Impact of macro-structural reforms on the productivity growth of regions: distance to the frontier matters

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Impact of macro-structural reforms on the productivity growth of regions: distance to the frontier matters

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Abstract:

Using a panel of 265 regions from 24 OECD countries from 1997 to 2007, we explore the impact of nation-wide macroeconomic and structural policies on the productivity growth of subnational regions. We find that average relationships between nation-wide policies and regional productivity growth can hide strong differentiated effects according to the distance to the frontier: relaxing employment protection legislation on temporary contracts, lowering barriers to trade and investment and increasing trade openness enhances productivity growth in lagging regions, whereas reducing barriers to entrepreneurship or higher levels of government debt has a positive effect on regions closer to the productivity frontier.

Keywords: structural reforms; regional growth; lagging regions.

JEL codes: R11, R58, O18.

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1. Introduction

This paper aims at analysing the impact of macro-structural factors on the productivity growth of regions. These economy-wide factors are generally defined in a uniform way for all regions in a given country, but their impact across regions can be very asymmetric. In this way, we aim at bridging the gap between national growth and policies designed at the national level and their regional impact in terms of productivity growth. At the country level, the neoclassical literature has traditionally investigated economic growth using Cobb-Douglas production functions (Solow, 1956 and Swan, 1956). This approach evolved towards the endogenous growth framework (Lucas, 1988 and Romer, 1986) focusing on understanding the country-level drivers of national growth, including country-level policies. In contrast, the literature investigating economic growth dynamics at the regional level explains regional growth based on region-specific factors. These studies includes models 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] To this date, a gap remains between these two approaches and as a result, there is a need to better understand the link between country-level factors and regional economic growth. 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 these factors impact regional convergence; however our knowledge of how country-wide factors influence performance at the regional level is still nascent.

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

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 productivity growth in the frontier region affects productivity 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. The fact that we are using regional data enables to control for fixed-effects without creating the usual collinearity problems with country-wide policy variables, which also may also enable to estimate better the effects of these policies.

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 focusing on temporary subsidies and short-term corrections in regional imbalances toward an approach focusing on competitiveness and growth with an aim to boost the overall performance of countries.[3] A criticism of regional transfers during earlier versions of EU regional policies 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

[3] See McCann and Ortega-Argiles (2013) for a detailed description of the changes to EU cohesion policy for example.

regional growth and does not seem to contribute effectively to foster income convergence across regions. Other work on EU regional transfers has highlighted 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.[4] Our results indicate that lagging regions differ from leading regions in their response to national-wide policies including structural reforms and therefore national policies can anticipate these effects in their initial design and or complemented with regionally designed policies. We find that average relationships between nation-wide policies and the growth of regions can hide strong differentiated effects according to the distance to the frontier: relaxing employment protection legislation on temporary contracts, lowering barriers to trade and investment as well as increasing trade openness enhances productivity growth in lagging regions, whereas reducing barriers to entrepreneurship or higher levels of government debt has a positive effect on regions that are closer to the productivity frontier.

The paper is structured around six sections. In the next section we provide an overview of the literature and 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.

2. Conceptual framework and review of the literature

[4] 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.

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 that the costs of market restrictions (e.g. regulatory barriers) in upstream sectors have an impact on the productivity growth of downstream sectors. The conclusion of their model is that the (induced) lack of competition in upstream sectors leads to lower productivity growth in downstream sectors.

In addition, Bourlès *et al.* (2013) shows the relevance of two factors that have been identified in the endogenous growth 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 sector and the follower sectors also enhances growth in the follower sectors. As highlighted in Acemoglu *et al.* (2006) and Aghion and Howitt (2006), productivity growth in follower countries increases in the productivity growth at the world technological frontier (pass-through effect) owing to technological spillovers from the frontier and also increases in the productivity gap between the follower country and the technological frontier owing to technological adoption (catching-up effect). A result of this is that regulations that curb competition between firms will reduce the incentive for firms to adopt the technology available at the frontier. This will slow down the catching-up of follower countries that are far from the technological frontier. Therefore the speed of catching-up depends not only on the distance to the frontier, but also indirectly on regulations or policies that might affect the distance to the frontier (Bourlès *et al.*, 2013). Another consequence is that, as shown in Griffith *et al.* (2004), countries that invest in R&D benefit from a double productivity boost, through greater catching-up possibilities owing to innovation and also through easier technological adoption from the frontier.

The structural policies that this and previous papers consider can affect productivity through two separate and opposing effects, the escape entry effect and the discouragement effect.[5] In the context of deregulation leading to heightened competition between firms, the escape entry effect would prevail in countries with a significant proportion of firms with productivity levels near the productivity frontier, and the discouragement effect would prevail in countries where most firms are far away from the frontier. In that case, in follower countries far from the frontier, the discouragement effect would prevent innovation taking place and reduce catching-up. Conversely, where the escape entry effect prevails, competition will increase average productivity. This effect may in fact prevail too in lagging countries or regions far from the frontier, where higher domestic or foreign competition may increase firms' incentives to adopt better technologies.

Recent work on the causes of the generalised productivity slowdown in OECD countries has also highlighted that there is an apparent average decline of productivity catching-up at the firm and sectoral level (OECD, 2015). This stylised fact is also confirmed when observing productivity trends in frontier and lagging regions (OECD, 2016). Among the drivers that could promote or hinder catching-up, OECD (2015) stresses the relative openness of economies to trade and investment, with an essential component associated with the participation in global value-added chains (GVCs); the existence of barriers that generate disincentives for up-scaling of firms, which in turn prevent firms from reaching the size required to face the fixed costs to adopt innovation or enter new markets; and finally, the existence of market restrictions that may also prevent the necessary firm selection and reallocation mechanisms from fully operating.

[5] See Aghion *et al.* (2004, 2006).

We transpose the country-sector framework of Bourlès *et al.* (2013) 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 (*i.e.* the region with the highest productivity level in its country in a given year) and for the latter we determine whether regional growth increases in distance to the frontier region.

Shifting the analysis from the sectoral to the region level necessitates the identification of a different set of explanatory variables in the growth regressions. In the rest of this section, we explain our choice of explanatory variables.

Our paper is concerned with the relationships between economic growth and levels of product market regulation, which have 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. The authors find that lower levels of entry barriers and state control enhance productivity growth, particularly in countries that lag behind in technology adoption. Their study also finds evidence of productivity gains from privatization. These results lead us to reflect 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. Their study 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. As regional policy funds are typically targeted on gaps of regional GDP per capita, depending on the distance to the frontier, the balance between positive and negative effects may change.

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.

Concerning inflation, despite evidence of its growth effects at the country level (Bassanini and Scarpetta, 2001), no clear predictions can be made on its effects on regional productivity. We therefore treat it as a control variable given its importance as one of the macroeconomic stabilisation indicators.

Among the structural policies in our model, we select reforms aimed at lowering employment protection legislation, state control, barriers to entrepreneurship and barriers to trade and investment. All these structural variables may affect regional productivity in a differentiated way depending on the distance to the frontier.

From the outset, it could be noted that the majority of the frontier regions in the OECD contain large cities, whereas most lagging regions are located in intermediate and predominantly rural areas (OECD, 2016). In this context, lagging regions may be particularly sensitive to barriers to entrepreneurship precisely because they do not fully benefit from density and agglomeration effects associated with the presence of other firms allowing for specialisation or knowledge spillovers. Indeed, Stephens *et al.* (2013), focusing on lagging rural regions of the Appalachians in the USA, find that, in such regions, employment growth is better enhanced by the presence of creative workers or a tradition of self-employment and entrepreneurship in the area than by knowledge-based factors such as the presence of universities, a greater proportion of patents or higher high-technology employment shares.

The openness of international trade and investment may also affect regions differently. OECD (2016) finds that exposure to tradable sectors appears to be one of the main drivers of the regional productivity catching-up in lagging regions. A possible explanation is that in tradable sectors (mainly industry), the international competitive pressures generate a sort of unconditional convergence (Rodrik, 2013), which is less dependent on specific country or regional conditions. The barriers to trade and investment could then be particularly detrimental for the productivity performance of the lagging regions.

State control can have different effects on regional growth depending on the form it takes and on the distance to the frontier. The extent of state ownership with direct control on public employment and investment can be a strong factor of growth in regions farther away from the frontier. On the other hand, state involvement in business operations, such as price controls and regulation can also reduce the efficient allocation of resources and affect incentives to innovate, with a detrimental impact on growth in frontier regions.

High levels of employment protection legislation (EPL) can have a limiting effect on competition and on creative destruction by reducing the flexibility of firm size: this can restrict up-scaling of firms but also limit the exit or downsizing of inefficient firms. By lowering the quality of job-market matching, it can also prevent effective resource reallocation with a detrimental effect on aggregate productivity growth. Lowering restrictions on temporary contracts can have a stronger effect on growth for regions that are farther away from the frontier, as these generally have thinner labour markets and are therefore more vulnerable to labour market rigidities.

We limit our analysis to the main structural reform and macroeconomic indicators. This is both motivated by the existence of institutional data and composite indicators that

allow for a comparative analysis across countries and, also, by the fact that these macro-structural variables have been used to implement ex-ante conditionalities associated with EU regional policy funds.

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 terms of l abour productivity growth. Similarly, we do not find in our data a relationship between innovative activity and regional productivity growth, at least at the TL2 level.[6] Obviously, in level terms, high intensity of innovation indicators R&D, patents), is highly correlated with high levels of regional labour productivity.

[6] For evidence on the convergence of R&D policies across regions see OECD (2016).

Our paper is part of a limited set 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 is based on a regional production function rather than a national one, as is often done in the regional growth literature. This specification allows 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.

We estimate the following reduced form equation:

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

$\Delta \ln Prod_{r,t}$ 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's frontier region.

The variable $\Delta \ln Prod_{F^C,t}$ is equal to zero if the region *r* is a frontier region in the given year. This is because otherwise if *r* is a frontier region, there would be perfect collinearity between the dependent variable and $\Delta \ln Prod_{F^C,t}$ and the estimate of β_1 obtained would be biased towards the share of frontier regions in our dataset (8%). By doing this, we obtain an estimate for β_1 that is estimated only over the non-frontier regions. 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.

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. β_2 indicates the (hypothetical) effect of increasing the productivity gap by one unit

when policy indicators are set to zero. We expect the marginal effect of $Prodgap$ 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.[7]

$Pol_{C,t-1}$ is the lagged level of the policy variable in country *C*. In order 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 policy variable is interacted with the productivity gap variable. In our full specification, we include all the structural policies together and the three macroeconomic indicators together. We obtain the marginal effects of each policy, $\beta_3 + \beta_4 . Prodgap_{r,t-1}$ as well as the corresponding confidence intervals. ζ_t are year-specific effects and γ_r region fixed-effects that account for time-invariant regional factors that influence regional productivity growth.

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

[7] This time lag allows reducing part of the possible endogeneity bias between policies and productivity. Nonetheless, in our sample, this endogeneity is anyway already minimised by the fact that structural policies are defined by central governments (or the EU) and the productivity growth is measured at the regional level.

