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Impact of Structural Reforms on Regional Growth: Distance to the Frontier Matters

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Abstract
This paper aims to understand the impact of nation-wide structural policies on the productivity growth of OECD regions. In particular, we explore how this impact varies with the productivity gap of regions with their country's frontier region. We use a policy-augmented growth model that allows us to estimate the effects of macroeconomic and structural policies on regional productivity growth. We estimate our model with an unbalanced panel dataset consisting of 265 regions from 24 OECD countries covering the period 1997 to 2007. We find that the effects on regional productivity growth are differentiated with respect to the regional productivity gap: Relaxing employment protection legislation on temporary contracts or lowering barriers to trade and investment would enhance productivity growth in lagging regions, whereas reducing the amount of state control has the opposite effect on lagging regions. Macroeconomic factors also influence regional performance: trade openness and the government debt to GDP ratio are more beneficial to lagging regions. These results reveal that average relationships between nation-wide policies and the productivity of regions can hide strong differentiated effects according to the distance to the country frontier. This carries important policy implications, mainly that these region-specific effects should be taken into account in the policy design

Keywords: structural reforms, regional growth, lagging regions
JEL Classifications: R11; R58; O18

1. Introduction

This paper aims at analysing the impact of macro-structural factors on the productivity growth of regions. These economy-wide factors may be defined in a uniform way for all regions in a given country, but their impact region by region can be very asymmetric. In this way, we aim at bridging the gap between the national and the regional dimensions in the study of economic growth, as well as in economic policy. On the one hand, at the country level, the neoclassical literature investigating economic growth based on Cobb-Douglas production functions (Solow, 1956 and Swan, 1956) which evolved towards the endogenous growth framework (Lucas, 1988 and Romer, 1986) focused on understanding the country-level drivers of national growth, including country-level policies. On the other hand, the literature investigating economic growth dynamics at the regional level explains regional growth based on regional factors. This includes studies of regional convergence (Sala-i-Martin, 1996, Barro and Sala-i-Martin, 2004) and more recently models of regional growth using frameworks from the New Economic Geography (Minerva and Ottaviano, 2009, Desmet and Rossi-Hansberg, 2010)[2] . There is still a gap between these two bodies of literature and as a result the link between country-level factors and regional economic growth needs to be better understood. Recent work has advanced our understanding of how the regional dimension maps into and contributes to aggregate growth (see OECD, 2011). Che and Spilimbergo (2012) using a limited set of structural reform indicators analysed how they impact regional convergence; however the study of how country-wide factors influence performance at the regional level is still nascent.

The country-level factors we examine comprise a broad package of structural policies, including product market regulation and labour market legislation, as well as macroeconomic factors such as trade exposure, the level of inflation and government debt. We consider their effect on the productivity growth of OECD regions, measured as growth in GDP per worker. 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 (the frontier region). We also examine the pass-through effect by estimating how growth in the frontier region affects

[2] See Breinlich *et al.* (2013) and OECD (2009) for a review.

growth in other regions within a country and the catching-up effect by estimating whether regions that are farther from the frontier (lagging regions) grow faster.

We believe our work carries important conclusions for both macro-structural and regional policies. Regional policy has evolved over the past decades from a paradigm dominated by temporary subsidies and short term corrections in regional imbalances to a modern approach focusing on competitiveness and growth with an aim to boost the overall performance of countries. A criticism of EU regional transfers has been made for example in Boldrin and Canova (2001) who find that productivity in poorer regions was unaffected by the amount of transfers received. The authors conclude that these policies simply have a redistributive role without enhancing either aggregate growth or that of lagging regions in the EU. More recently, Breidenbach *et al.* (2016) found that the disbursement of EU structural funds is negatively correlated with regional growth and does not seem to contribute effectively to foster income convergence across regions. Other work on EU regional transfers has highlighted the fact that their overall efficiency could be improved by reallocating these transfers towards a select group of target regions (Becker *et al.*, 2012). Our paper aims to contribute to the current debate over the conditionality of regional transfers whereby unconditional transfers have been deemed insufficient and transfers are now increasingly tied to specific structural improvements.[3] Our results indicate that lagging regions differ from leading regions in their response to structural reforms and therefore that regionally differentiated policies could have a significant role to play in national growth policy.

The paper is structured around six sections. In the next section we provide an overview of the literature and of our conceptual framework. The third section describes the model and Section 4 is dedicated to the data. Section 5 presents the results of our estimates as well as robustness checks. The final section presents our conclusions.

[3] The heterogeneity of the effect of transfers on regional growth is analysed in Becker *et al.* (2013), who find that regions with better governance and human capital enjoy greater growth in response to EU transfers.

2. Conceptual framework and review of the literature

Our empirical model is inspired by the model in Bourlès *et al.* (2013). 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. Bourlès *et al.* (2013) examine whether competition and policies affecting competition have an impact on the productivity growth of downstream sectors. The conclusion of their model is that lack of competition in upstream sectors leads to lower productivity growth in downstream sectors. In addition, this model shows the relevance of two factors that have been identified in the literature as influencing positively sector productivity growth. First, growth at the international technological frontier 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 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 country frontier.

Our paper is concerned with the relationship between economic growth and levels of product market regulation, which has been studied before at the country level by Nicoletti and Scarpetta (2003) for OECD countries. The results in Nicoletti and Scarpetta (2003) indicate that differences in regulatory reform explain part of the cross-country growth disparities. They find that lower levels of entry barriers and state control enhance productivity growth, particularly in countries that lag behind in technology adoption. They also find productivity gains from privatization. This leads us to ask whether such reforms might explain differences in the growth of subnational regions. In addition, we also consider the impact of employment protection legislation (EPL) on regional growth.

