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The Role of Openness in Regional Economic Growth. The Case of Polish and Spanish NUTS-2 Regions[2]

Summary

With the use panel data techniques, we estimate an empirical growth model for Polish and Spanish NUTS-2 regions – two similar-in-size European economies with the inferior initial level of development and at the same time major recipients of EU structural funds. The analysis is carried out for 16 Polish voivodeships and 19 NUTS-2 level municipalities, provinces and autonomous communities observed over the period 2000–2014. Within the joined group of regions, we observe a clear beta-absolute and sigma-convergence. Within countries, the evidence points to divergence. The level of regional sigma convergence is similar. Of particular interest to us is the assessment of the role of broadly defined economic openness in the process of regional economic growth. The initial analysis points to the bidirectional relationship. We then estimate a dynamic panel data model with the use of GMM due to non-stationary nature of the key variables. We control for potential interactions of openness with regional human capital endowments as well as other major determinants postulated by theoretical models. The obtained results are in line with theoretical predictions.

Keywords: regional development, economic growth, panel data, Poland, Spain

JEL Classification Codes: C23, R11, F43, O18, O4

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[2] Acknowledgments: The study has been supported by a grant from the National Science Centre [grant number 2015/19/B/HS4/01704] 'Regional Exporting Activity. Assessment of Determinants in Light of Contemporary Foreign Trade Theory for Poland and Spain' supervised by Prof. Stanislaw Umiński and carried out by Institute for Development. The data for the regional trade of Spain have been retrieved by Marcin Skurczyński and Anna Fornalska-Skurczyńska. We appreciate the comments from two peer reviewers as well as the comments from the participants of the conference at Warsaw School of Economics on 12 May 2017 and the comments and suggestions from Stanisław Umiński, Jarosław Nazarczuk and Dorota Ciołek.

1. Introduction

With ongoing globalisation, the degree of openness of national and thus regional economies is increasing, even in the aftermath of the global financial crisis. Liberalisation of trade flows and greater mutual openness lead to defragmentation of production and emergence of the so-called global value chains, which increases mutual interdependence of economies. Greater openness increases exposure to international shocks, which could be considered as one of its major costs.

Despite the dominance of the viewpoint of the beneficial impact of openness (liberalisation) on economic growth, the review of both theoretical and empirical literature does not bring clear results. Nonetheless, the significance and direction of causality in the relationship between openness and economic growth is an important issue both in theoretical and empirical economic literature. On the theoretical ground, a significant progress was made in the 80 s and 90 s, with the emergence of the new growth theory and the new economic geography. On the empirical ground, the major development was a shift from standard cross-sectional regressions (a la Barro) to more sophisticated panel data, including dynamic panel data models. Most of the empirical studies so far have been carried out at national economies level and not the within the country or inter-country regional level of analysis.

The purpose of the paper is to identify the role of trade openness in determining the growth of Polish and Spanish NUTS-2 regions, controlling for other significant factors affecting economic growth process. With the use panel data techniques, we estimate an empirical growth model for NUTS-2 regions of Poland and Spain – two similar-in-size European economies with the inferior initial level of development and at the same time major recipients of the EU structural funds. The analysis is carried out for 16 Polish voivodeships and 19 NUTS-2 level municipalities, provinces and autonomous communities of Spain, observed over the period 2000–2014. Assuming that Spanish and Polish regions share the same steady-state point in the long run and noting the higher present mean level of development of Spanish regions, we can learn a lot from their experience in the EU (Spain entered the EU – then EEC back – in 1986).

The remainder of the paper is constructed as follows. Section 2 reviews the theoretical literature, while Section 3 reviews the empirical literature. Section 4 describes the data. Section 5 discusses the dependent variable, potential beta and sigma convergence of income per capita, the changes in the openness rate

as well the relation between the two. Section 6 presents the results of an empirical model. The final section concludes.

2. Openness in economic growth – review of theoretical literature

In the neoclassical growth theory (Solow[3]&Swan[4]) openness does not matter in the long-run, as growth is independent of economic policy. It could only lead to the level effects. In the short-run, capital deepening is the major source of growth – as income per capita is proportional to capital per capita. The level of real income per capita in the steady state is a positive function of the rate of saving (investment), a negative function of the population growth rate n and depreciation of capital δ. Technological progress affects the level of real GDP per capita positively. The only factor affecting the long-run growth rate is the rate of exogenous technological progress. In this setting the impact of an increase in openness due to trade policy on economic growth is temporary.

In an augmented model of Mankiw et al.[5] in addition, the human capital endowment is taken into account. The augmented neoclassical model by Brodzicki[6] takes further the impact of infrastructure into account. In the model, in accordance with Mincerian tradition, the average level of education may be specified as a function of average years of schooling and average years of experience[7].