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.[8]

4. The data

Our data consist of a panel of 265 regions from 24 OECD countries[9] defined at Territorial Level 2 (TL2), taken from the OECD Regional Database and covering the period 1997 to 2007.[10] 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 ($prodgap$).

[8] 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.

[9] 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.

[10] 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.

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

[11] 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.

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 labour 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 effects, 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.

In column (6), we include the four policy variables together as well as all interaction terms with the productivity gap in a fixed effects specification. The coefficient on *Frontiergrowth* remains unchanged, while the coefficient of -13.95 on the productivity gap represents a fictitious case where the value of 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.

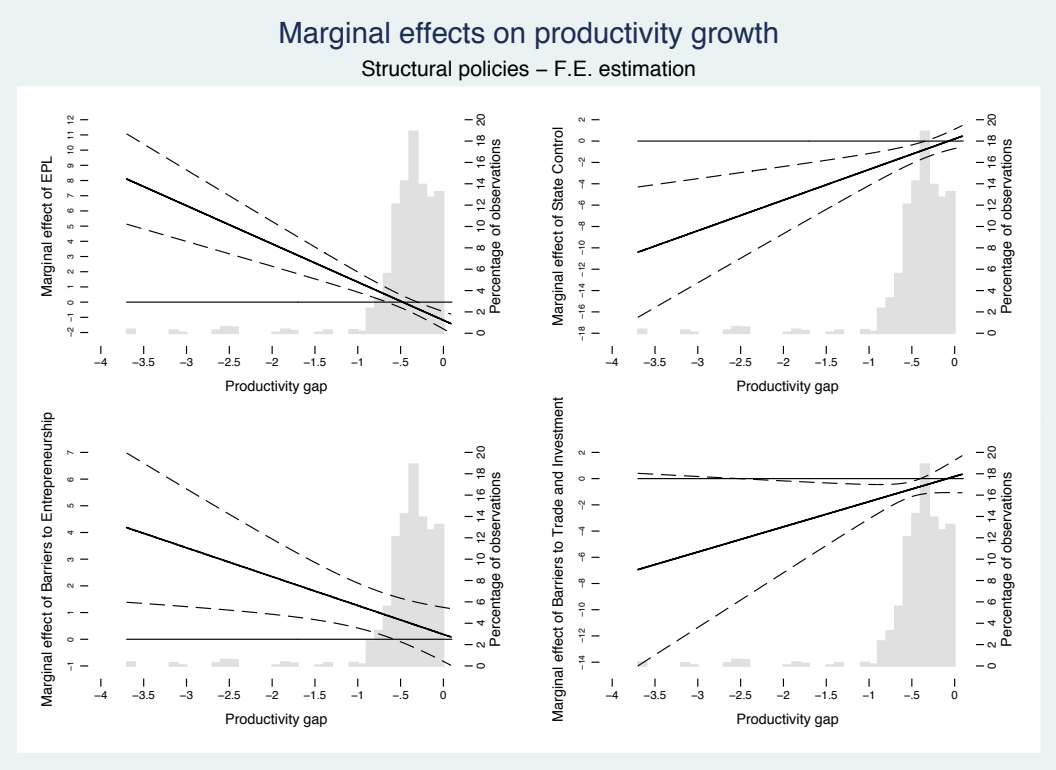
The cross-section effects dominate, capturing agglomeration forces rather than convergence forces. Indeed, regional growth can be the result of convergence and agglomeration forces. The former tend to favour lagging or poorer (often low-density, rural) areas. Conversely, the agglomeration forces favour the dense, urbanised areas (see Garcilazo and Oliveira Martins, 2013). The fixed effects and system GMM with region effects methods however capture the convergence forces.

Figure 1 below represents the marginal effects with 95% confidence intervals of each of our four structural reforms, based on the estimations underlying the results reported in column (6) of Table 2. Each panel of Figure 1 represents, along the left vertical axis, the marginal effect of a one-point increase in the value of the variable (*i.e.* greater deregulation) on regional productivity growth, at different levels of the productivity gap with the frontier region. In addition, each panel shows, according to the right vertical axis, the histogram of the productivity gap variable. This enables us to see the magnitude and the significance of the marginal effects, over a meaningful range of the productivity gap.

Figure 1 shows that deregulating temporary contracts EPL has a small negative effect on the productivity growth of regions that are near the frontier, whilst the effect is large and positive for a relatively small number of regions with a productivity gap lower than -0.6. The positive effect on growth increases in the productivity gap. For the middle range of regions, the marginal effect of deregulating EPL is not significantly different from zero. Deregulating State Control seems to have no significant effect on regions close to the frontier, while there is an increasingly negative impact on growth points for regions with a productivity gap smaller than -0.4 as they get further from the frontier. Turning to barriers to entrepreneurship, in this specification deregulation appears to have no significant effect on the growth of most

regions (with a productivity gap greater than -0.6) while there is a positive and significant effect on lagging regions that increases with distance to the frontier. Finally, reducing barriers to trade and investment has a negative and significant effect for the middle range of regions, with a larger negative impact on regions as their distance to the frontier increases.

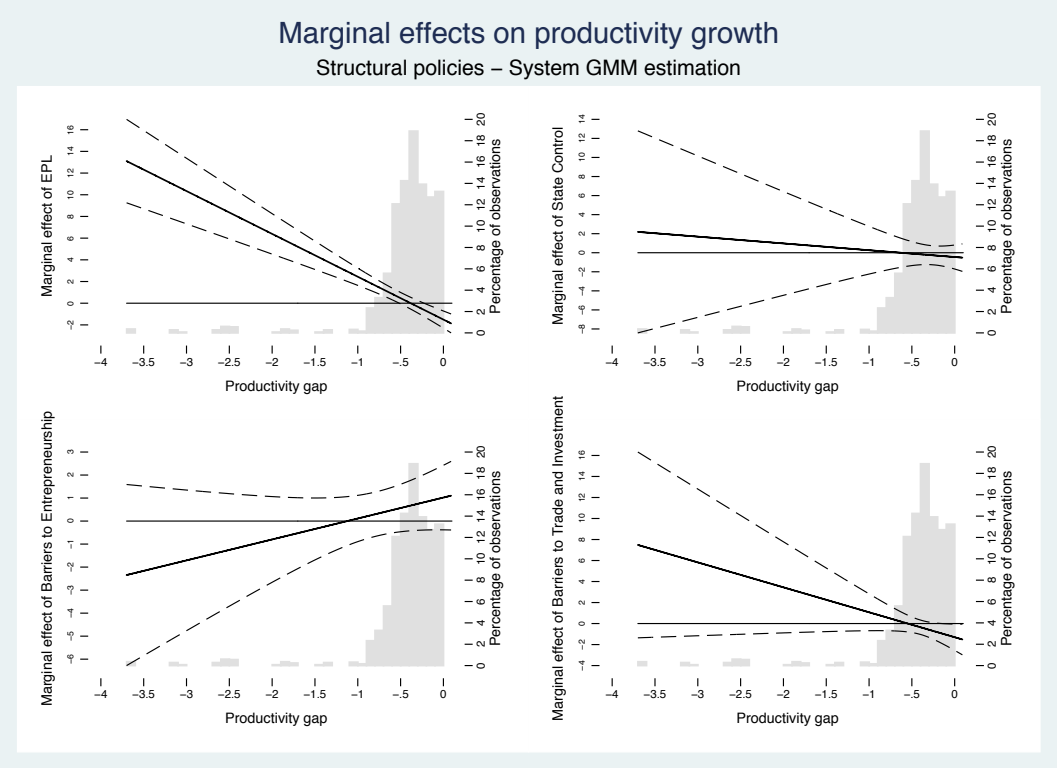
Figure 1: Marginal effects of structural reforms, OLS Fixed-effects



As explained in Section 3, our preferred estimation method is system GMM. The corresponding results in column (8) of Table 2 confirm the pass-through effect of the frontier region with a highly significant coefficient of +0.07 on the frontier region growth. The graphs in Figure 2 below represent the marginal effects obtained from this specification. The system GMM estimation yields very similar results for EPL. 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.

Figure 2: Marginal effects of structural reforms, GMM



In this preferred specification, the effects of deregulating state control, barriers to entrepreneurship and barriers to trade and investment on regional growth are no longer significant over the entire range of productivity gap. We now investigate this further by using an alternative definition of the frontier as well as checking for sample selection issues.

Robustness checks

Our results may be sensitive to specificities of our data or to the way in which we have defined a single frontier region for each country. We first consider the possibility that the presence of frontier regions in our dataset for analysis may influence our results. 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 3. The marginal effects computed from the results of the OLS and system GMM specifications of columns (6) and (7) respectively are shown graphically in Figures 3 and 4 below.