Our approach is also related to that of Bassanini and Scarpetta (2001), who build a country-level "policy-augmented" growth model analysing the effects of macroeconomic policies such as inflation targeting, fiscal policy or international trade on national economic

growth in OECD countries. Their findings suggest that high inflation hinders output growth, possibly due to its negative effect on investment and capital accumulation. They also find a negative effect of the size of government on growth, whereas trade exposure is found to be positively associated with output growth.

As highlighted in Bassanini and Scarpetta (2001), government deficit can affect country-level growth by reducing private sector investment, and by implying 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 (*i.e.* how productive it is). At the regional level, in contrast to Bassanini and Scarpetta (2001), by estimating the effect of local taxes and public expenditures on regional economic growth in Korea, Kim (1997) 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) also 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, 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.

Our empirical framework focuses on pass-through, catching-up and structural framework conditions. It also accounts for time-invariant regional drivers of growth. It does not explicitly control for other time-varying region-level drivers of regional growth such as physical and human capital and innovation. Although 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, the evidence at the regional level is mixed. 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. However Crescenzi and Rodriguez-Pose (2012) fail to find a role for transport infrastructure in regional economic growth among EU regions. Turning to human capital, although empirical evidence on the importance of human capital for regional growth can be found in Glaeser et al. (1995), Henderson et al. (1995) and Rauch (1993), we do not find such evidence in our dataset. Similarly, we do not find in our data a relationship between innovative activity and regional productivity growth.

Our paper is part of a very small number of studies that have combined the notions of macroeconomic policies, regional economic growth and convergence. Studying the case of Indian states, Ahluwalia (2000) discusses 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 certain state-specific characteristics. However he does not provide empirical evidence on how nation-wide structural reforms can have different impacts on states as these differ in their characteristics. More recently, related work by Che and Spilimbergo (2012) has estimated the effect of structural reforms on the speed of convergence between regions in developed and developing countries, concluding that financial development, trade openness, sound institutions and some labour market reforms favour regional convergence.

3. Description of the model

As previously explained, our model is based on a modified version of Bourlès *et al.* (2013) adapted to the regional context. Our policy-augmented growth model allows us to estimate the effects of macroeconomic and structural policies on regional productivity growth and simultaneously measure how this effect varies with respect to a region's distance to the "frontier" or most productive region in the country (the catching-up effect) and the direct

impact of the frontier region on productivity growth (the pass-through effect). Our hypothesis is that regional productivity growth is positively related to the productivity growth of the frontier region within the country and positively related to the productivity gap with the frontier region (in other words productivity growth increases with distance to the productivity frontier as lagging regions catch up).

In terms of structural policies, we consider labour market legislation, the level of state control, barriers to entrepreneurship and barriers to trade and investment which are described in the next section. Our macroeconomic variables are trade exposure, government debt and inflation.

Our econometric estimates are based on the following reduced form:

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

$\Delta \ln prod_{r,t}$ is the percentage growth in region *r*'s productivity between *t-1* and *t* (productivity measured as GDP per worker), $\Delta \ln prod_{F^C,t}$ is the percentage growth of the country frontier region's productivity in year t and $prodgap_{r,t-1}$ is the lagged productivity gap with the country frontier region. The productivity gap variable $prodgap_{r,t-1}$ is defined as $\ln\left(\frac{Prod_{r,t-1}}{Prod_{F^C,t-1}}\right)$. The gap is equal to zero at the frontier and becomes increasingly negative for regions 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 $prodgap_{r,t}$ takes negative values, increasing $prodgap_{r,t}$ is equivalent to decreasing the distance to the frontier, which we expect to reduce the catching-up effect on regional growth. $Pol_{C,t-1}$ is the lagged level of the policy variable in country *C*. To facilitate the interpretation of the coefficients, we normalise the structural policy indicators (see below). Higher values of labour market legislation, state control and barriers to entrepreneurship or barriers to trade variables are indicative of lower levels of regulation. Since we are interested in the impact of nation-wide factors on different types of regions, and in particular on regions depending on their distance to the country's productivity frontier, each nation-wide variable is interacted with the productivity gap variable. A negative

estimate of β_4 means that deregulation in labour markets or state control for example has a positive effect on the growth of lagging regions (compared to the effect on the frontier region) and *vice versa*. ζ_t are year-specific effects and γ_r region fixed-effects that account for time-invariant regional factors that influence regional productivity growth.

In our estimations we multiply the variable $\Delta \ln prod_{Fc,t}$ by a dummy variable equal to zero if the region is a frontier region in the given year. This is because otherwise if r is a frontier region then β_1 in equation (1) would be equal to 1 and the estimate obtained would be biased towards the share of frontier regions in our dataset (8%). By doing this, we obtain an estimate for β_1 which is estimated only over the non-frontier regions.

We estimate the model using OLS with fixed effects. However the variable $prodgap_{r,t-1}$includes a term which is the lagged dependent variable that in its transformed form is correlated with the transformed error term. This would lead to estimation by fixed effects being biased. In order to address this, and given the serial correlation in our variables and the relatively small number of years in our dataset, we follow Blundell and Bond (1998) and also estimate our model using a system-GMM method.

Noteworthy, the fact that we are using regional data enables to control for fixed-effects without creating the usual collinearity problems with the country-wide policy variables, which often do not display strong time variability.[4]

4. The data

Our data consist of a panel of 265 regions from 24 OECD countries[5] defined at Territorial Level 2 (TL2), taken from the OECD Regional Database and covering the period 1997 to

[4] This is a recurrent problem in many cross-country econometric growth studies using structural policy variables that do not display a time dimension or have low time variability. To circumvent this problem, researchers often have to revert to pooled or the GLS estimates that may generate bias on their own.

