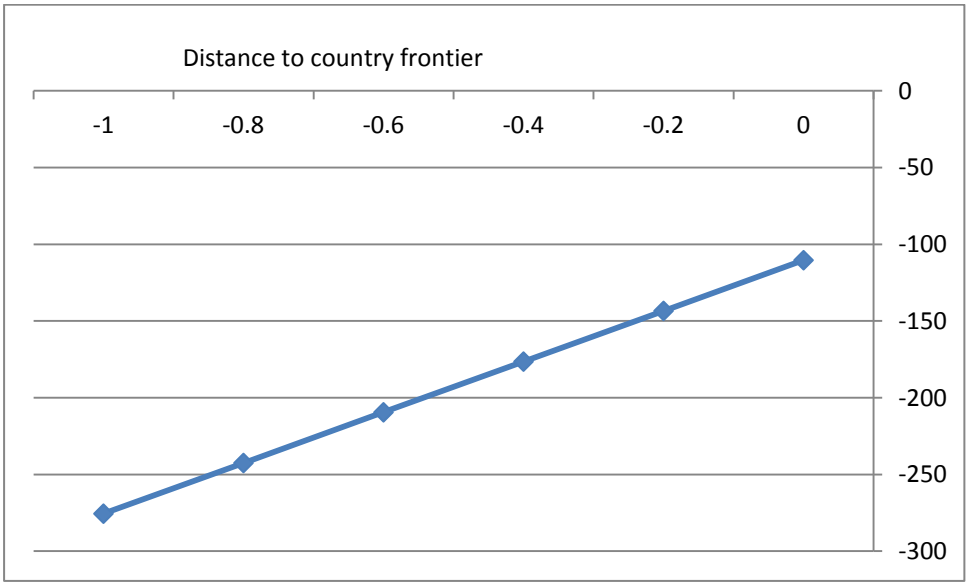
Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

The signs and magnitudes of the coefficients on the base model variables are similar to those obtained in Table 2 confirming the effects of the catching-up and the technological pass-through on regional productivity growth and the importance of agglomeration effects.

The effects of regulation on productivity growth are quite robust: regulations in the six upstream sectors curb productivity growth in five of the six sectors considered with a strong statistical significance. Only regulation in the communication sector does not appear statistically significant. The negative effects of regulation are largest in the sectors of financial intermediation, business services, and retail and wholesale trade.

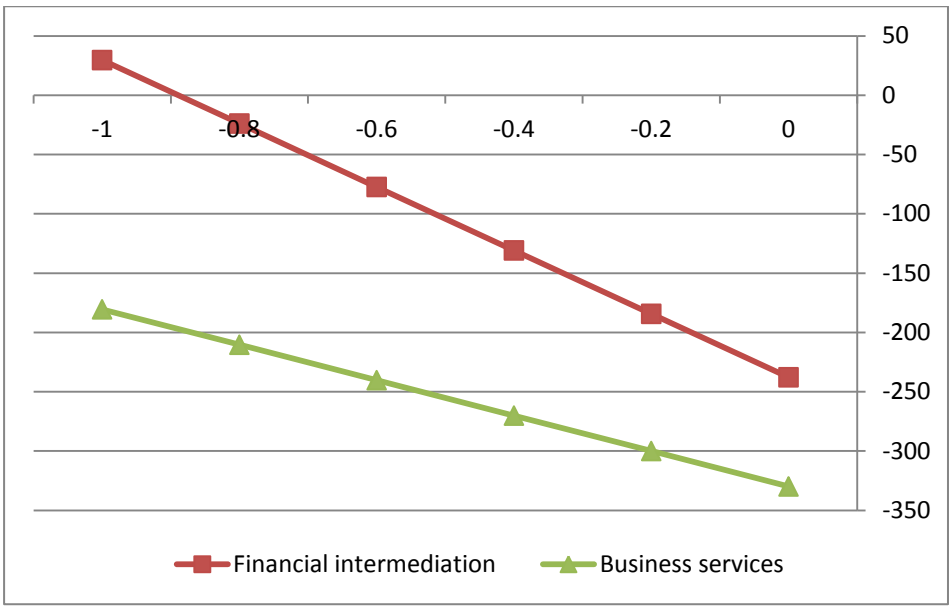
The interaction term multiplying the productivity gap with the regulation variable enables to differentiate the effects of regulation on regions closer and further away from the production possibility frontier. In three among the six sectors considered we find evidence of a differentiated impact in regions according to their distance to the frontier: wholesale and retail trade and repairs, financial intermediation and business services. It should be noted that the specification of robust standard errors is quite restrictive, which may deprive some variables of significance but strengthens confidence in results that still pass the significance tests. When the interaction terms are included, the results suggest that the negative effects of regulation in wholesale and retail trade appear to be particularly pronounced in regions further from the productivity frontier (Figure 1).