Figure 3: Exclusion of frontier regions, OLS Fixed-effects

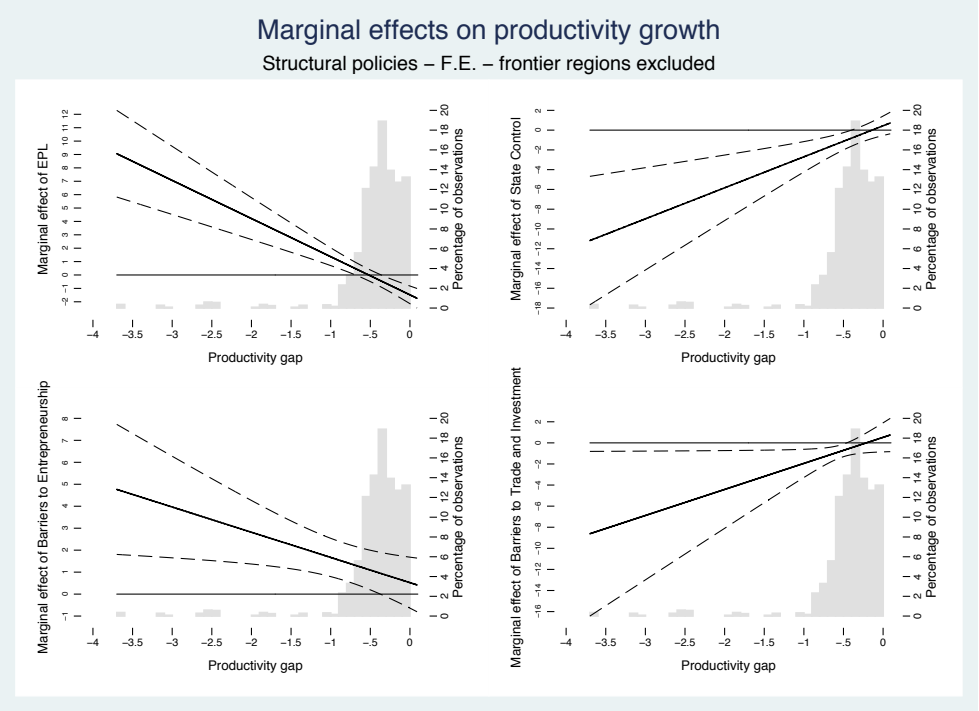
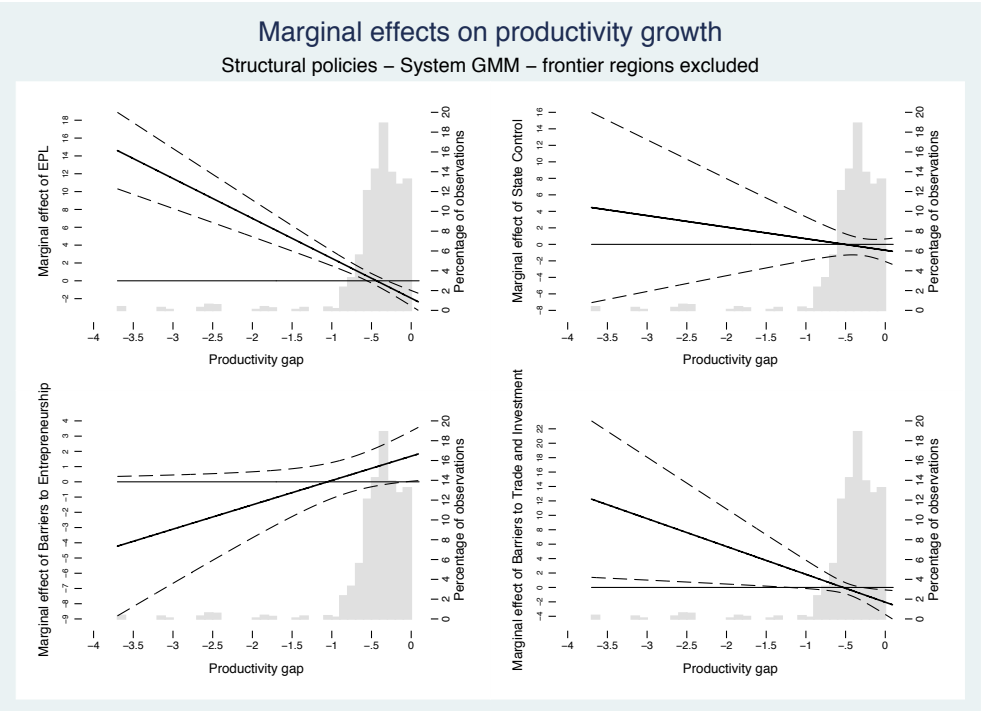


Figure 4: Exclusion of frontier regions, system GMM



Results from the OLS with fixed effects specification are similar to those obtained previously. Focusing on our GMM results (Figure 4), the positive effect of labour market deregulation on lagging regions is confirmed, while deregulating barriers to trade and investment now has a positive and significant effect on lagging regions, that increases with distance to the frontier.

Similarly, in Table 4 we remove the observations corresponding to the top-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. The pass-through and catching-up effects are robust as indicated by the coefficients in column (1). Figures 5 and 6 below represent the marginal effects obtained from the OLS and GMM estimations of columns (6) and (7).

Again, the fixed effects results are very similar to those obtained from the whole sample, with more pronounced effects of EPL and barriers to trade (Figure 5). Turning to the GMM results in Figure 6, we find that again reducing labour market rigidities on temporary contracts has a positive effect on growth for lagging regions; reducing barriers to entrepreneurship has a positive and significant effect for a range of regions close to the productivity frontier, with the largest effect closer to the frontier, and reducing barriers to trade and investment still has a clear positive and significant impact on growth for lagging regions. The effect of state control again is not significant for lagging regions although there is a negative and significant effect of deregulating state control on growth near the frontier.

Figure 5: Excluding the top three regions, OLS.

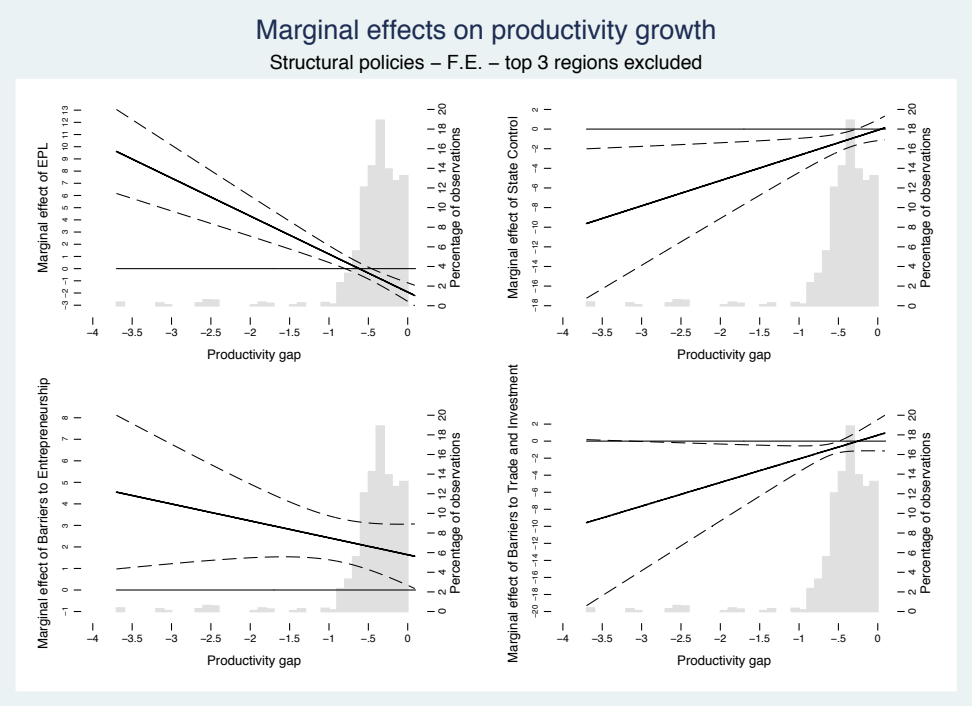
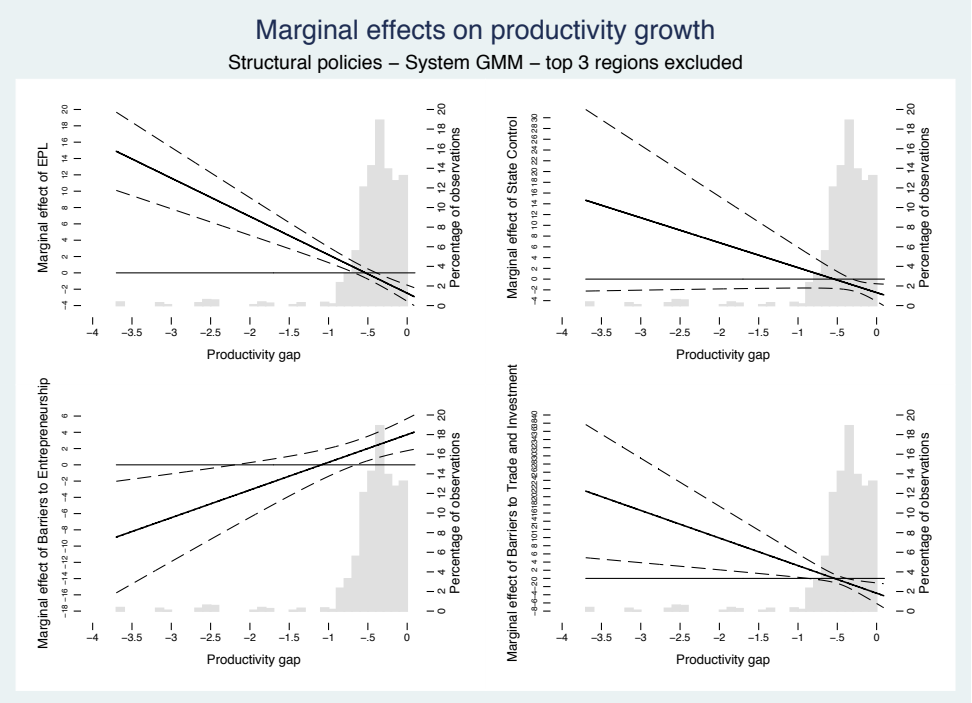


Figure 6: Excluding the top three regions, GMM.



Another possible important 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 and to capture the effect of this synthetic frontier and of the policies on those regions that are not part of this frontier.

The results in Table 5 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 base 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 4 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. We therefore focus on this particular definition of the frontier and the results associated with it.

The marginal effects are depicted in Figure 7 (OLS with region fixed effects) and Figure 8 (GMM) below. Given the new definition of the frontier and the exclusion of the top three regions, the distribution of the productivity gap variable has changed, with a higher minimum

(-2.94) and a lower maximum (-0.003). This is reflected in the horizontal axis and in the histograms represented on both figures.

Figure 7: Alternative frontier region, excluding the top three regions, OLS.

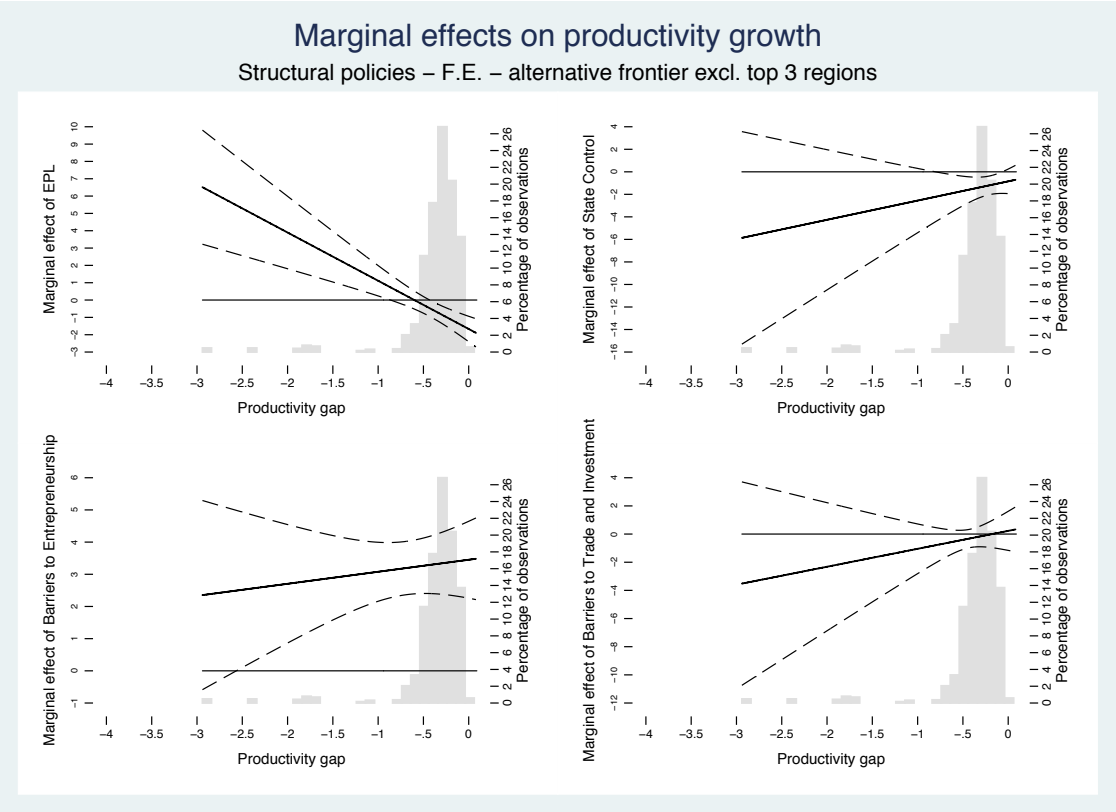


Figure 8: Alternative frontier region, excluding the top three regions, GMM.