[5] We do not use the full set of OECD countries and regions due to restrictions on data availability. The countries covered are Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, UK and USA.

2007.[6] We observe regional productivity since 1996, defined as GDP per worker, 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. This allows us to compute the productivity growth of the frontier region ($\Delta \ln prod_{Fc}$) and the distance between a given region and the country frontier region ($prodgap$).

Turning to our country-year level policy and macroeconomic variables, our measures of regulation are drawn from the OECD's Product-Market Regulation (PMR) Database.[7] The 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. In the original data, the values for each indicator vary between 1 and 6, with higher values indicating higher levels of restrictions. To make their interpretation more comparable with the other structural indicators, we use the PMR with a reverse scale (i.e. higher values mean lower restrictions). 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. We use the three main PMR components rather than the composite indicator because the latter combines quite different dimensions, possibly affecting regional growth in a very diverse manner. The first is *State control* that measures the extent of state ownership (scope of public enterprise, direct control over business enterprises and government involvement in network sectors) and the state's involvement in business operations (price controls, use of command and control regulation). The second are *Barriers to entrepreneurship* that measures regulatory and administrative opacity, administrative burdens on start-ups and barriers to competition.

[6] We prefer to restrain our sample to the pre-crisis period in order to capture the structural effects of policies. During an economic depression, structural reforms may have temporary deflationary effects counteracting their long-run benefits. This may generate a bias in the estimates of the gains from structural reform.

[7] See Wolfl *et al.* (2009) for a detailed description of the PMR data as well as Koske *et al.* (2015) for a more recent update on the PMR data.

Finally, *Barriers to trade and investment* encompasses barriers to FDI, tariffs, discriminatory procedures and regulatory barriers to trade and investment.

Our second structural policy area is that of labour market legislation. We use the employment protection legislation (EPL) indicator constructed by the OECD's Directorate for Labour and Social Affairs, which varies from 1 to 6 (like for the PMR, we are using here a reverse scale, which increases with labour market deregulation). EPL 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). EPL indicators are available for all 35 OECD countries as well as for 39 non-OECD countries and territories. Two EPL indicators were available to us: the first one, pertaining to regular contracts, was not retained in our analysis due to the lack of time and cross-country variation in this measure; the second one, pertaining to temporary contracts, presents considerable variation as this form of employment contracts has been subject to reform in many countries in the period we consider.

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 inflation (measured as the rise in the consumer price index). All macroeconomic data are drawn from OECD sources.

Table 1 provides summary statistics of the variables. Annual productivity growth has an average value of 1.7% and ranges from -7.8% to +13.9%. Outlier observations with productivity growth lower than -8% or greater than 14% have been removed from the sample, although the frontier region growth is allowed to exceed these values. 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.

5. Results

5.1 Impact of structural reforms

Table 2 reports our results on the effects of structural variables using regional fixed effets, pooled OLS and system GMM methods. The first six columns in Table 2 report the estimates from fixed effects regressions. In column (1), the positive and statistically significant coefficient on *frontiergrowth* indicates that increasing the productivity growth of the country frontier region has a positive effect on the growth of the other regions, as expected. The 0.05 coefficient means that a 1 percentage point increase in the annual productivity growth of the country frontier region is associated with a 0.05 percentage point increase in regional productivity growth. Although the effect is positive and significant, it is of small magnitude: the frontier region is the region with the highest productivity level in the country and may not have particularly high growth. We further investigate the pass-through effect from the frontier in our robustness checks. Turning to the *prodgap* coefficient, this is negative and statistically significant as expected and means that one standard deviation increase in the distance to the frontier is associated with a 2.9% higher regional growth.

Introducing the policy variables and their interaction with the productivity gap one-by-one (columns (2) to (5)) shows that for all the policies, except barriers to trade, the effect on regional growth varies significantly with the distance to the frontier. Including the four policy variables together in a fixed effects specification as in column (6) leads to some coefficients changing sign. Although deregulating EPL and barriers to entrepreneurship still increases the growth of lagging regions in the full specification, deregulating state control now appears to have a detrimental effect on lagging regions (the coefficient on the interaction term being positive) and so does reducing barriers to trade (although the coefficient is of low significance). This highlights the importance of including the structural policy indicators simultaneously. The coefficient of -13.95 on the productivity gap represents a fictitious case where all the structural variables would be at zero, meaning the highest possible levels of regulation. The overall effect of the productivity gap however, computed at average levels of the structural variables, is -9.2, meaning that increasing the productivity gap by one standard deviation would increase regional growth by 4%.

Column (7) presents, as a means of comparison, the results obtained from a pooled OLS estimation. Without region-specific effects, the effect of the frontier is no longer significant. The cross-section effects dominate, capturing agglomeration forces rather than convergence forces. Indeed, regional growth can be the result of convergence and agglomeration forces. The former tend to favour lagging or poorer (often low-density, rural areas). Conversely, the agglomeration forces favour the dense, urbanised (see Garcilazo and Oliveira Martins, 2013). The fixed effects and system GMM with region effects methods however capture the convergence forces.