Figure 1. The effect of PMR in wholesale and retail trade and repairs on regional productivity growth



In financial intermediation and business services, heavier regulation tends to have a more pronounced negative effect on productivity performance in the leading regions than in lagging ones (Figure 2), and both interaction terms are highly significant. This is likely to reflect the greater role of those two sectors in denser, more diversified economies.

Figure 2. The effect of PMR in financial intermediation and business services on regional productivity growth



We next examine the effects of overall regulation captured through a simple average of the six upstream sectors covered. We also estimate the effects of complementarities in the six sectors and we also estimate the combined effects of both. The results are reported in Table 4.

The overall level of product market regulation (PMR) is clearly negative and highly significant (column 1). However, there is little evidence of a differential effect across regions when considering PMR overall. The complementarity of regulation across the six upstream sectors has a positive effect on regional growth suggesting that reforming policies in a complementary framework will yield a stronger impact on regional productivity growth than if reforms are undertaken in isolation. This is an important message concerning the need for the integration of policies.

Table 4. Impact of average and complementarity of regulation on regional productivity growth

	(1)	(2)	(3)	(4)	(5)	(6)
Frontier growth (t-1)	0.11***	0.11***	0.10***	0.10***	0.12***	0.12***
	(0.036)	(0.037)	(0.036)	(0.036)	(0.035)	(0.036)
Productivity gap (t-1)	-13.53***	-19.50**	-13.15***	12.61	-15.24***	-22.53
	(3.280)	(7.940)	(3.227)	(25.125)	(3.262)	(23.009)
Physical capital (t-1)	-1.17	-1.20	-1.08	-1.06	-1.39*	-1.42*
	(0.821)	(0.836)	(0.867)	(0.867)	(0.818)	(0.839)
Human capital (t-1)	-6.24***	-6.13***	-6.28***	-6.50***	-7.98***	-7.86***
	(2.059)	(2.084)	(2.044)	(2.043)	(2.060)	(2.082)
Patents (t-1)	-0.66	-0.66	-0.13	-0.18	-0.52	-0.52
	(0.403)	(0.408)	(0.408)	(0.407)	(0.406)	(0.411)
Density (t-1)	0.03***	0.04***	0.04***	0.04***	0.04***	0.04***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.011)	(0.012)
Regulation (t-1)	-88.84***	-81.56***			-68.00***	-60.15***
	(12.856)	(16.670)			(12.837)	(18.083)
Reg x prod gap (t-1)		19.21				20.68
		(24.376)				(25.046)
Complementarity (t-1)			10.39***	8.31***	7.22***	7.31***
			(1.458)	(2.781)	(1.387)	(2.589)
Compl x prod gap (t-1)				-4.63		0.15
				(4.526)		(4.534)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Region effects	Yes	Yes	Yes	Yes	Yes	Yes
N	1,234	1,234	1,234	1,234	1,234	1,234
R^2	0.191	0.193	0.180	0.181	0.217	0.219
Number of regions	217	217	217	217	217	217

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Next, we report in Table 5 the results of including the second regulation variable Employment Protection Legislation (EPL) into the augmented model. The results reveal a negative effect of EPL on regional productivity growth and the effect is more pronounced in regions further from the productivity frontier.

Intuitively, this differential impact among different kinds of regions can be driven by the density of labour markets. Regions further from the productivity frontier tend to be less dense. While density and distance from the frontier are distinct variables, theory suggests and the data confirm that larger agglomerations do tend to be characterised by higher *per capita* income and productivity levels (though not growth rates). This means that there is likely to be a strong relationship between density and distance to the frontier. That, in turn, means that labour markets in regions close to the frontier are likely to be "thicker", with larger and more diverse populations of workers. Other things being equal, labour-market rigidities are likely to be less costly in thicker labour markets and in those that are better endowed with skills, because skill supply and matching are likely to be easier under any given regulatory regime. Regulatory rigidities are likely to exact a much higher price in less dense markets.