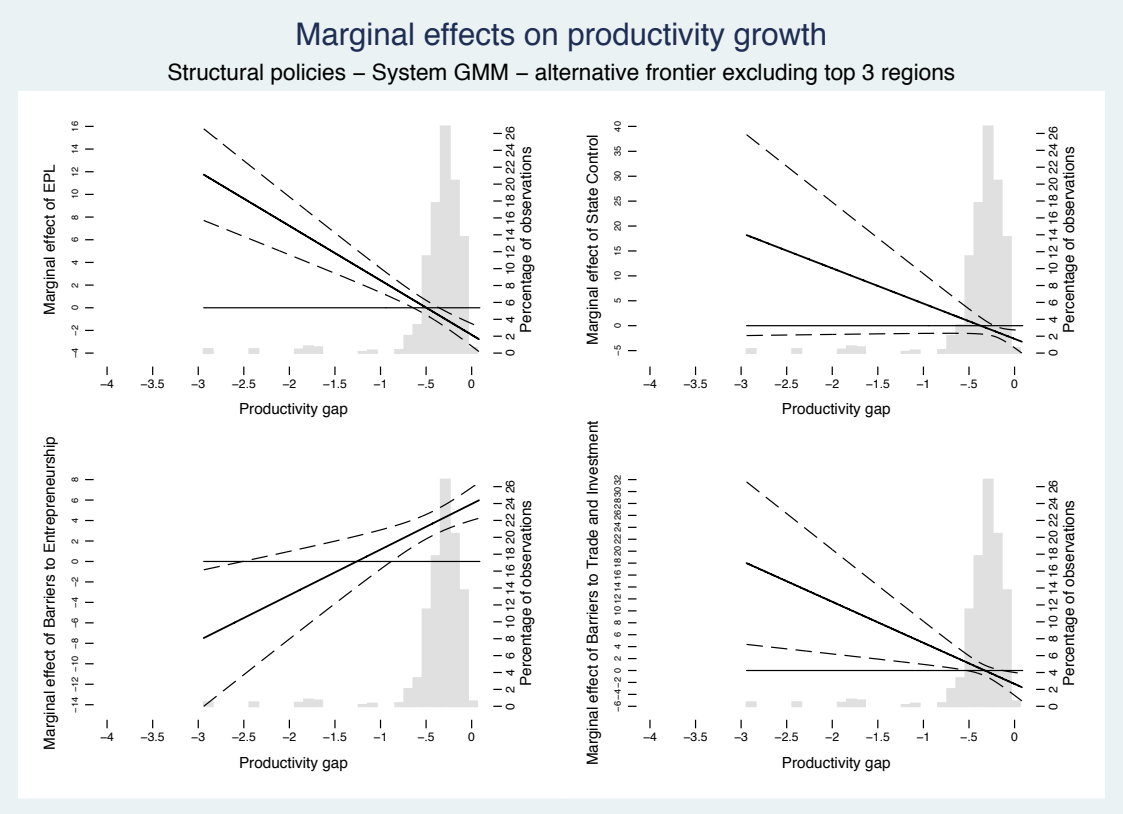


Figure 8 above confirms the patterns found on EPL. For lagging regions, the reduction in rigidities in temporary contracts acts in favour of reallocation and labour market experimentation, while for regions near the frontier, deregulating temporary contracts might in fact prevent the accumulation of specific capital in firms. For a region with a productivity gap of -0.7, a one-point increase in the EPL indicator (just less than one standard deviation) is associated with an increase in productivity growth of 1 percentage point. For a region with a productivity gap of -1.5, the same amount of deregulation is associated with an increase in growth of 4.8 points.

While the marginal effect of deregulating state control is positive and increasing in distance to the frontier, it is still insignificant. This could be due to the different aspects of state control in this variable having counteracting effects. We also find that reducing barriers

to entrepreneurship has a positive and significant effect on regional growth for a large range of regions with productivity gap greater than -0.9. This effect increases for regions closer to the frontier. For example, for a region with a productivity gap of -0.5, increasing the policy indicator by one point (roughly two standard deviations) is associated with a 3.4 point increase in productivity growth, whilst for a region with a productivity gap of -0.3, the marginal effect is 4.3 growth points. For regions farther from the frontier, contrary to our expectations, the effect of reducing barriers to entrepreneurship is insignificant: The discouragement effect may be prevailing in these regions as competition increases with the lowering of these barriers.

Turning to barriers to trade and investment, as expected, a reduction of this type of rigidities has a positive and significant effect on growth for the range of regions farther away from the frontier (with a productivity gap less than -0.5). For example, for a region with a productivity gap of -0.5, increasing the policy indicator by one point (here also roughly two standard deviations) is associated with a 1.2 point increase in productivity growth. For a region with a productivity gap of -1, the effect of the same increase in the policy indicator is a 4.64 point increase in productivity growth. Although the effects estimated on lagging regions are very large, they remain of a more realistic magnitude over the main range of regions in our dataset.

Finally, 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 base estimates after removing Polish, Irish and Spanish regions from our sample (see Table 6). Marginal coefficients represented in Figures 9-11 show that our results are robust to the exclusion of these countries.

Figure 9: Excluding Spanish regions.

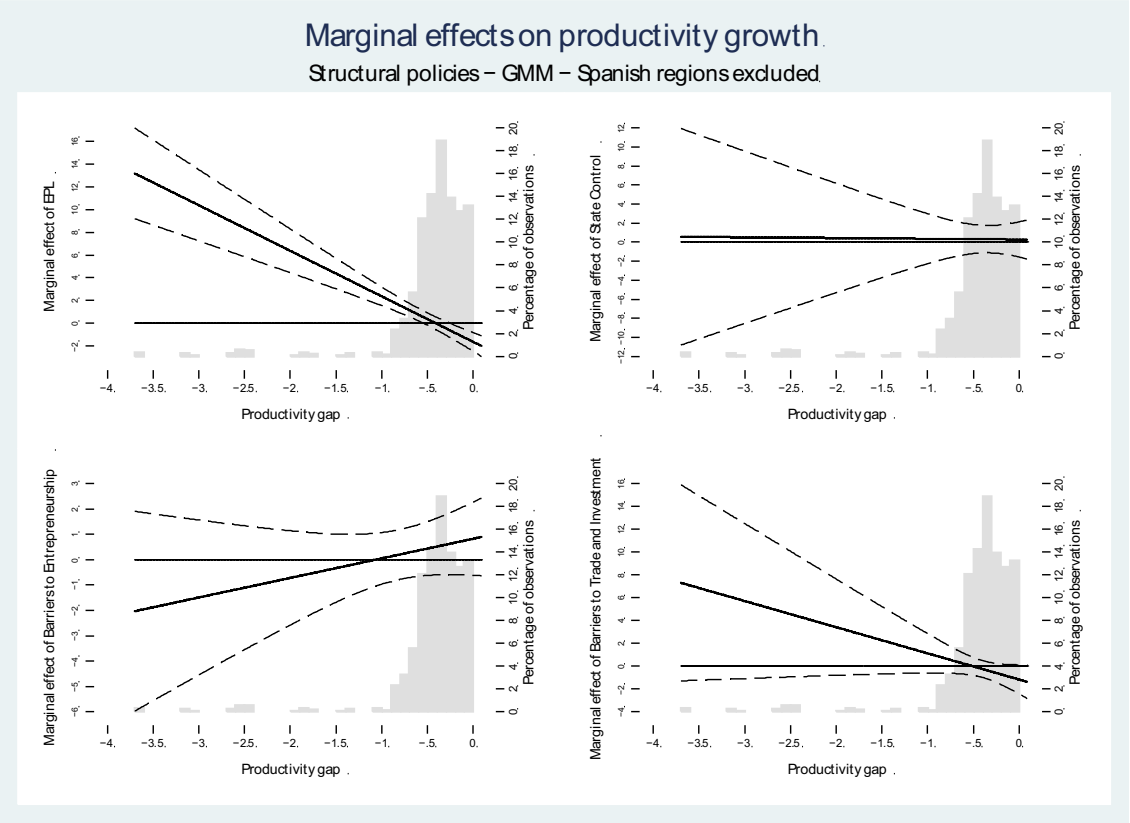


Figure 10: Excluding Polish regions.