The emergence of the endogenous growth and new trade theories (Lucas[8], Romer[9]) has led to the reopening of the debate on the role of trade, and more general, the degree of openness in determining economic growth in the medium

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3 Solow R. (1957), A Contribution to the Theory of Economic Growth, QJE 70(1)/1956, 65–94; idem, Technical Change and the Aggregate Production Function, *Review of Economics and Statistics* 39, 312–320.

4 Swan T. (1956), Economic Growth and Capital Accumulation, *Economic Record* 32, 334–361.

5 Mankiw G., Romer D., Weil D. (1992), A Contribution to the Empirics of Economic Growth, *Quarterly Journal of Economics* 107(2), 407–437.

6 Brodzicki T. (2015), Shallow determinants of growth of Polish regions. Empirical analysis with panel data methods, *Collegium of Economic Analysis Annals* 39, 25–40.

7 Bils M., Klenow P.J. (2000), Does Schooling Cause Growth?, AER 90, 1160–1183.

8 Lucas R. (1988), On the mechanics of economic development, *Journal of Monetary Economics* 22(1), 3–42.

9 Romer P.M. (1986), *Increasing Returns and Long-run Growth*, JPE 94/1986, 1002–1037; idem, *Endogenous Technological Change*, JPE 1990, 98(5), 71–102.

and long run. The models of the first and second generation endogenized the rate of growth of technology, either by allowing for the impact of human capital or introducing a separate R&D sector purposefully producing knowledge in the form of patents. It is worth to point out, however, that even in a semi-endogenous model of Ben-David&Romer[10], openness to trade through its impact on the process of accumulation of knowledge and technology transfer leads to endogenization of economic growth.

The new growth theory models of Rivera-Batiz&Romer[11] or Grossman&Helpman[12] differ – a policy shift leading to a greater extent of openness, could lead to a permanent effect – long-run growth rate could be affected but not only positively, an adverse impact is also possible. In brief, the balance of costs and benefits of greater openness (liberalisation) depends on the nature and the exact product structure of trade.

Greater openness to trade affects the rate of accumulation of knowledge mostly through imports. They work as a channel allowing absorption of more advanced knowledge positively affecting overall efficiency and thus growth rates. Rivera-Batiz&Romer[13] show however that whether the effect is positive or adverse depends on the distance of economy from global technology frontier and the nature of diffusion of knowledge (perfect versus imperfect). Imperfect knowledge flows coupled with openness can actually harm underdeveloped states or regions.

From a theoretical standpoint, openness affects growth through a number of channels. First of all, it leads to reallocation of factors of production to more productive sectors and thus to specialisation in accordance with the comparative or competitive advantage thus resources are allocated efficiently. Secondly, it leads to increased diffusion and accelerated absorption of knowledge and technology (technology transfer) in particular through imports[14] or inflow of FDI[15].

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[10] Ben-David D., Loewy M.B. (2002), Trade and the Neoclassical Growth Model, *Journal of Economic Integration*, 18, 1–16.

[11] Rivera-Batiz L., Romer P.M. (1991), Economic Integration and Endogenous Growth, QJE 106(2), 531–555.

[12] Grossman G.M., Helpman E. (1991), Innovation and Growth in the Global Economy, MIT Press, Cambridge MA.
Grossman G.M., Helpman E. (1992), Innovation and Growth: Technological Competition in the Global Economy, MIT Press, Boston.

[13] Rivera-Batiz L. et. al. (1991), *op.cit*.

[14] Coe D.T., Helpman E. (1995), International R&D spillovers, EER 39(5), 859–887.

[15] Branstetter L. (2006), Is foreign direct investment a channel of knowledge spillovers? Evidence from Japan's FDI in the United States, *Journal of International Economics* 68(2), 325–344.

Thirdly, it stimulates the rate of innovation as it is frequently associated with an increase in the expenditures on research and development. Fourthly, it allows better utilisation of scale economies and agglomeration externalities as a result of greater specialisation. At the same time, it leads to enhanced accumulation of factors of production. Finally, it stimulates competition in national and international markets thus forcing companies to be more innovative.

It is worth stressing that Rodrik[16] perceives openness or the extent of integration as one of three fundamental deep determinants of economic growth alongside the quality of institutions and geographical conditions.

A further insight can be brought by the new economic geography literature. As Breinlich et al.[17] stress, NEG theory is based on trade theory, and thus the relationship between external trade, internal economic geography, and regional disparities, is at its core. Fujita et al.[18] suggest that openness could work to disperse manufacturing industry as a whole but also lead to the spatial clustering of specific industries. External trade thus affects spatial patterns of activity by changing market access considerations[19].

It is also worth addressing the direction of causality between trade openness and economic growth. If openness affects growth than we deal with export-led growth process through the channels described above. On the other hand, the causality could go from growth to openness. High productivity in the larger domestic market (home marker effect) translates into greater international competitiveness and increase in exports. At the same time, larger domestic economy creates a larger demand for imports. Thus a bidirectional relationship is likely to exist if these two are allowed to hold simultaneously[20].