Table 5. Impact of employment protection legislation on regional productivity growth

	(1)	(2)
Frontier growth (t-1)	0.08**	0.07**
	(0.038)	(0.036)
Productivity gap (t-1)	-8.42***	-29.93***
	(3.175)	(8.626)
Physical capital (t-1)	-0.12	0.09
	(0.918)	(0.902)
Human capital (t-1)	-1.59	-2.16
	(2.088)	(1.987)
Patents (t-1)	-0.28	-0.22
	(0.415)	(0.415)
Density (t-1)	0.04***	0.04***
	(0.013)	(0.013)
EPL (t-1)	-3.39***	-0.36
	(1.179)	(1.852)
EPL x prod gap (t-1)		8.19**
		(3.273)
Year dummies	Yes	Yes
Region effects	Yes	Yes
N	1,234	1,234
R^2	0.129	0.148
Number of regions	217	217

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Augmenting the model to macro-economic factors

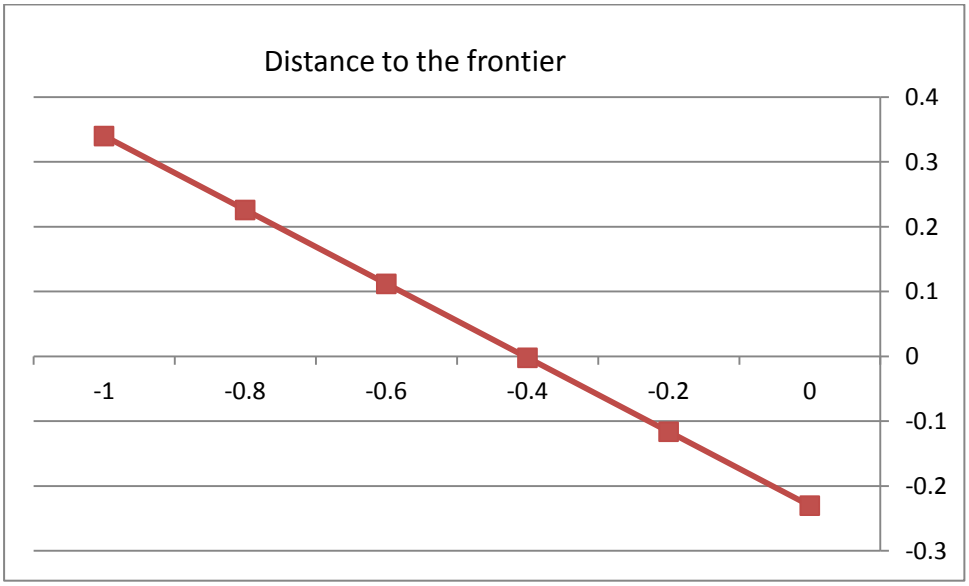
Table 6 now introduces the macroeconomic variables. The effect of trade exposure is insignificant overall but the results in column 2 indicate that it has a negative effect on the frontier region and a positive effect on lagging regions suggesting increased openness to external trade, measured as the volume of trade as a percentage of GDP, seems to be particularly good for lagging regions (Figure 3).

Table 6. The effects of macroeconomic variables on regional productivity growth

	(1)	(2)	(3)	(4)	(5)	(6)
Frontier growth (t-1)	0.09**	0.07**	0.12**	0.11***	0.08**	0.08**
	(0.038)	(0.034)	(0.046)	(0.043)	(0.037)	(0.037)
Productivity gap (t-1)	-9.10***	9.40	-10.00***	-17.11	-8.70***	-6.63**
	(3.209)	(5.984)	(3.377)	(11.882)	(3.260)	(3.200)
Physical capital (t-1)	-0.58	-1.35	-0.97	-0.79	-0.95	-0.96
	(0.892)	(0.955)	(0.819)	(0.826)	(0.914)	(0.895)
Human capital (t-1)	-2.51	-3.04	-1.64	-2.20	-4.09**	-4.09**
	(2.052)	(2.004)	(1.984)	(2.010)	(1.987)	(1.974)
Patents (t-1)	-0.16	-0.24	-0.18	-0.16	-0.15	-0.03
	(0.417)	(0.406)	(0.447)	(0.458)	(0.411)	(0.411)
Density (t-1)	0.03***	0.04***	0.04***	0.04***	0.04***	0.04***
	(0.013)	(0.013)	(0.013)	(0.014)	(0.013)	(0.013)
Trade (t-1)	0.03	-0.23***				
	(0.055)	(0.089)				
Trade x prod gap (t-1)		-0.57***				
		(0.158)				
Debt (t-1)			0.08*	0.12		
			(0.050)	(0.081)		
Debt x prod gap (t-1)				0.11		
				(0.179)		
Inflation (t-1)					-0.37***	-0.77***
					(0.140)	(0.288)
Infl x prod gap (t-1)						-1.01*
						(0.543)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Region effects	Yes	Yes	Yes	Yes	Yes	Yes
N	1,234	1,234	1,224	1,224	1,234	1,234
R^2	0.118	0.164	0.126	0.129	0.129	0.136
Number of regions	217	217	217	217	217	217