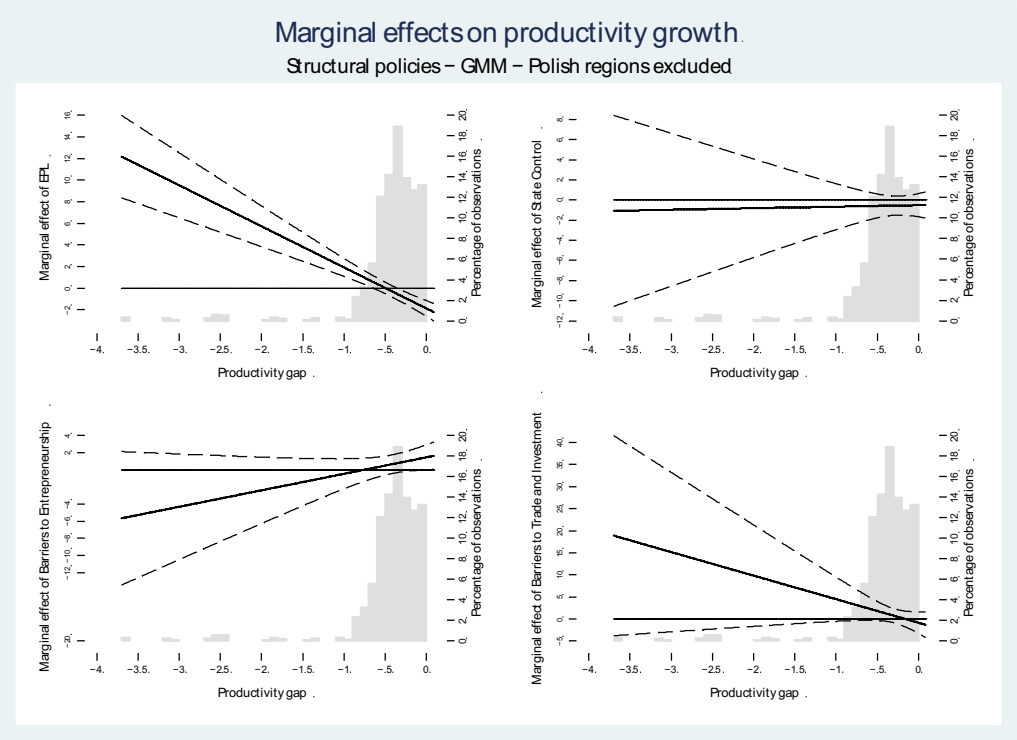
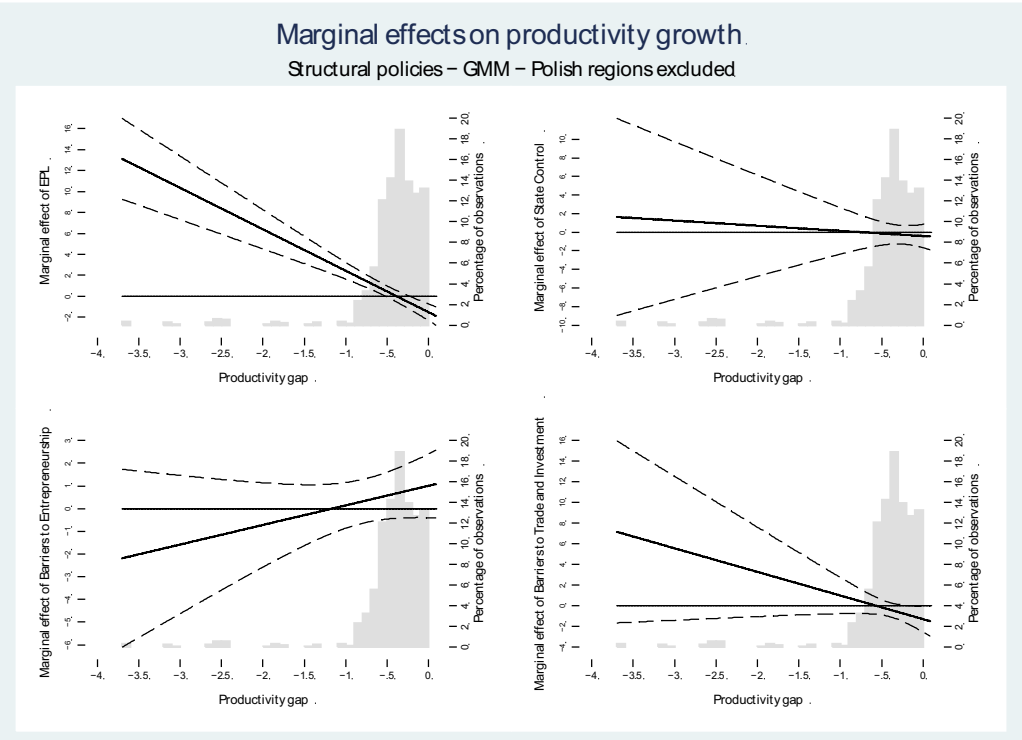


Figure 11: Excluding Irish regions.



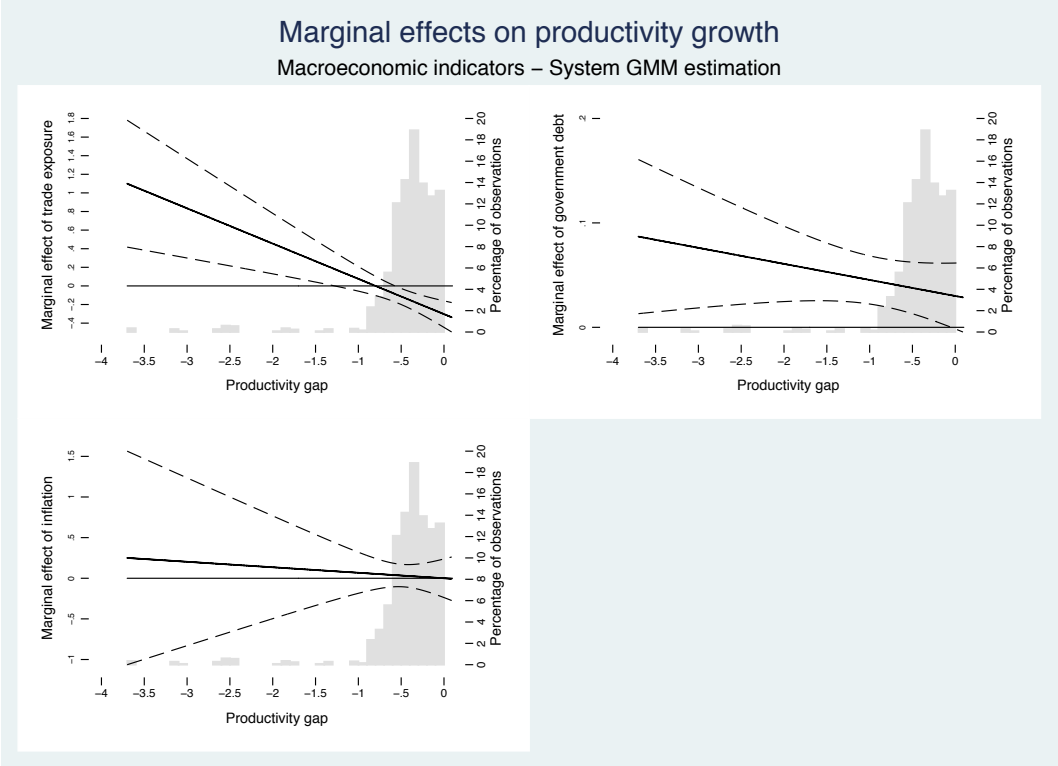
5.3 Impact of macroeconomic factors

We now turn to the analysis of the macroeconomic variables. Table 7 reports our base results using the full dataset and the single frontier region. The first three robustness checks, including the alternative definition of the frontier, are offered in Table 8. Table 9 shows the results obtained once we exclude Polish, Spanish and Irish regions. Again, the coefficient on frontier region growth is highly significant and robust across specifications. We show below in Figures 12-18 the marginal coefficients obtained from our preferred GMM estimations. Figures from the OLS with region fixed effects estimations are included in the appendix.

Figure 12 corresponds to the results from column (7) in Table 7. As expected, increasing trade exposure has a positive and significant effect on regions with large productivity gaps (values less than -1.3). For a region with a productivity gap of -1.5, increasing trade openness by one standard deviation is associated with a 4.32 point increase in growth. However, we also find a negative and significant effect on regions close to the frontier (values greater than -0.6). For a region with a productivity gap of -0.5, increasing trade openness by one standard deviation is associated with a 1.76 point decrease in growth. These results are similar to and consistent with those found on the effects of liberalising trade and investment (Figures 2 and 8) and they are robust to our modifications in the sample and the definition of the frontier presented in Figures 13-18 and Tables 8 and 9. They however go against the theory that, in regions close to the productivity frontier, heightened competition brought about by greater trade and investment would stimulate the escape entry effect, raising productivity. In our less stringent, alternative definition of the frontier however (Figure 15), the negative effect of trade exposure is only significant for a smaller range of regions very close to the frontier. Overall, both estimates on structural policies and on macroeconomic

factors support the hypothesis that exposure to international trade has an enhancing effect on regional productivity growth, at least for regions far enough from the frontier. As explained in Section 2, a possible explanation could be related to the role of the tradable sector as an engine of unconditional growth (Rodrik, 2013).

Figure 12: Marginal effects of macroeconomic variables, GMM.



Government debt has a positive and significant effect on regional growth that increases with distance to the frontier.[12] In the base results, for a region with a productivity gap of -0.5, increasing government debt (as a percentage of GDP) by one standard deviation is associated with a 1.1 point increase in growth. For a region farther from the frontier, with a productivity gap of -1.5, the same increase in government debt would yield a 1.7 point increase in growth. In our alternative specifications, although the effect of debt remains

[12] Note that this is the effect of increases in debt over time due to the inclusion of region fixed effects.

positive and significant and of similar magnitude for a range of regions not too far from the frontier, the effect is now (very mildly) decreasing with distance to the frontier. As shown in Figure 15, when we use the average frontier and exclude the top three regions, the effect of government debt is positive and significant for regions with values of the productivity gap greater than -1.3 and the effect is no longer precisely estimated for the small number of regions farther from the frontier. For a region with a productivity gap of -0.5, increasing government debt by one standard deviation is associated with a 1.5 point increase in growth. As can be seen from our results in Figures 12-18, the positive effect of government debt on regional growth for a meaningful range of regions is robust across our specifications. It is puzzling that, when we remove the frontier regions, we are not able to find a significant positive effect of debt on lagging regions, whilst these regions are most likely to be on the receiving end of public investment.

Finally, throughout our estimations, we do not find evidence of a significant role of inflation in regional growth. This is not due to a lack of time variation in our data. Rather, as explained in Section 2, this variable is included as one of the macroeconomic imbalance indicators but there is no clear prediction on its differential effect on regional growth. For example, inflation in lagging regions may affect export competitiveness due to the price of their exports increasing, while at the same time reducing the cost of imported intermediates. If lagging regions are particularly sensitive to increases in trade openness, as our results show, we may expect inflation increases to affect their productivity growth, but the net effect would be unclear.

Figure 13: Excluding frontier regions.

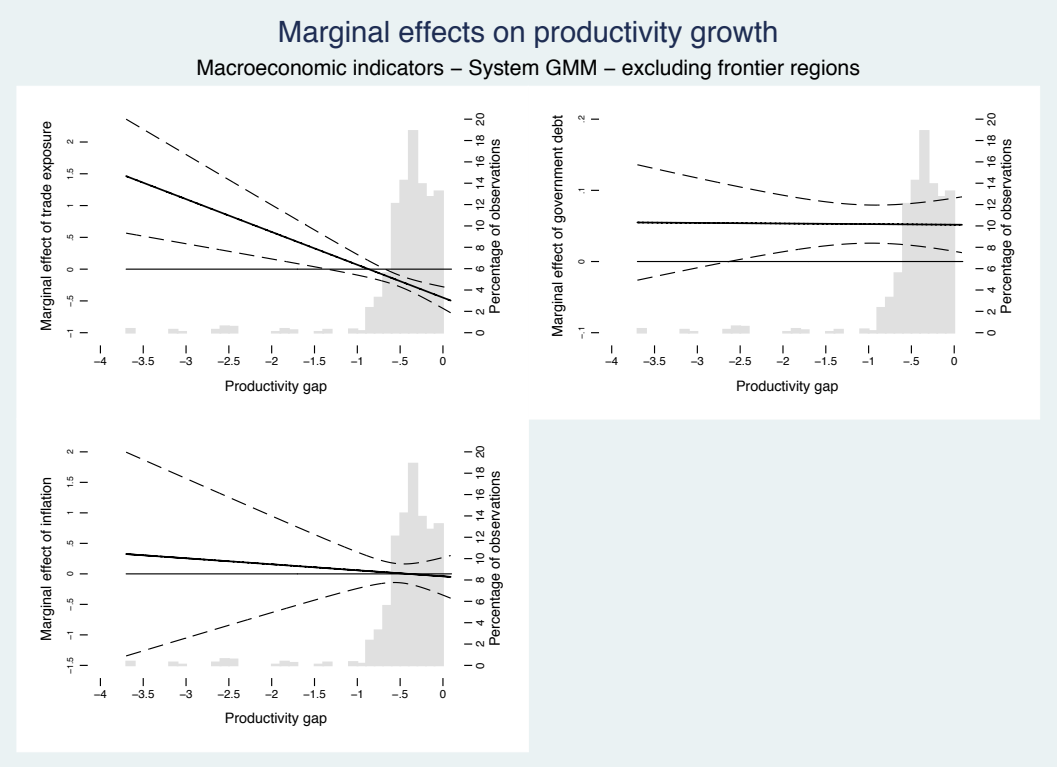


Figure 14: Excluding top three regions.