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16 Rodrik D. (2003), Institutions, Integration and Geography: In Search of the Deep Determinants of Economic Growth, in: Search for Prosperity: Analytic Narratives on Economic Growth, Princeton University Press, Princeton.

17 Breinlich H. et al. (2013), Regional growth and regional decline, CEP Discussion Paper 1232.

18 Fujita M. et al. (1999), The spatial economy: cities, regions and international trade, MIT Press, Cambridge MA.

19 Hanson G. (1996), Localization Economies, Vertical Organization and Trade, AER, 86(5), 1266–1278.

20 Liu X., Song H., Romilly P. (1997), An empirical investigation of the causal relationship between openness and economic growth in China, *Applied Economics* 29(12), 1679–1686.

3. Review of empirical literature

In the empirical literature, two strands dominate – macro approach – mostly cross-sectional analysis of global or more homogeneous groups and the micro approach – analysis for individual countries based on sectoral or firm level data. Many variables are utilised as proxies of openness, nonetheless, the openness ratio is the most popular.

Barro[21] identified a positive and statistically significant impact of the level of openness on economic growth in a cross-section of countries. Dollar[22] noting a potential bias in the index, utilised an index of exchange rate disturbances, finding it to adversely affect economic growth. The result was confirmed by Easterly et al.[23] and Lee[24] using similar approaches. Sachs &Werner[25] utilised a dichotomous index of openness, conditional on meeting 5 criteria finding openness to matter for growth in a cross-section of countries. It was also utilised by Gallup et al.[26] leading to similar result even if deep-rooted geographical factors were taken into account and Vamvakidis[27] finding positive and statistically significant effects of multilateral economic integration. On the other hand, Wacziarg&Welch[28] found the studies applying Sachs-Werner index to be sensitive to the period under analysis.

Edwards[29] (1998) in his seminal study analysed the impact of 9 different indices of openness/disturbances in the exchange rate on TFP and thus indirectly on real GDP per capita in a cross-section of 93 countries. The impact was

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21 Barro R.J. (1991), Economic Growth in a Cross Section of Countries, QJE 106/1991, 407–443.

22 Dollar D. (1992), Outward-oriented Developing Economies Really To Grow More Rapidly: Evidence from 95 LDCs, 1976–1985, *Economic Development and Cultural Change*, 523–544.

23 Easterly W. et al. (1993), Good Policy or Good Luck?, *Journal of Monetary Economics* 32(3), 459–483.

24 Lee J.W. (1993), International Trade Distortions and Long-run Growth, *IMF Staff Papers*, 40(2), 299–328.

25 Sachs J.D., Warner A. (1995), Economic Convergence and Economic Policies, NBER Working Paper 5039.

26 Gallup J.L., Sachs J.D., Mellinger A. D (1999), Geography and Economic Development, *International Regional Science Review* 22(2), 179–232.

27 Vamvakidis A. (1999), Regional Trade Agreements or Broad Liberalization: Which Path Leads to Faster Growth?, *IMF Staff Papers* 46(1), 42–68.

28 Wacziarg R., Welch K.H. (2003), Trade Liberalization and Growth: New Evidence, *Research Paper* 1826.

29 Edwards S. (1998), Openness, Productivity and Growth: What Do We Really Know?, *The Economic Journal* 108, 383–398.

found to be positive however its magnitude was found to be inferior in comparison to the initial level of GDP per capita or the initial level of human capital.

Due to potential endogeneity IV approach is frequently utilised. For instance, Frankel&Romer[30] proposed an instrumental variable based on geographical factors that determine to a large extent trade while having exogenous nature in relation to the level of income. The impact of openness proved to be insignificant in two large cross-sections. In contrast, Irwin&Tervio[31] reiterated the test by Frankel&Romer[32] in a slightly modified manner in a panel of countries. The results pointed to a positive relationship between the intensity of trade and the level of GDP per capita. Romalis[33] found similar results using the instrumental variable approach in a large panel of countries (135) observed over a period of 40 years (1960–2000).

Vamvakidis[34] tested six different measures of openness in a longer time period (1920–1999) finding that the positive relationship between openness and growth exists only after 1970, which could be related to overall higher openness with increasing extent of globalisation.

Wacziarg &Welch[35] utilized a different approach to analysing the effects of cases of significant trade-policy liberalizations and found that, on average, the investment rate increased by 1.5 to 2 percent, and the share of trade in GDP by 5 percent, while the ex-post growth rate was higher than ex-ante growth rate by a mean of 1.5 percent.

Using the extreme bounds analysis, Levine&Renelt[36] found the index of openness to be one of the variables affecting the growth rate in a cross-section of countries indirectly through an impact on the process of accumulation of capital (rate of investment). The direct impact of openness was rejected. In contrast,

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30 Frankel J., Romer D. (1996), Trade and Growth: An Empirical Investigation, *NBER Working Paper* 5476; Frankel J., Romer D. (1999), Does Trade Cause Growth?, AER 89(3), 379–399.