As explained in Section 3, our preferred estimation method is system GMM. The corresponding results in column (8) confirm the pass-through effect of the frontier region with a highly significant coefficient of +0.07 on the frontier region growth. The catching-up effect is maintained as the average effect of the productivity gap at average levels of the policy variables is still negative. Turning to the interaction terms, EPL and barriers to trade affect regional growth differently according to the distance to the frontier. For a region at the average distance to the frontier, increasing EPL of temporary contracts (i.e. deregulating) by one standard deviation is associated with a 2 percentage point higher regional growth, with a greater positive effect on lagging regions. Intuitively, this differential impact of labour market legislation among different kinds of regions can be driven by agglomeration effects. 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 in labour markets are likely to exact a much higher price in regions farther from the frontier.

Our estimates continue to indicate that reducing state control does not have a significant impact on regional growth and the same goes for barriers to entrepreneurship in our GMM estimation. Removing barriers to trade and investment is however also beneficial to the growth of lagging regions: increasing the policy variable by one standard deviation increases the growth of the average distance region by 0.5 percentage points. The results obtained across the specifications presented in Table 2 suggest that considering policy

variables separately, or considering their effect on average regional growth only, can be misleading.

5.2 Impact of macroeconomic factors

Table 3 reports our results using the three macroeconomic variables. Again, the coefficient on frontier region growth is highly significant and robust across specifications. Including macroeconomic factors one by one in fixed effects estimations again yields significant coefficients on the interactions terms, indicating that the effects vary with distance to the frontier (columns (2) to (4)). Combining all the variables and interaction terms together as shown in column (5) confirms that increasing trade exposure and government debt at the country level enhances the growth of lagging regions, but means that the interaction coefficient for inflation loses its significance. Turning to our system GMM results in column (7), we find a more pronounced effect for trade exposure. The coefficient of -0.38 means that for a region at the average distance to the frontier, one standard deviation increase in trade exposure is associated with 2.6 additional points in economic growth. We do not find evidence of a strong role of government debt or inflation in regional growth.[8]

Overall, both estimates on structural policies and on macroeconomic facts support the hypothesis that exposure to international trade has an enhancing effect on regional productivity growth. A possible explanation could be related to the role of the tradable sector as an engine of unconditional growth (Rodrik, 2013).

5.3 Robustness checks

Next, we investigate if our results are sensitive to specificities of our data. We first consider the possibility that the results may be driven by the presence of frontier regions in our dataset for analysis. We remove from our data all the observations that correspond to a country's frontier region in any given year. As a result we are left with 2,281 observations for which the productivity gap is not zero. Results are presented in Table 4. Our results are maintained

[8] Note that this is the effect of increases in debt. In the pooled OLS results (column (6)), we do find a highly significant negative effect of debt levels on regional growth.

both in the fixed effects and GMM estimations. In the fixed effects specification (column 6), the effects of the structural policies are similar yet more pronounced. In our GMM results in column (7), we also find a positive effect of deregulation in EPL and barriers to trade on the regional growth of lagging regions that is more pronounced than in the full sample. In this restricted sample we now find a negative effect of reducing barriers to entrepreneurship on lagging regions (from no significant effect in the whole sample). This is mitigated however by the very small magnitude of this effect: one standard deviation increase in the barriers to entrepreneurship indicator corresponds to a 0.37 point decrease in regional growth for the region at the average distance to the frontier.

Similarly, in Table 5 we remove the observations corresponding to the three regions with the highest productivity in each country in each year. This estimates the effects of the frontier and of structural policies on the periphery. Again, the fixed effects results are very similar to those obtained from the whole sample, with effects of EPL and barriers to trade that are more pronounced. Turning to the GMM results, the effects of EPL and of barriers to trade and investment are much stronger. The coefficients on the interactions of state control and barriers to entrepreneurship with the productivity gap are now significant: reducing the level of state control enhances the growth of lagging regions whereas lowering barriers to entrepreneurship is beneficial to regions closer to the frontier and less so for lagging regions. Finally, in both the fixed effects and GMM results, the pass-through effect of the frontier is greater for this restricted sample of peripheral regions.

Another possible bias may come from our definition of the frontier regions. Instead of using the region with the highest productivity in region *r*'s country, we propose an alternative definition of the frontier by creating a synthetic frontier where the productivity is equal to the average productivity in the three most productive regions in the country in a particular year. We also compute an alternative measure of the distance to the frontier, which is now equal to the difference between the log of productivity of region *r* and the log of the average productivity of the three most productive regions. We then remove from our dataset the three regions that were used in order to create the synthetic frontier region. This is to avoid having a positive productivity gap between the highest productivity region and the synthetic average.

The results in Table 6 show that regional growth increases in the growth of the synthetic frontier, it also increases in the distance to the synthetic frontier, as presented in our

main results in Table 2. It is noteworthy that the pass-through effect estimated here is much larger than that identified in Table 2 with the full sample or even in Table 5 without the top three regions: a one percentage point increase in the growth of the synthetic frontier is associated with a 0.3 point increase in regional growth for the other regions. For all regions except the three most productive, the pass-through of the economic core of the country is more meaningful than that of the single frontier region. Although in the fixed effects estimation (column (6)), only the interacted effect of EPL remains significant and similar to that obtained in the main results, the results obtained from our system GMM estimation (column (7)) are similar to those obtained in Table 5 from the sample omitting the top three regions, where lowering restrictions on EPL, barriers to trade and state control enhance the growth of lagging regions.

Given the time period of our analysis it could be argued that Poland, Ireland and Spain could have an overly important weight on the results. During the pre-crisis period, these three countries experienced particularly rapid growth and undertook important structural reforms. Accordingly, we replicated our main estimates after removing Polish, Irish and Spanish regions from our sample (see Table 7). Our results on the effect of growth in the frontier region and on the effect of the distance to the frontier are robust to the exclusion of Spanish and Irish regions separately. When we exclude Polish regions, the results are robust except for the estimates on the effects of barriers to trade. In particular, we no longer find a significant effect of barriers to trade and investment in the GMM specification.