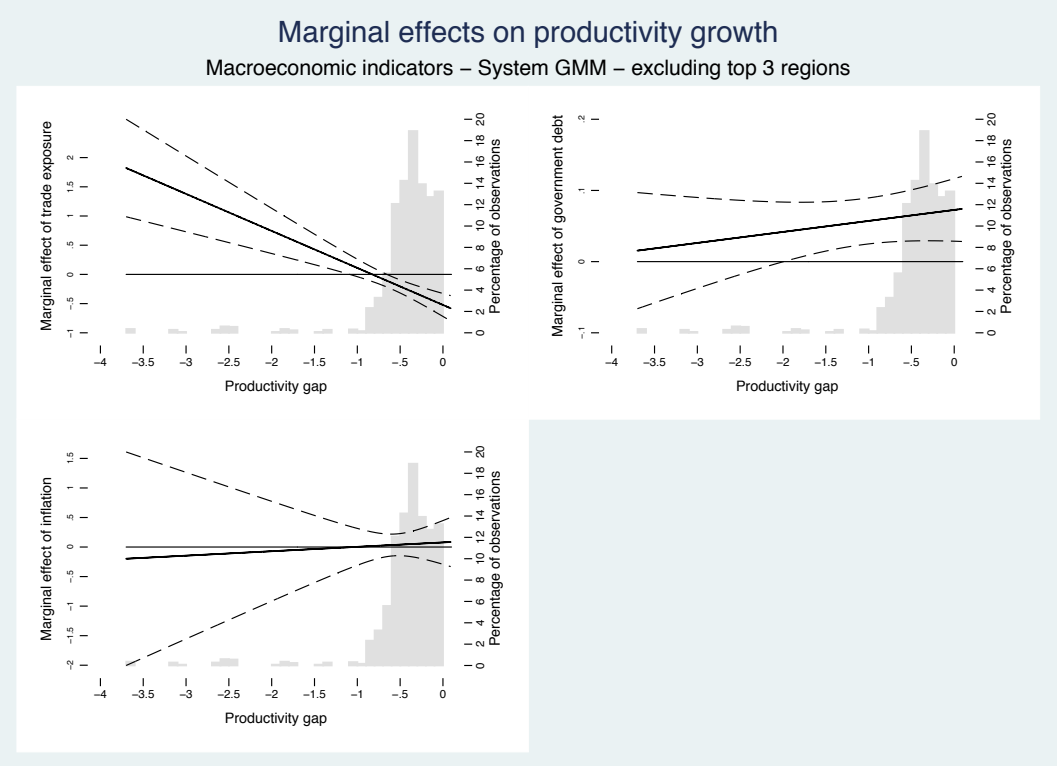


Figure 15: Alternative frontier region.

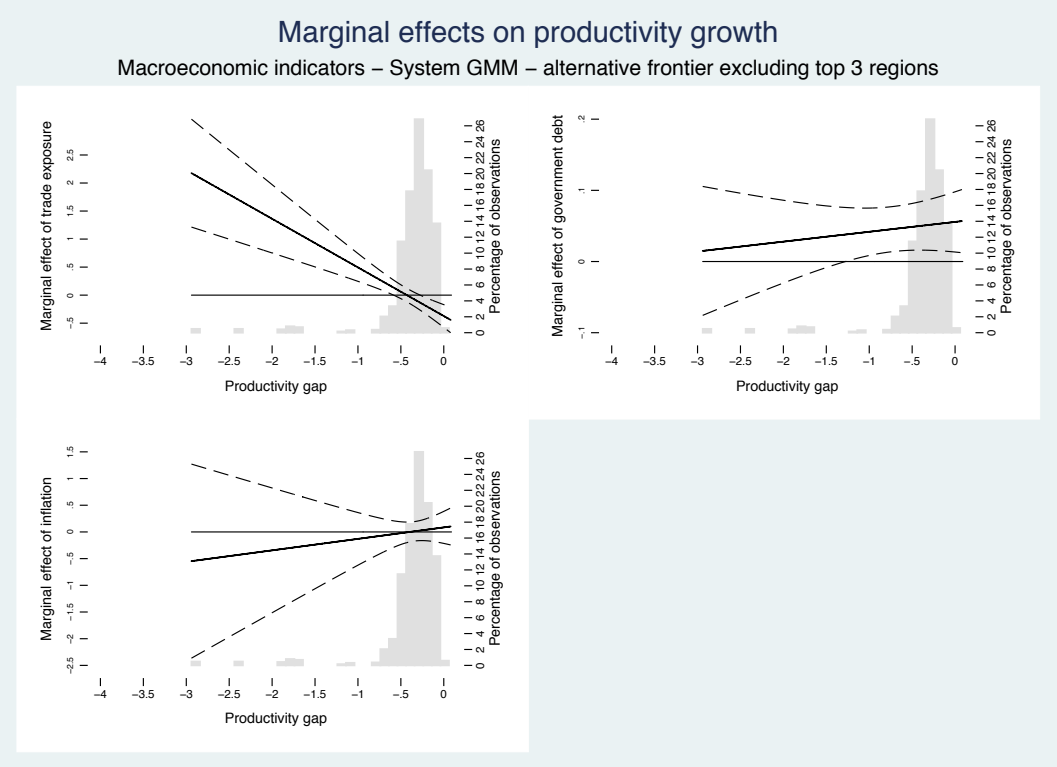


Figure 16: Excluding Spanish regions.

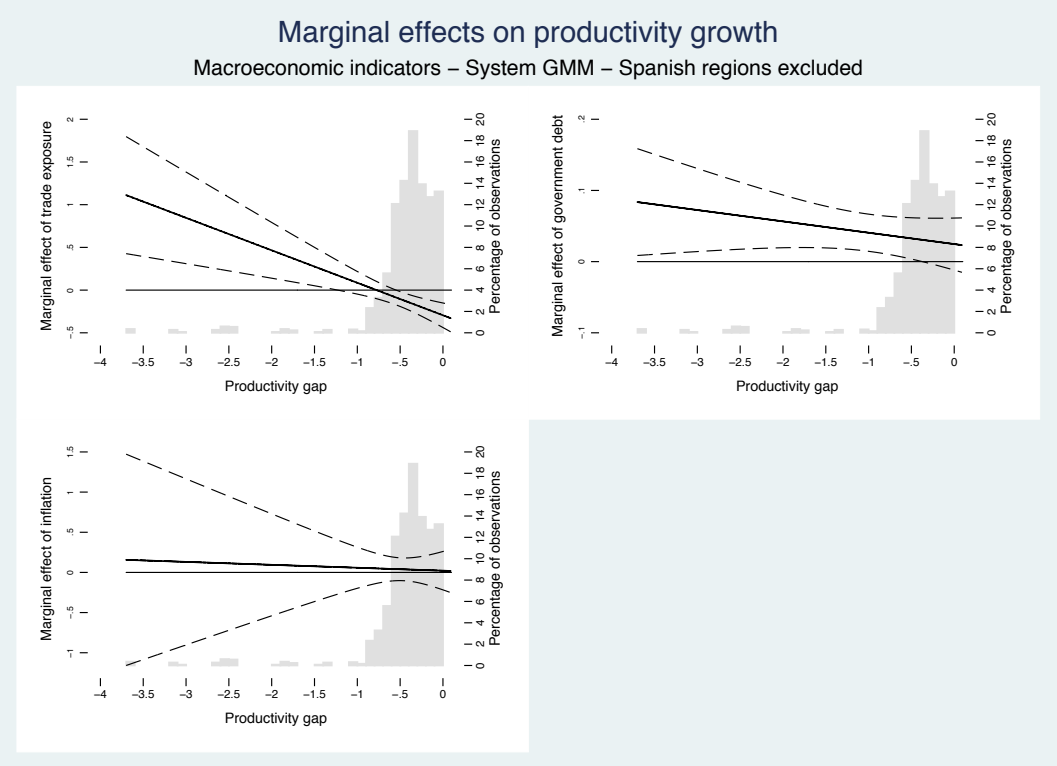


Figure 17: Excluding Polish regions.