31 Irwin D., Tervio M. (2002), Does trade raise income? Evidence from the twentieth century, *Journal of International Economics* 58, 1–18.

32 Frankel J., Romer D. (1999), Does Trade Cause Growth? *op.cit*.

33 Romalis J. (2007), Market Access, Openness and Growth, *NBER Working Paper* W13048/2007.

34 Vamvakidis A. (2002), How Robust is the Growth-Openness Connection? Historical Evidence, *Journal of Economic Growth* 7, 57–80.

35 Wacziarg R., Welch K.H. (2003), *op.cit*.

36 Levine R., Renelt D. (1992), A Sensitivity Analysis of Cross-country Growth Regressions, *American Economic Review* 82, 942–963.

Doppelhofer, Sala-i-Martin&Miller[37] using the Bayesian Averaging of Classical Estimates for a balanced panel of 88 countries and 68 variables founding the time since the opening of the economy (impact of liberalisation) to positively affect economic growth. The overall openness was found to matter less.

The studies on the impact of openness on growth at the regional level are rather rare. In recent years a number of studies have been performed on Asian economies. And thus Sun et al.[38] show in a study of Chinese regions at manufacturing industries level that openness to trade (trade orientation and FDI) have a positive effect on technical efficiency. Leong[39], analysing the impact of special economic zones as cases of liberalisation on regional economic growth in China and India, found that both FDI and export to positively affect growth. The presence of SEZs increases regional growth, however, an increase in the number of SEZs has a negligible effect on growth. Leong finds greater openness (wider liberalisation) as a precondition of further growth. Wei et al.[40] in a panel of Chinese regions over the entire period 1979–2003 proved that FDI inflows were one of the forces behind the observed regional discrepancies in growth. The authors claim however that FDI cannot be blamed for inequality as it was due to the uneven distribution of FDI and not the FDI itself.

Anwar&Nguyen[41] using simultaneous equations model found in a panel of 61 provinces of Vietnam from 1996–2005, a mutually reinforcing two-way process between FDI and regional economic growth. The benefits of FDI inflow could be further strengthened by more investments into education and training, development of the financial market and reducing technology gap between foreign and local firms.

According to Kanbur&Venables[42], rising spatial disparities in regional development in many developing states are mostly due to uneven impact of increased trade openness and globalisation. It leads to efficiency gains mostly due to con-

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37 Doppelhofer G., Miller R.I., Sala-i-Martin X. (2000), Determinants of Long-term Growth: A Bayesian Averaging of Classical Estimates (BACE) Approach, *NBER Working Paper* W7750.

38 Sun H. et al. (1999), Economic Openness and Technical Efficiency: A Case Study of Chinese Manufacturing Industries, *Economics of Transition* 7(3), 615–636.

39 Leong C.K. (2013), Special Economic Zones and Growth in China and India: An Empirical Investigation, *International Economics and Economic Policy* 10(4), 549–567.

40 Wei K., Yao S., Liu A. (2009), Foreign Direct Investment and Regional Inequality in China, *Review of Development Economics* 13(4), 778–791.

41 Anwar S., Nguyen L.P. (2010), Foreign Direct Investment and Economic Growth in Vietnam, *Asia Pacific Business Review* 16 (1–2), 183–202.

42 Kanbur R., Venables A. (2005), Rising Spatial Disparities and Development, *UNI-WIDER Policy Brief* 3.

certation of economic activity in major cities and coastal districts, adversely affecting inland regions. In a study on Latin America, Serra et al.[43] argue that regional disparities modestly increased, at least temporarily, in the wake of trade liberalisation. It was especially marked for Mexico.

When analysing the nexus between openness and economic growth at regional level we have to note the direct or indirect impact of other accompanying variables or processes. For instance, Sachs et al.[44] studying σ -convergence and ß-convergence show that more than 80 percent of the cross-state variation in growth rates among Indian states can be explained solely by an urbanisation variable. Agglomeration factors are also strongly postulated by NEG theories.

The role of human capital accumulation is clear on theoretical and empirical grounds. However, the scope of the definition of human capital differs. For example, in the study by Boschma&Fritsch[45] points in line with Florida to an important contribution of the so-called creative class for regional growth in 7 European countries. They are however not able to determine whether human capital as measured by the creative occupation, outperforms standard indicators based on formal education and whether formal education has a stronger impact. The creative class endowment is positively affected by the regional climate of tolerance and openness as well as regional job opportunities.

The economic structure could matter as well including the size and share of the industrial sector. For instance, the study by Hansen&Zhang[46] points to the key role of the industrial sector in explaining the regional variation in growth among Chinese provinces. The result supports the Kaldorian approach to regional economic growth with cumulative causation between trade liberalisation, the rise in export demand, the growth of industrial sector (industrialisation) and its impact on overall productivity and thus increases in international competitiveness.