Turning to the macroeconomic variables, the first three robustness checks are offered in Table 8. We find again a positive impact of trade exposure on the growth of lagging regions and no significant effect of either government debt or inflation. Table 9 shows the results obtained once we exclude Polish, Spanish and Irish regions. Here again the significant effect of trade exposure is confirmed. The small positive effect of debt on lagging regions in the fixed effects regressions is also confirmed.

6. Conclusions

Our analysis measures the effects of country-wide macro and structural factors on regional performance. We consider both the effects of regulatory policies and macroeconomic factors

on regional productivity using a panel covering 265 regions from 24 OECD countries over the period 1997-2007 representing roughly three business cycles. We find strong statistical links between economy-wide macroeconomic and structural policies and regional productivity that are not homogenous across regions; they tend to vary with respect to the distance of regions to their national productivity frontier, with typically lagging regions being the most affected by rigidities in product and labour markets. 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 where growth in the frontier regions boosts the productivity growth of the other regions.

Our estimates reveal that deregulating employment protection legislation in temporary contracts or reducing the level of barriers to trade and investment has a strong positive effect on the growth of lagging regions. For a region at the average distance to the frontier, deregulating EPL of temporary contracts by one standard deviation increases regional growth by 2 percentage points, with a greater positive effect on lagging regions. Lowering barriers to trade and investment by one standard deviation is associated with 0.5 point higher regional growth. The effect of international trade is confirmed in our separate results on macroeconomic factors: increasing trade openness (expressed as trade volume as a percentage of GDP) at the country level by one standard deviation increases regional growth of a region at the average distance to the frontier by 2.6 percentage points, with a more pronounced effect for lagging regions.

Our results also confirm the pass-through growth effect from the national frontier region to other regions. In particular, the effect of the frontier is more pronounced for peripheral regions than for regions immediately following the frontier in terms of productivity. We also find that the top three most productive regions, which we can consider the core of each country, have a stronger effect on regional growth than the single most productive region.

These findings reveal a strong link between the national and the regional dimension which carries important policy implications. First they help to understand how national factors have a differentiated impact across regions 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 have been made on the basis of harming vulnerable or strategic regions. Our results do not warrant these views. On the contrary, macro-structural policies tend to support catching-up of the lagging regions. This also provides some basis to justify conditionalities associated with structural reforms. 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.

Tables

Table 1: Summary statistics

	Mean	Std. dev.	Min	Max
Productivity	60730.7	36522.7	14169.69	609012.8
Productivity growth	1.69	3.04	-7.84	13.9
Frontier region growth	3.66	6.42	-10.57	64.68
Productivity gap	-0.43	0.43	-3.7	0
EPL temporary contracts	4.47	1.21	1.25	5.75
PMR state control	3.52	0.79	1.76	4.85
PMR barriers to entrepreneurship	3.71	0.54	2.55	4.56
PMR barriers to trade and investment	5.14	0.53	2.85	5.77
Trade openness	31.17	16.05	9.48	92.37
Debt as % of GDP	66.77	28.13	12.6	175.27
Inflation rate	2.36	1.65	-0.9	14.15

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

Table 2: Structural reforms and regional growth

Dependent variable: regional productivity growth	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	FE	FE	FE	FE	FE	FE	Pooled OLS	System GMM
Frontiergrowth X nofrontier	0.05***	0.05***	0.05***	0.05***	0.05***	0.05**	0.03	0.07***
	(0.018)	(0.018)	(0.018)	(0.019)	(0.019)	(0.019)	(0.017)	(0.021)
Productivity gap $_{t-1}$	-6.80***	1.48	-2.37	-4.77***	-5.52*	-13.95**	7.28**	12.59
	(1.310)	(1.877)	(2.499)	(1.419)	(2.952)	(5.996)	(2.889)	(9.414)
EPL temp $_{t-1}$		-0.95***				-1.19***	0.30*	-1.51***
		(0.254)				(0.292)	(0.169)	(0.403)
EPL temp X prodgap $_{t-1}$		-2.27***				-2.51***	-0.66*	-3.95***
		(0.384)				(0.459)	(0.349)	(0.607)
Statecontrol $_{t-1}$			-0.72**			0.20	-0.22	-0.45
			(0.339)			(0.463)	(0.220)	(0.643)
Statecontrol X prodgap $_{t-1}$			-1.29**			2.87***	0.58	-0.71
			(0.609)			(0.902)	(0.440)	(1.561)
Barrierstoentr $_{t-1}$				-0.43		0.18	-0.75***	1.02
				(0.408)		(0.516)	(0.259)	(0.716)
Barrierstoentr X prodgap $_{t-1}$				-0.64***		-1.08**	-0.15	0.91
				(0.163)		(0.456)	(0.265)	(0.667)
Barrierstotrade $_{t-1}$					-0.19	0.17	-0.94***	-1.30**
					(0.355)	(0.631)	(0.263)	(0.640)
Barrierstotrade X prodgap $_{t-1}$					-0.25	1.92*	-1.18**	-2.37*
					(0.517)	(1.161)	(0.576)	(1.361)
N	2,492	2,492	2,492	2,492	2,492	2,492	2,492	2,492
R^2	0.087	0.103	0.089	0.091	0.087	0.110	0.112	
AR(1)								0.000
AR(2)								0.115
Sargan								0.000
Number of instruments								337
Number of regions	265	265	265	265	265	265		265

Dependent variable is regional productivity growth at the TL2 level. Robust standard errors in parentheses. Standard errors are clustered by region. ***, **, * indicate significant at the 1%, 5% and 10% level respectively.