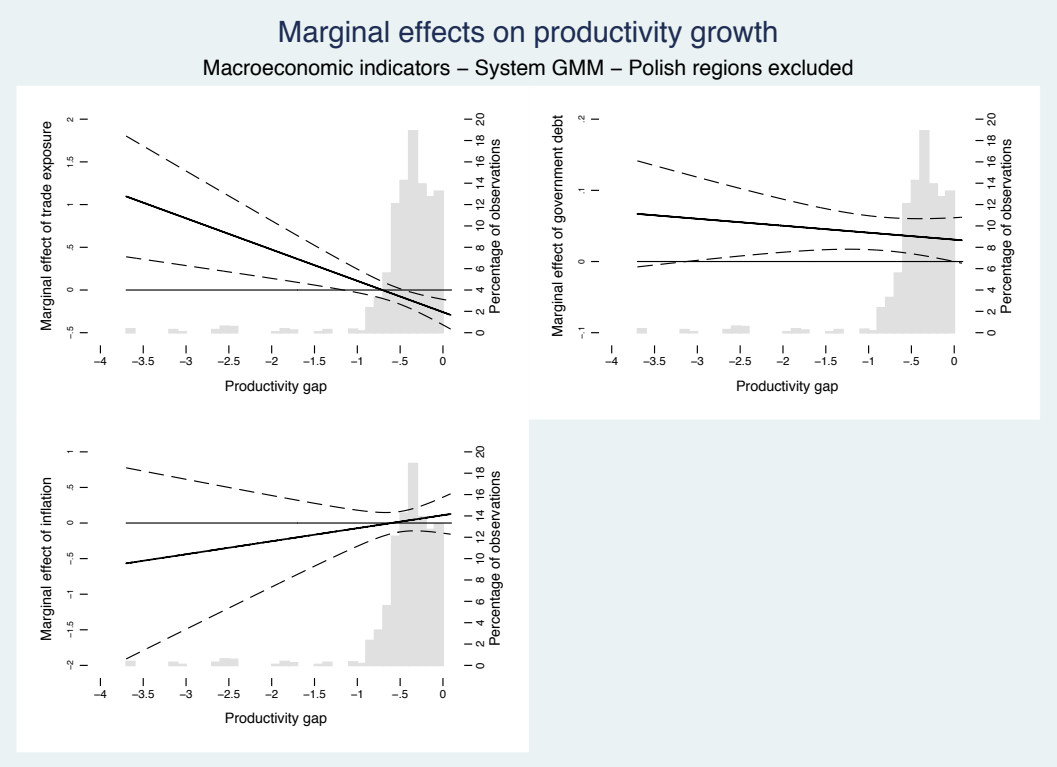
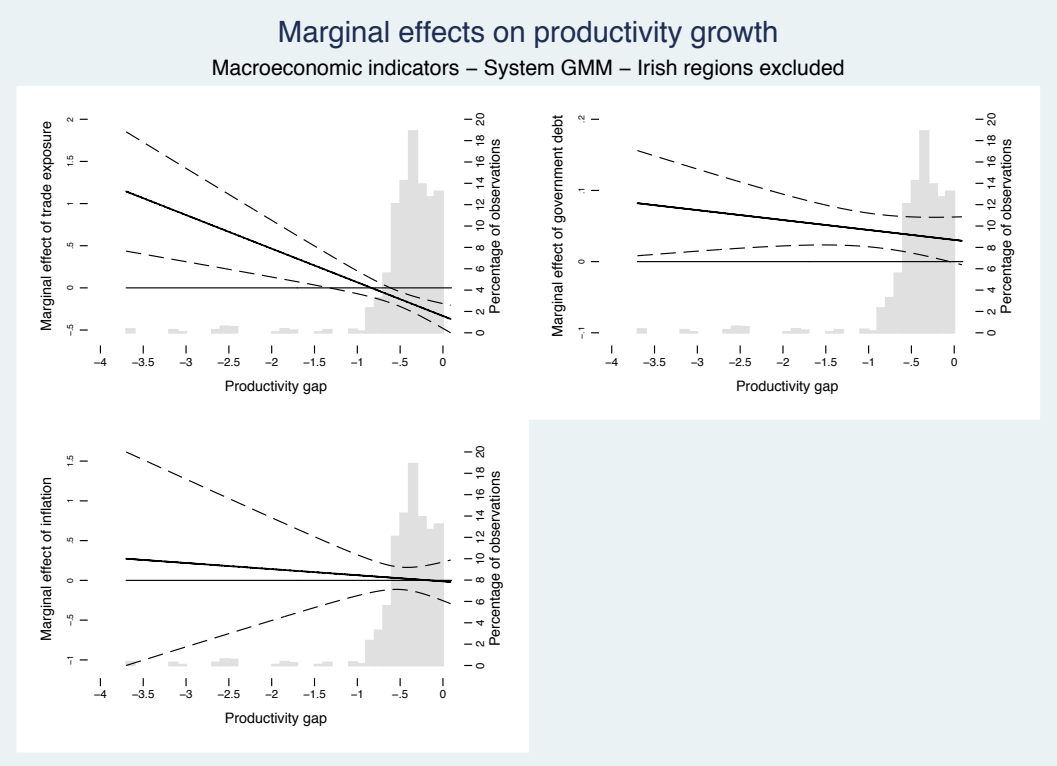


Figure 18: Excluding Irish regions.



6. Conclusions

Our analysis measures the effects of country-wide macroeconomic 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. 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.

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 and that this increases in distance to the frontier. The increase in regional growth from deregulating EPL of temporary contracts by one point on the indicator scale (0.8 of a standard deviation) varies from 1 to 4.8 growth points between a region at a productivity gap of -0.7 and another region at a productivity gap of -1.5. Deregulating barriers to trade and investment by one point (roughly two standard deviations)

is associated with 1.2 point higher regional growth for a region with a productivity gap of -0.5 and 4.6 points for a region with a productivity gap of -1.

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 increases regional growth of regions that are far from the productivity frontier, with a more pronounced effect for lagging regions.

On the other hand, reducing barriers to entrepreneurship increases productivity growth for regions closer to the frontier: for a region with a productivity gap of -0.5, deregulating barriers to entrepreneurship by one point (roughly two standard deviations) is associated with a 3.4 point increase in growth. This effect is larger for regions nearer the frontier but in our GMM results we do not find a significant effect on regions that are the most lagging. We also fail to find a significant effect of reducing state control on regional growth, across the range of regions with our GMM specification.

Our findings also indicate that government debt has a positive and significant effect on growth for most regions with values of the productivity gap greater than -1.3. For a region with a productivity gap of -0.5, increasing government debt by one standard deviation is associated with a 1.5 point increase in growth and the magnitude of the effect is larger for regions nearer the frontier.

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 show 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.

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Tables

Table 1: Summary statistics

	Mean	Std. dev.	Min	Max
Productivity levels (US$ constant prices)	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 (X+M)/GDP	31.17	16.05	9.48	92.37
Debt as % of GDP	66.77	28.13	12.6	175.27
Inflation rate (in %)	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	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: 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 4: Sensitivity of the results to the exclusion of the top 3 productivity regions

Dependent variable: regional productivity growth	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	FE	FE	FE	FE	FE	FE	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 5: 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 6: Sensitivity of the results to the removal of Spanish, Irish and Polish regions

Dependent variable: regional productivity growth	Without Spain		Without Poland		Without Ireland	
	(1)	(2)	(3)	(4)	(5)	(6)
	FE	System GMM	FE	System GMM	FE	System GMM
Frontiergrowth	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 7: Macroeconomic factors and regional growth

Dependent variable: regional productivity growth	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	FE	FE	FE	FE	FE	Pooled OLS	System GMM
Frontiergrowth	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 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)	(2)	(3)	(4)	(5)	(6)
	FE	System GMM	FE	System GMM	FE	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)	(2)	(3)	(4)	(5)	(6)
	FE	System GMM	FE	System GMM	FE	System GMM
Frontiergrowth	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.

Appendix

Fixed effects estimates of marginal effects of the macroeconomic variables:

Figure A1: Marginal effects of macroeconomic variables, OLS.

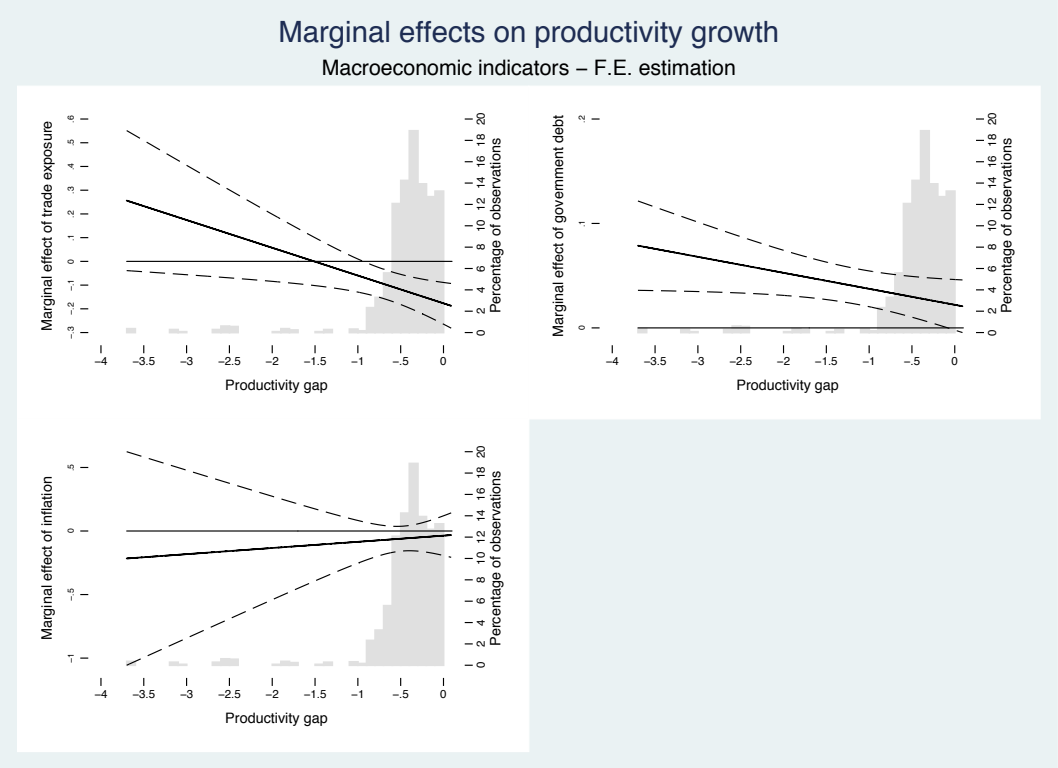

Figure A2: Excluding frontier regions, OLS.

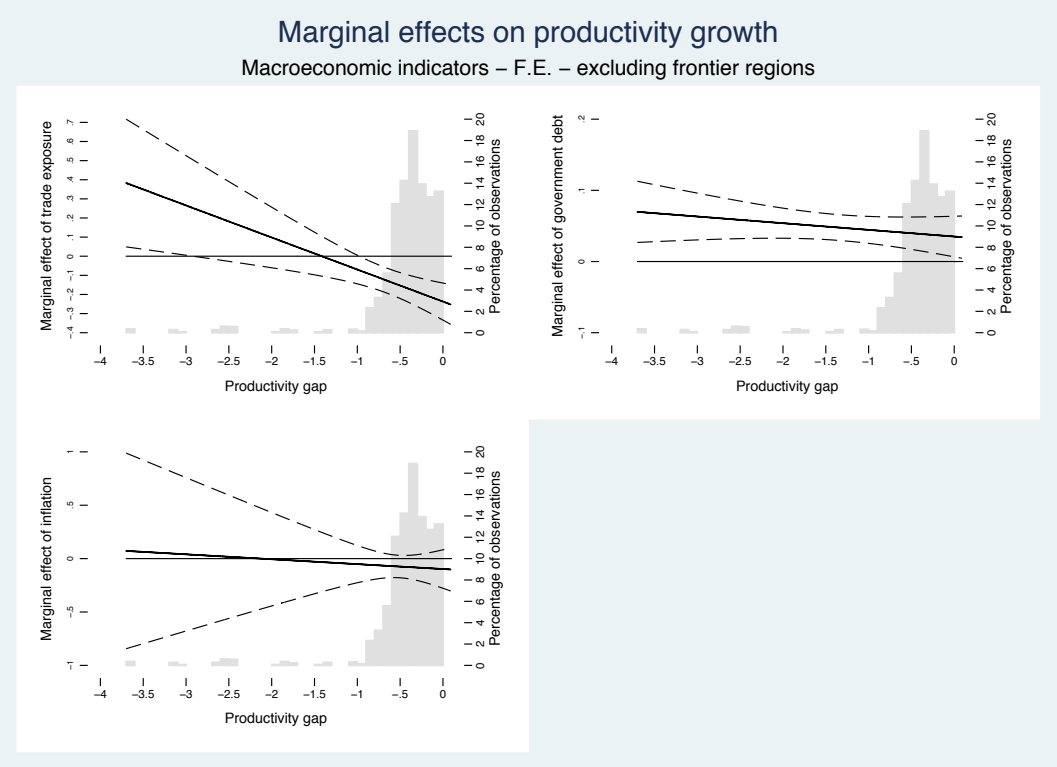

Figure A3: Excluding top three regions, OLS.