One of the issues that cannot be overlooked is the issue of path-dependency in regional development. For instance, Felice&Vecchi[47] indicate that the regional North-South variation in Italy was already present the moment the

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43 Serra M.I. et al. (2006), Regional Convergence in Latin America, IMF Working Paper 06(125).

44 Sachs J. et al. (2002), Understanding Regional Economic Growth in India, *Asian Economic Papers* 1(3), 32–62.

45 Boschma R.A., Fritsch M. (2009), Creative Class and Regional Growth: Empirical Evidence from Seven European Countries, *Economic Geography* 85(4), 391–423.

46 Hansen J.D., Zhang J. (1996), A Kaldorian Approach to Regional Economic Growth in China, *Applied Economics* 28(6), 679–685.

47 Felice E., Vecchi G. (2015), Italy's Modern Economic Growth, 1861–2011, *Enterprise & Society* 16(2), 225–248.

country was unified and then increased. The explanation of the present variation involves endogenous factors – natural resources, human capital endowment, and social capital.

In an article Brodzicki[48] published in the *Annals*, attempted to identify shallow determinants of growth of Polish regions as well the sign and magnitude of macroeconomic' education – externality and macroeconomic infrastructure externality. We constructed accordingly an augmented neoclassical growth model incorporating a Mincerian approach to human capital accumulation, further assuming a direct impact of infrastructure on the overall productivity. The estimated panel model, accounting for fixed region-specific effects, was robust and explained approx. 90 percent of observed variation in GDP per capita. The return to the accumulation of human capital through education and experience for Polish regions was found to be statistically significant, robust and positive. The macroeconomic infrastructure externality proved to be, in turn, positive – however overall insignificant with the impact of quality of railway.

4. Dataset

In the empirical part of the paper, we utilise foremost the data from the QoG EU Regional dataset (Charron et al.[49] 2016). The trade data for Polish and Spanish regions have been obtained from the Polish Customs Chamber (Izba Celna) and retrieved from DataComex Español database[50]. They cover the period 2005–2015.

QoG EU Regional database is a dataset consisting of approximately 450 variables covering three levels of European regions NUTS0, NUTS1, and NUTS2. The data is given in time-series version (from 1990 to 2015) and the unit of analysis is region-year. The data on GDP per capita are available for the period 2000–2014 only.

[48] Brodzicki T. (2015), *op.cit*.

[49] Charron N. et al. (2016), The Quality of Government EU Regional Dataset, version Sep.16, University of Gothenburg: The Quality of Government Institute, http://www.qog.pol.gu.se.

[50] http://datacomex.comercio.es/principal_comex_es.aspx.

5. Convergence in regional incomes and the openness ratio

The empirical analysis is carried out for a group of 16 Polish and 19 Spanish NUTS-2 regions within the period 2000 to 2014.

The dependent variable is the present study is a natural logarithm of GDP per capita (ln_y). The other key variable is an openness index of regions is measured using the standard openness index – the ratio of exports and imports to GDP (ln_open).

If we treat two regions jointly the relation of the initial log of GDP per capita and the mean growth rate of GDP per capita over the observed period is negative and points to beta convergence. Polish regions are clearly catching up with Spanish regions in terms of the level of development. If we treat both countries separately, the data are less conclusive pointing to weak regional divergence in Poland and weak regional beta-convergence in Spain, however, the results are not statistically robust.

We know from economic growth theory that beta-convergence is a necessary however not sufficient condition for sigma-convergence. Thus the above result should be indicative of sigma-divergence in both countries at NUTS 2 level. We test is by plotting the evolution of standard deviation of the log of GDP per capita for both countries over the analysed period.

The result points to clear sigma-divergence in Poland over the analysed period and U-shape pattern for Spain – with the initial sigma-convergence and then divergence in the aftermath of the financial and eurozone crises. It seems that less developed Spanish regions have been more adversely affected by the crises.

The openness ratio increased in most of the analysed regions from 2005 to 2014 (on average by 9 percent). The openness ratio dropped only in the case of Mazowieckie, Illes Balears, Canarias and Comunidad de Madrid.

On the other extreme, the highest increases have been reported in Andalucía, Łódzkie, Dolnośląskie and Opolskie (by more than 15 percent), Lubuskie by approx. 25 per cent, Región de Murcia 33 percent and Pomorskie by 34.3 percent.

We now will investigate the relationship between income per capita and openness. The correlation between the two is rather weak. We have to note that within a panel, non-stationarity and cross-sectional dependence could exist. At the same time, we deal with a heterogeneous panel data model that is a model in which all parameters (constant and slope coefficients) vary across regions analysed (we thus assume conditional convergence to hold).