Table 3: Macroeconomic factors and regional growth

Dependent variable: regional productivity growth	(1) FE	(2) FE	(3) FE	(4) FE	(5) FE	(6) Pooled OLS	(7) System GMM
Frontiergrowth X nofrontier	0.05***	0.05***	0.06***	0.05***	0.05***	0.03**	0.06***
	(0.018)	(0.018)	(0.019)	(0.019)	(0.019)	(0.017)	(0.020)
Productivity gap $_{t-1}$	-6.80***	-0.45	-5.91***	-7.74***	-2.76	0.97	2.48
	(1.310)	(2.240)	(1.375)	(1.348)	(1.996)	(0.825)	(3.598)
Trade $_{t-1}$		-0.19***			-0.18***	0.01	-0.30***
		(0.048)			(0.045)	(0.008)	(0.073)
Trade X prodgap $_{t-1}$		-0.19***			-0.12**	-0.03*	-0.38***
		(0.058)			(0.048)	(0.016)	(0.109)
Debt $_{t-1}$			0.01		0.02*	-0.01***	0.03*
			(0.012)		(0.012)	(0.003)	(0.016)
Debt X prodgap $_{t-1}$			-0.03***		-0.02*	-0.01*	-0.02
			(0.006)		(0.008)	(0.005)	(0.013)
Inflation $_{t-1}$				0.09	-0.04	0.11	-0.00
				(0.072)	(0.080)	(0.074)	(0.121)
Inflation X prodgap $_{t-1}$				0.39***	0.05	0.23	-0.07
				(0.135)	(0.132)	(0.142)	(0.207)
N	2,492	2,492	2,492	2,492	2,492	2,492	2,492
R^2	0.087	0.100	0.100	0.091	0.110	0.083	
AR(1)							0.000
AR(2)							0.137
Sargan							0.000
Number of instruments							335
Number of regions	265	265	265	265	265		265

Dependent variable is regional productivity growth at the TL2 level. Robust standard errors in parentheses. Standard errors are clustered by region. ***, **, * indicate significant at the 1%, 5% and 10% level respectively.

Table 4: Sensitivity of the results to the exclusion of frontier regions

Dependent variable: regional productivity growth	(1) FE	(2) FE	(3) FE	(4) FE	(5) FE	(6) FE	(7) System GMM
Frontiergrowth	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***	0.08***
	(0.019)	(0.019)	(0.019)	(0.020)	(0.019)	(0.019)	(0.022)
Productivity gap $_{t-1}$	-7.31***	1.68	-1.83	-5.37***	-6.25**	-16.90***	21.74**
	(1.402)	(1.948)	(2.635)	(1.511)	(3.089)	(6.436)	(10.801)
EPL temp $_{t-1}$		-1.12***				-1.48***	-1.95***
		(0.259)				(0.337)	(0.439)
EPL temp X prodgap $_{t-1}$		-2.48***				-2.85***	-4.48***
		(0.390)				(0.511)	(0.678)
Statecontrol $_{t-1}$			-0.85**			0.44	-0.72
			(0.340)			(0.502)	(0.696)
Statecontrol X prodgap $_{t-1}$			-1.62**			3.14***	-1.43
			(0.639)			(0.969)	(1.702)
Barrierstoentr $_{t-1}$				-0.34		0.52	1.70**
				(0.439)		(0.592)	(0.838)
Barrierstoentr X prodgap $_{t-1}$				-0.65***		-1.15**	1.61**
				(0.172)		(0.500)	(0.774)
Barrierstotrade $_{t-1}$					-0.12	0.52	-2.06**
					(0.376)	(0.703)	(0.865)
Barrierstotrade X prodgap $_{t-1}$					-0.21	2.47**	-3.89**
					(0.543)	(1.245)	(1.698)
N	2,281	2,281	2,281	2,281	2,281	2,281	2,281
R^2	0.094	0.114	0.098	0.099	0.095	0.123	
AR(1)							0.000
AR(2)							0.182
Sargan							0.000
Number of instruments							321
Number of regions	249	249	249	249	249	249	249

Dependent variable is regional productivity growth at the TL2 level. Robust standard errors in parentheses. Standard errors are clustered by region. ***, **, * indicate significant at the 1%, 5% and 10% level respectively.

Table 5: Sensitivity of the results to the exclusion of the top 3 productivity regions

Dependent variable: regional productivity growth	(1) FE	(2) FE	(3) FE	(4) FE	(5) FE	(6) FE	(7) System GMM
Frontiergrowth	0.06***	0.06***	0.06***	0.06***	0.06***	0.07***	0.09***
	(0.020)	(0.019)	(0.020)	(0.020)	(0.020)	(0.020)	(0.023)
Productivity gap $_{t-1}$	-6.37***	2.90	1.25	-5.02***	-5.69	-16.23**	43.15***
	(1.603)	(2.035)	(2.829)	(1.706)	(3.453)	(7.987)	(16.085)
EPL temp $_{t-1}$		-1.38***				-1.92***	-2.48***
		(0.275)				(0.388)	(0.497)
EPL temp X prodgap $_{t-1}$		-2.62***				-3.12***	-4.69***
		(0.397)				(0.551)	(0.749)
Statecontrol $_{t-1}$			-1.25***			-0.11	-2.50***
			(0.323)			(0.543)	(0.823)
Statecontrol X prodgap $_{t-1}$			-2.28***			2.57**	-4.64*
			(0.690)			(1.140)	(2.458)
Barrierstoentr $_{t-1}$				0.04		1.64**	3.72***
				(0.479)		(0.725)	(0.992)
Barrierstoentr X prodgap $_{t-1}$				-0.54***		-0.79	3.41***
				(0.167)		(0.611)	(1.087)
Barrierstotrade $_{t-1}$					-0.03	0.69	-3.62***
					(0.436)	(0.936)	(1.265)
Barrierstotrade X prodgap $_{t-1}$					-0.13	2.77*	-6.75***
					(0.607)	(1.577)	(2.526)
N	1,856	1,856	1,856	1,856	1,856	1,856	1,856
R^2	0.098	0.124	0.105	0.104	0.098	0.139	
AR(1)							0.000
AR(2)							0.123
Sargan							0.000
Number of instruments							288
Number of regions	216	216	216	216	216	216	216