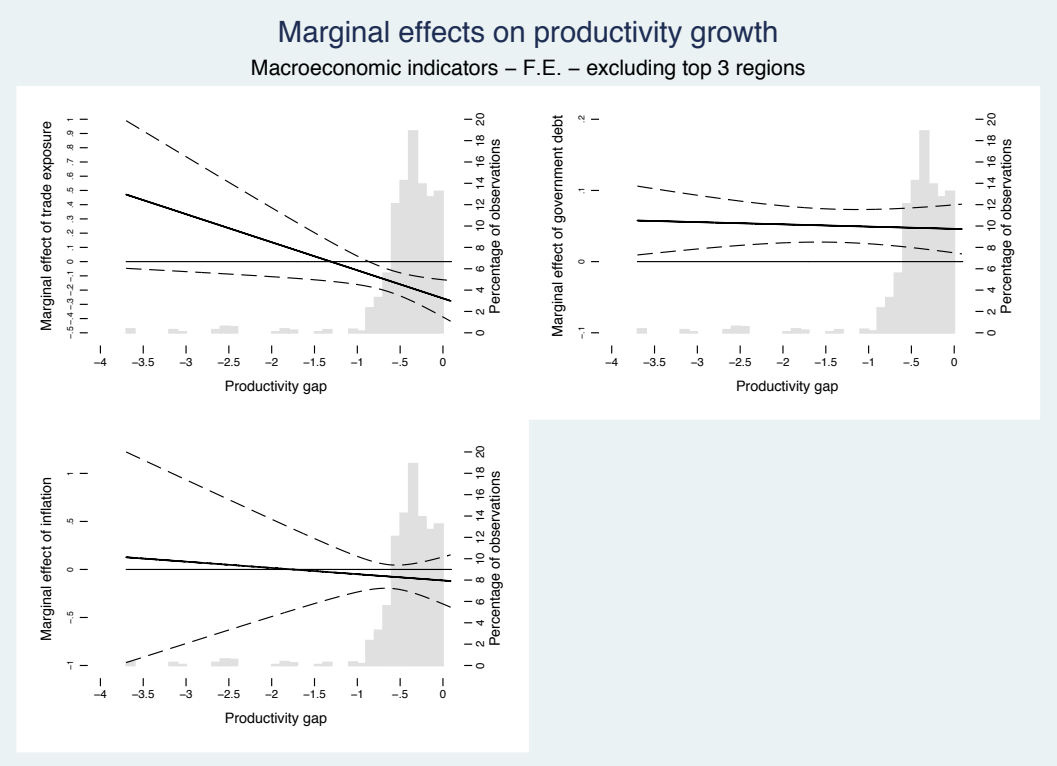

Figure A4: Alternative frontier region, OLS.

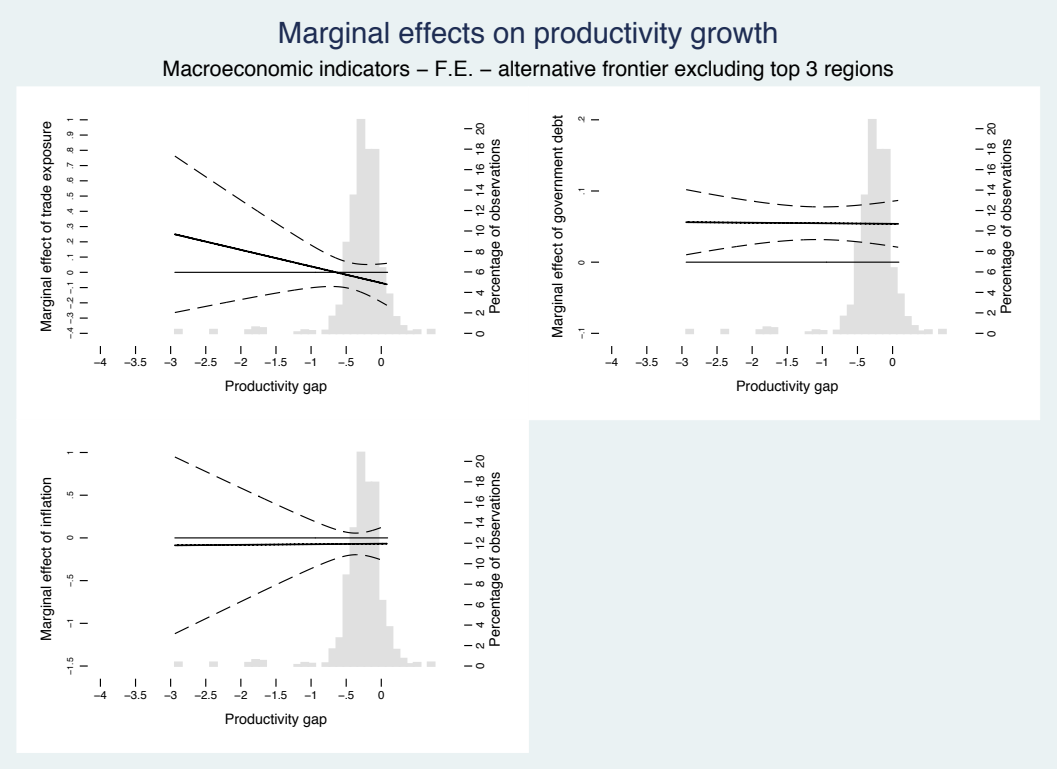

Figure A5: Excluding Spanish regions, OLS.

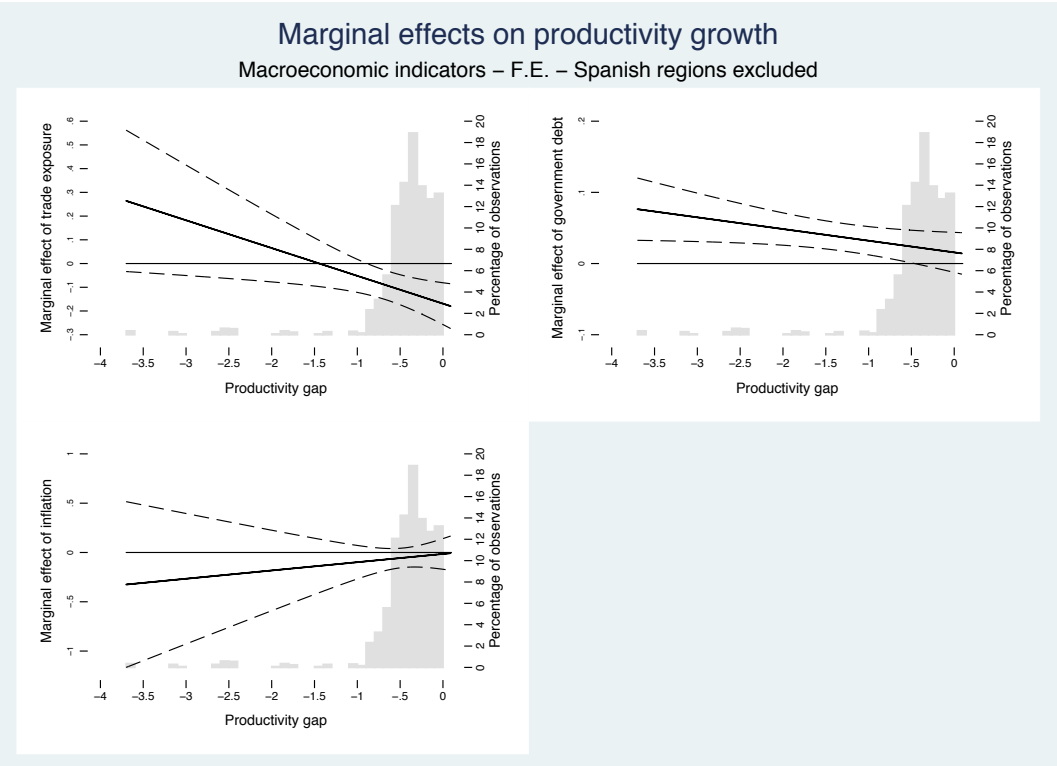

Figure A6: Excluding Polish regions, OLS.

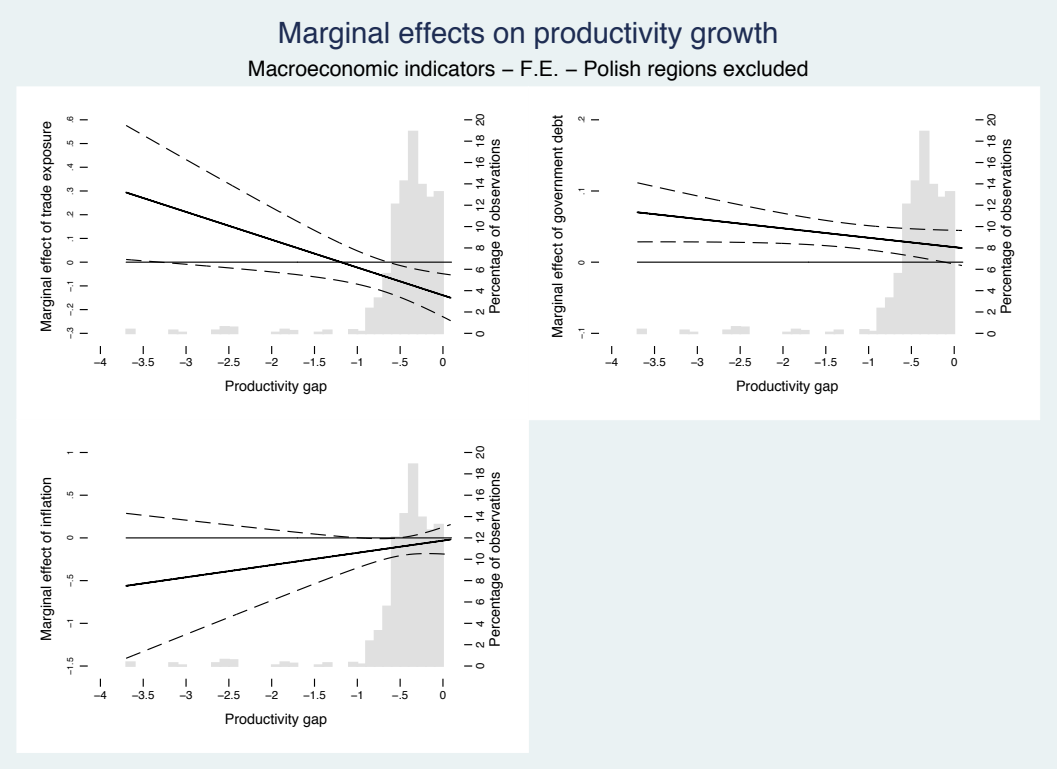

Figure A7: Excluding Irish regions, OLS.