We first apply Im–Pesaran–Shin test (Im et al.[51] 2003) as we cannot infer that all panels share a common autoregressive parameter. Cultural, other institutional and deeper rooted factors make this assumption rather feeble. The two key variables, a namely log of GDP per capita and a log of openness ratio, are non-stationary and we cannot reject the null hypothesis of no cointegration. In the further econometric analysis, we thus utilise the standard solution in the empirical literature of the subject thus applying a dynamic panel data model estimated with the use of GMM (Arellano-Bover[52] & Blundell-Bond[53]).

The results of Pesaran's test of cross-sectional independence (29.653, Pr = 0.0000) indicate that we have to reject the null hypothesis of cross-sectional independence and thus we deal with cross-sectional dependence.

Finally, we analyse whether there exists a causality relationship among the key variables using the causality test developed by Dumitrescu&Hurlin[54]. The authors proposed a simple Granger[55] non-causality test for heterogeneous panel data models. Under the null hypothesis of Homogeneous Non-Causality (HNC), there exists no causal relationship for any of the cross-section units of the panel. Under the alternative, one subgroup of cross-section unit is characterised by causal relationships and the other subgroup indicates no causal relationship. The test statistic depends on the individual Wald statistics of Granger non-causality averaged across the cross-section units. Dumitrescu&Hurlin proposed a block bootstrap procedure implemented in STATA to deal with cross-sectional dependence.

The value of panel standardised statistic Z^{HNC}, based on the assumption of asymptotic moments, allows us to reject the null hypothesis of no Granger-causality, in favour of the alternative hypothesis that there is Granger-causality in at least one panel. The results point to bidirectional causality between GDP per capita and openness in our sample of Polish and Spanish NUTS-2 regions. This is in line with some of the theoretical postulates described in Section 2 and empirical results in Section 3.

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[51] Im S.K., Pesaran M., Shin Y. (2003), Testing for Unit Roots in Heterogeneous Panels, *Journal of Econometrics* 115, 53–74.

[52] Arellano M., Bover O. (1995), Another Look at the Instrumental Variable Estimation of Error-Components Models, *Journal of Econometrics* 68(1), 29–51.

[53] Boschma R.A., Fritsch M. (2009), Creative Class and Regional Growth: Empirical Evidence from Seven European Countries, *Economic Geograph* 85(4), 391–423.

[54] Dumitrescu E.I., Hurlin C. (2012), Testing for Granger Non-causality in Heterogeneous Panels, *Economic Modelling* 29(4), 1450–1460.

[55] Granger C.W. (1969), Investigating Causal Relations by Econometric Models and Cross--spectral Methods, *Econometrica* 37(3), 424–438.

6. The empirical model & discussion of the results

Noting the non-stationarity of the dependent variable, we utilise the dynamic panel data approach estimated with GMM using the xtdpdsys command. The command fits dynamic panel-data estimators with the Arellano–Bover/Blundell–Bond system estimator. Noticing problems with one-step GMM (the high values of the Sargan test of overidentifying restrictions) we apply the two-step GMM estimator. The initial results are presented in Table 2, where we estimate the models for a joint sample of Polish and Spanish NUTS-2 regions. Analyses are performed for a number of different specifications of the model with a varying selection of explanatory variables.

Our analysis is restricted by the availability of data in our dataset. We, unfortunately, have been unable so far to control the investments rates or regional physical endowments (apart from transport infrastructure). We control for the population growth rate (n) as well as the human capital endowment (ln_h – log of population share with tertiary education).

As we do not use fixed effects method due to the utilised econometric approach (dynamic panel model based on first differences) we cannot assume that initial differences in the level of technology are included in the region-specific fixed effects. In order to account for potential differences, we take into account the evolution of the ratio of General Expenditures of Research and Development to GDP (d_gerd).

Similarly to Brodzicki[56], we take the quality of infrastructure into account based on the methodology proposed by Careijo et al [57]. The index of infrastructure quality ICQ relativizes the infrastructure endowment by normalising the infrastructure endowment by population and land area and simultaneously comparing it to a benchmark. In the present article, we take the mean for Polish and Spanish regions as the respective benchmark. ICQ is calculated in accordance with the following formula:

$$ICQ_r = \left(\frac{X_r / N_r}{X_{a.PLES} / N_{a.PLES}} \right)^{0,5} \left(\frac{X_r / A_r}{X_{a.PLES} / A_{a.PLES}} \right)^{0,5} \quad (1)$$

[56] Brodzicki T. (2015), *op.cit*.

[57] Careijo E. et al. (2006), Indicadores de Convergencia Real Para los Países Avanzados, Estudios de la Fundación, FUNCAS, Madrid.

where X_r i X_B gives the infrastructure endowment of a given region and the benchmark (mean for Poland and Spain), while N and A represent, respectively, population and land area.