Dependent variable is regional productivity growth at the TL2 level. Robust standard errors in parentheses. Standard errors are clustered by region. ***, **, * indicate significant at the 1%, 5% and 10% level respectively.

Table 6: Sensitivity of the results to an alternative definition of frontier regions

Dependent variable: regional productivity growth	(1) FE	(2) FE	(3) FE	(4) FE	(5) FE	(6) FE	(7) System GMM
Frontiergrowth	0.27***	0.26***	0.27***	0.30***	0.28***	0.30***	0.32***
	(0.035)	(0.035)	(0.036)	(0.035)	(0.036)	(0.034)	(0.038)
Productivity gap $_{t-1}$	-16.71***	-8.65***	-10.81***	-17.76***	-14.88***	-21.50**	30.86
	(1.954)	(2.360)	(4.046)	(1.976)	(4.065)	(8.996)	(20.563)
EPL temp $_{t-1}$		-1.07***				-1.67***	-2.39***
		(0.275)				(0.374)	(0.497)
EPL temp X prodgap $_{t-1}$		-2.09***				-2.78***	-4.81***
		(0.487)				(0.663)	(0.811)
Statecontrol $_{t-1}$			-0.95***			-0.85	-2.64***
			(0.356)			(0.556)	(0.901)
Statecontrol X prodgap $_{t-1}$			-1.79*			1.71	-7.08*
			(0.984)			(1.753)	(3.688)
Barrierstoentr $_{t-1}$				1.63***		3.45***	5.62***
				(0.435)		(0.609)	(0.807)
Barrierstoentr X prodgap $_{t-1}$				-0.13		0.37	4.46***
				(0.212)		(0.639)	(1.309)
Barrierstotrade $_{t-1}$					0.15	0.23	-2.25**
					(0.411)	(0.708)	(0.964)
Barrierstotrade X prodgap $_{t-1}$					-0.41	1.27	-6.89***
					(0.670)	(1.461)	(2.613)
N	1,856	1,856	1,856	1,856	1,856	1,856	1,856
R^2	0.184	0.194	0.187	0.195	0.185	0.219	
AR(1)							0.000
AR(2)							0.477
Sargan							0.000
Number of instruments							288
Number of regions	216	216	216	216	216	216	216

Dependent variable is regional productivity growth at the TL2 level. Robust standard errors in parentheses. Standard errors are clustered by region. ***, **, * indicate significant at the 1%, 5% and 10% level respectively.

Table 7: Removal of Spanish, Irish and Polish regions

Dependent variable: regional productivity growth	Without Spain		Without Poland		Without Ireland	
	(1) FE	(2) System GMM	(3) FE	(4) System GMM	(5) FE	(6) System GMM
Frontiergrowth X nofrontier	0.04**	0.06***	0.04**	0.06***	0.05**	0.07***
	(0.020)	(0.023)	(0.019)	(0.022)	(0.019)	(0.021)
Productivity gap $_{t-1}$	-14.86**	11.53	-24.73**	22.11	-14.11**	11.77
	(5.747)	(9.411)	(10.877)	(16.490)	(5.981)	(9.382)
EPL temp $_{t-1}$	-1.45***	-1.64***	-1.44***	-1.87***	-1.23***	-1.52***
	(0.300)	(0.419)	(0.293)	(0.370)	(0.293)	(0.405)
EPL temp X prodgap $_{t-1}$	-2.75***	-4.01***	-2.12***	-3.80***	-2.54***	-3.96***
	(0.468)	(0.628)	(0.473)	(0.589)	(0.461)	(0.609)
Statecontrol $_{t-1}$	1.30*	0.29	-0.27	-0.51	0.23	-0.41
	(0.675)	(0.939)	(0.426)	(0.586)	(0.465)	(0.643)
Statecontrol X prodgap $_{t-1}$	3.96***	-0.08	2.33***	0.15	2.99***	-0.56
	(1.007)	(1.711)	(0.855)	(1.386)	(0.905)	(1.562)
Barrierstoentr $_{t-1}$	-0.06	0.83	0.26	1.45*	0.17	1.01
	(0.518)	(0.732)	(0.513)	(0.746)	(0.517)	(0.716)
Barrierstoentr X prodgap $_{t-1}$	-1.20***	0.77	-1.66**	1.92	-1.09**	0.86
	(0.436)	(0.668)	(0.816)	(1.193)	(0.454)	(0.664)
Barrierstotrade $_{t-1}$	0.20	-1.16*	2.39***	-0.84	0.13	-1.28**
	(0.583)	(0.644)	(0.828)	(1.242)	(0.629)	(0.637)
Barrierstotrade X prodgap $_{t-1}$	1.78	-2.29*	4.57*	-5.33	1.91*	-2.28*
	(1.081)	(1.317)	(2.360)	(3.363)	(1.156)	(1.355)
N	2,309	2,309	2,355	2,355	2,474	2,474
R^2	0.099		0.115		0.109	
AR(1)		0.000		0.000		0.000
AR(2)		0.205		0.148		0.116
Sargan		0.000		0.000		0.000
Number of instruments		318		321		335
Number of regions	246	246	249	249	263	263

Dependent variable is regional productivity growth at the TL2 level. Robust standard errors in parentheses. Standard errors are clustered by region. ***, **, * indicate significant at the 1%, 5% and 10% level respectively.