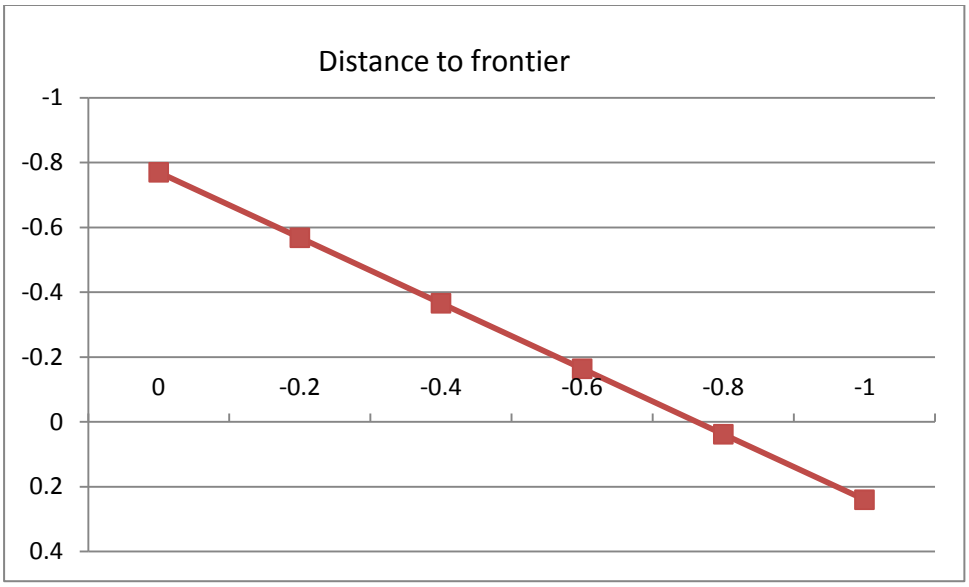
Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Figure 3. The effect of trade openness on regional productivity growth



The effect of debt on regional growth is positive but no longer significant once we include the interaction term. Finally, as expected, inflation is bad for productivity growth overall, however the effect is differentiated (Figure 4) with a stronger negative effect on regions closer to the productivity frontier, and in extreme lagging regions inflation can even have a positive effect.

Figure 4. The effect of inflation on regional productivity growth



V. Conclusion

Our analysis measures the effects of country-wide factors on regional performance. We consider both the effects of regulatory policies and macroeconomic factors on regional productivity using a panel covering 217 regions from 22 OECD countries over the period 1995-2007 representing roughly three business cycles. We find strong statistical links between economy-wide national factors and regional productivity. Furthermore these effects are not homogenous across regions; they tend to vary with respect to the distance of regions to their national productivity frontier. Our estimates find that regulation curbs productivity growth in five among six upstream sectors considered in the analysis. Overall regulation and regulation in labour markets also harm regional performance. Finally, coherence and complementarities in policies boost productivity growth according to our estimates. This indicates that reforms in regulation should not be undertaken in isolation.

The effects of regulation tend to vary among regions according to their distance to the frontier: regulation in wholesale and retail trade and in employment protection legislation tend to curb productivity growth more in lagging regions further away from the frontier than in leading regions. In contrast regulation in financial intermediation and business services is more harmful to productivity growth in leading regions close to the frontier.

Macroeconomic factors also influence regions in distinct ways: trade openness has a negative effect on the frontier regions and a positive effect on lagging regions. Inflation in contrast has an overall negative effect on productivity growth and this effect tends to be stronger in leading regions closer to the frontier.

In addition, our analysis finds evidence of a catching up effect with faster productivity growth in lagging regions and evidence of a pass-through effect in which improvements by the frontier regions boost overall productivity growth.

These findings reveal a strong link between the national and the regional dimension which carry important policy implications. First they help understand how national factors have a differentiated impact across different spatial dimensions enabling us to better assess their overall effects. Our results also suggest that structural and macroeconomic policies should account for these regional effects in their design by complementing these policies with policies targeted to specific regions to enhance their effects or restrain their negative effects.

Finally, arguments against regulatory reform tend to be made on the basis of harming vulnerable or strategic regions. While our results tell us that regulatory effects tend to vary according to regions' distance to the frontier, they also highlight the fact that different forms of regulation have different regional impacts. Moreover, our findings do not support this claim given the strong negative effects of regulatory policies on the productivity growth of regions overall.

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