Our base empirical model fits the data relatively well. The coefficient on lagged dependent variable is statistically significant, indicating the presence of absolute (1) or conditional convergence. In (2) we introduce n and ln_h. In most of the specifications, their impact is statistically significant and in accordance with theoretical predictions – the impact of population growth rate is negative while the impact of the human capital endowment is positive on the level of regional income per capita. In (3) we introduce and control for variation in regional R&D potential by the introduction of GERD (d_gerd). The impact of general expenditure on R&D is statistically significant, however, adverse. Finally, in (4) we introduce our key explanatory variable – ln_open. Its impact on the dependent variable is clearly positive and statistically significant. A greater degree of trade openness boosts the economic growth of Polish and Spanish regions, ceteris paribus. In models (5) we account for the potential joint effect of openness and human capital endowment on the level of GDP per capita by an introduction of an interaction term (open_h). The magnitude of the impact of openness when we account for the interaction is significantly stronger, however, the interaction term is negative and statistically significant which means that it decreases in the human capital endowment. That is an increase in the extent of openness brings stronger effects on GDP per capita of regions with initially lower levels of human capital endowment.

In the last two specifications, we control for regional infrastructure endowment and its quality (in icq2 we benchmark against the mean in the group). The impact is statistically significant and positive in line with the results by Cieślik&Rokicki[58] for Poland or the results of Crescenzi&Rodriguez-Pose[59] for whole Europe.

As an extension, we could acknowledge the potential spatial correlation between regions can be included in the model through the introduction of the agglomeration effects or the introduction of spatial weighting matrixes in a more sophisticated spatial econometric approach.

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7. Conclusions

With the use dynamic panel data model estimated using two-step GMM, we have estimated an empirical growth model for Polish and Spanish NUTS-2 regions over the period 2000–2014 in order to identify the dependence of regional growth on the extent of openness. We first review theoretical and empirical literature. Within the joined group of regions, we observe a clear beta-absolute and sigma-convergence. Within countries, the evidence points to sigma-divergence. It holds in particular for Spain, after the financial and euro zone crises. Greater openness seems overall to positively affect regional economic growth in our sample. The results of Granger non-causality test point, however, to the existence of a bidirectional relationship between the variables.

In comparison to our previous article devoted to the issue of determinants of regional variation of the growth process in Poland, we have extended the analysis by using a new dataset, increasing the temporal dimension and cross-sectional dimension by using data for Spanish NUTS-2 regions and finally focusing on the role of openness to trade. Furthermore, we have utilised a more sophisticated dynamic panel model, estimated with two-step GMM noting the non-stationary nature of key variables.

Our analysis has several limitations. It is mostly due to the limited availability of data at regional level. Nonetheless, we plan to extend our analysis in several dimensions: extending the analysis further to all NUTS 2 regions of the EU28 and accounting for potential spatial interactions with the use of spatial econometric techniques, extending the notion of openness by considering the flows of FDIs as well as by controlling for institutional determinants of regional development.

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Table 1. Dumitrescu&Hurlin (2012) Granger non-causality test results

Direction of causality	W^{HNC}-bar	Z^{HNC}-bar	Z^{HNC}-bar title
OPEN => Y	2.2386	5.1815*** (p-value = 0.0000)	1.3028 (p-value = 0.1926)
Y => OPEN	1.8232	3.4439*** (p-value = 0.0006)	0.5702 (p-value = 0.5686)

Note: ***, **, * determine significance at 1%, 5%, and 10% level respectively. The approximated critical values for the average statistic W were computed from equation (30) for the case K = 1. The simulated critical values were computed via stochastic simulations with 50, 000 replications. For N=25, T=10 the simulated critical value is 2.40 (Dumitrescu and Hurlin; 2012; Table 4).

Table 2. Results of estimation of dynamic panel model using two-step GMM

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
L.ln_y	0.936***	0.813***	0.814***	0.859***	0.908***	0.763***	0.748***
	(0.000648)	(0.00508)	(0.00653)	(0.0124)	(0.0160)	(0.0289)	(0.0237)
N		–0.0358***	–0.0357***	–0.0422***	–0.0408***	–0.0430***	–0.0426***
		(0.000606)	(0.00150)	(0.00184)	(0.00221)	(0.00411)	(0.00570)
ln_h		0.240***	0.277***	0.181***	0.847***	0.291***	0.320***
		(0.00932)	(0.00991)	(0.0160)	(0.156)	(0.0615)	(0.0739)
d_gerd			–0.0416***	–0.0563***	–0.0601***	–0.104***	–0.110***
			(0.00862)	(0.0127)	(0.0205)	(0.0111)	(0.0254)
ln_open				0.0821***	0.711***	0.0669***	0.0802***
				(0.00561)	(0.139)	(0.00992)	(0.00726)
open_h					–0.194***		
					(0.0425)		
ln_icq						0.157***	
						(0.0385)	
ln_icq2							0.160***
							(0.0352)
Constant	0.635***	1.257***	1.165***	0.782***	–1.850***	2.385***	1.476***
	(0.00546)	(0.0326)	(0.0439)	(0.0879)	(0.523)	(0.511)	(0.287)
Observations	490	311	254	169	169	119	119
No of reg_id	35	30	28	26	26	21	21
Sargan test	34.983	28.767	25.415	22.705	24.007	19.007	16.566
AR(1)	–3.9494	–2.0051	–1.8532	–2.0451	–2.1912	–1.7245	–1.7704
AR(2)	–2.4204	–2.4587	–2.2987	–2.1368	–1.9034	–1.5303	–1.3751
Wald chi(2)	2.09e+06	149166.58	109129.98	44602.91	44252.18	5613.77	43152.18