Table 8: Robustness checks for the macroeconomic variables

Dependent variable: regional productivity growth	Removing frontier regions		Removing top 3 regions		Alternative frontier region - removing top 3	
	(1) FE	(2) System GMM	(3) FE	(4) System GMM	(5) FE	(6) System GMM
Frontiergrowth	0.06***	0.07***	0.06***	0.07***	0.28***	0.27***
	(0.019)	(0.021)	(0.020)	(0.022)	(0.038)	(0.043)
Productivity gap $_{t-1}$	-1.81	5.71	-1.09	5.68	-14.52***	-2.83
	(2.114)	(3.896)	(2.655)	(4.560)	(3.120)	(6.392)
Trade $_{t-1}$	-0.24***	-0.45***	-0.26***	-0.52***	-0.07	-0.37***
	(0.049)	(0.086)	(0.067)	(0.099)	(0.064)	(0.102)
Trade X prodgap $_{t-1}$	-0.17***	-0.52***	-0.20**	-0.63***	-0.11	-0.87***
	(0.055)	(0.142)	(0.085)	(0.135)	(0.104)	(0.191)
Debt $_{t-1}$	0.04**	0.05***	0.05***	0.07***	0.05***	0.06***
	(0.015)	(0.019)	(0.017)	(0.022)	(0.016)	(0.021)
Debt X prodgap $_{t-1}$	-0.01	-0.00	-0.00	0.02	-0.00	0.01
	(0.008)	(0.014)	(0.009)	(0.014)	(0.011)	(0.019)
Inflation $_{t-1}$	-0.10	-0.04	-0.11	0.08	-0.07	0.09
	(0.092)	(0.157)	(0.125)	(0.186)	(0.097)	(0.151)
Inflation X prodgap $_{t-1}$	-0.05	-0.10	-0.07	0.07	0.01	0.22
	(0.146)	(0.265)	(0.180)	(0.288)	(0.203)	(0.350)
N	2,281	2,281	1,856	1,856	1,856	1,856
R^2	0.125		0.129		0.206	
AR(1)		0.000		0.000		0.000
AR(2)		0.181		0.169		0.259
Sargan		0.000		0.000		0.000
Number of instruments		319		286		286
Number of regions	249	249	216	216	216	216

Dependent variable is regional productivity growth at the TL2 level. Robust standard errors in parentheses. Standard errors are clustered by region. ***, **, * indicate significant at the 1%, 5% and 10% level respectively.

Table 9: Further robustness checks for the macroeconomic variables

Dependent variable: regional productivity growth	Without Spain		Without Poland		Without Ireland	
	(1) FE	(2) System GMM	(3) FE	(4) System GMM	(5) FE	(6) System GMM
Frontiergrowth X nofrontier	0.05**	0.05**	0.05**	0.06***	0.05***	0.06***
	(0.020)	(0.021)	(0.019)	(0.020)	(0.019)	(0.020)
Productivity gap $_{t-1}$	-2.17	3.33	-2.33	2.07	-2.13	3.08
	(2.035)	(3.614)	(1.948)	(3.455)	(1.986)	(3.637)
Trade $_{t-1}$	-0.17***	-0.29***	-0.14***	-0.26***	-0.20***	-0.33***
	(0.045)	(0.073)	(0.046)	(0.076)	(0.045)	(0.075)
Trade X prodgap $_{t-1}$	-0.12**	-0.38***	-0.12**	-0.37***	-0.13***	-0.40***
	(0.049)	(0.109)	(0.047)	(0.113)	(0.050)	(0.113)
Debt $_{t-1}$	0.02	0.02	0.02*	0.03*	0.02*	0.03*
	(0.014)	(0.019)	(0.012)	(0.016)	(0.013)	(0.016)
Debt X prodgap $_{t-1}$	-0.02**	-0.02	-0.01*	-0.01	-0.01*	-0.01
	(0.008)	(0.013)	(0.008)	(0.012)	(0.008)	(0.013)
Inflation $_{t-1}$	-0.01	0.02	-0.03	0.11	-0.05	-0.01
	(0.079)	(0.121)	(0.080)	(0.128)	(0.079)	(0.124)
Inflation X prodgap $_{t-1}$	0.08	-0.04	0.14	0.18	0.03	-0.08
	(0.132)	(0.206)	(0.132)	(0.212)	(0.132)	(0.211)
N	2,309	2,309	2,355	2,355	2,474	2,474
R^2	0.095		0.107		0.112	
AR(1)		0.000		0.000		0.000
AR(2)		0.245		0.135		0.131
Sargan		0.000		0.000		0.000
Number of instruments		316		319		333
Number of regions	246	246	249	249	263	263

Dependent variable is regional productivity growth at the TL2 level. Robust standard errors in parentheses. Standard errors are clustered by region. ***, **, * indicate significant at the 1%, 5% and 10% level respectively.

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