Note: Source: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Estimated in STATA 14 (xtdpdsys).

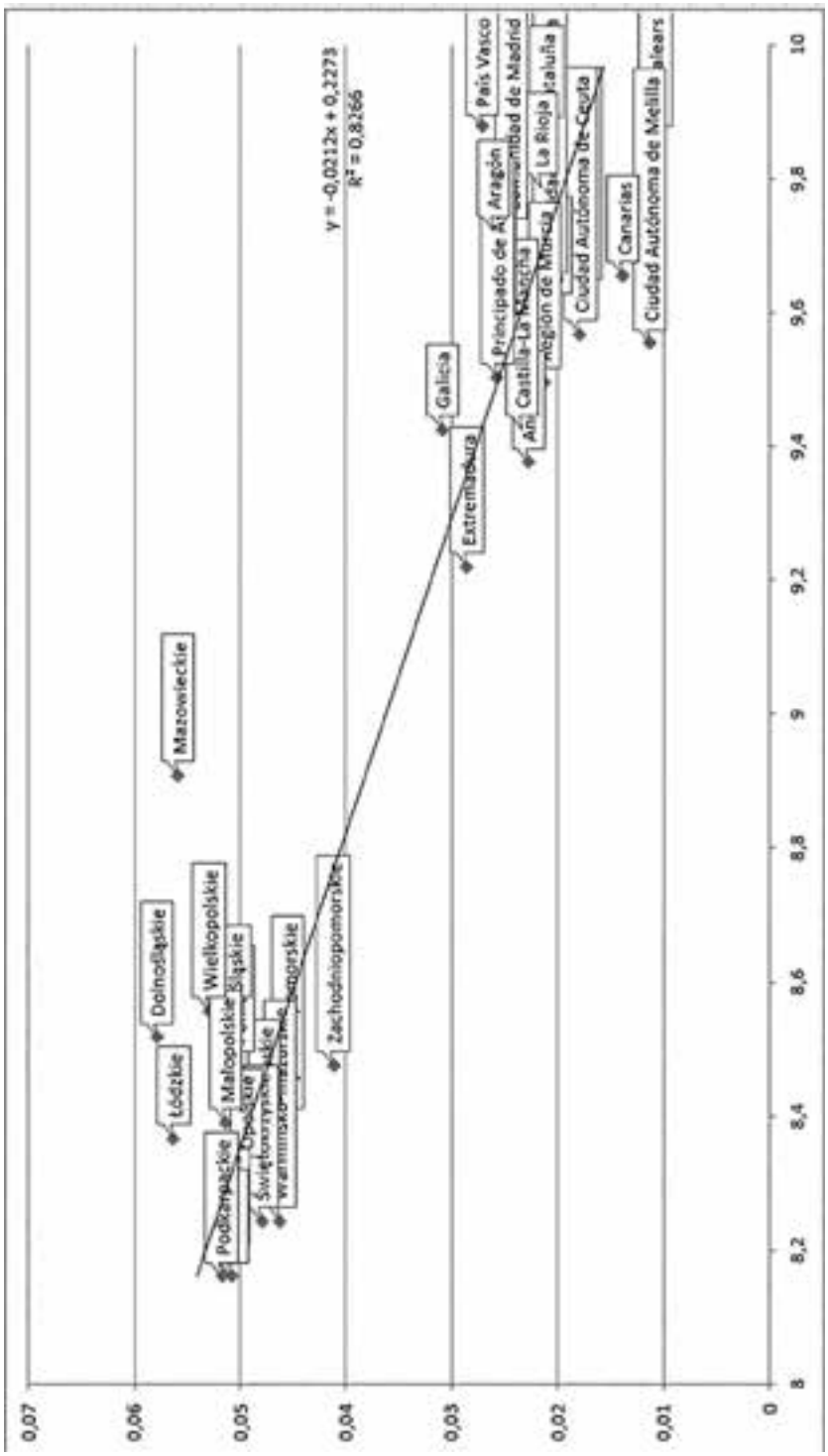

Figure 1. Beta-absolute convergence in the sample of Polish and Spanish regions

Source: Own elaboration.

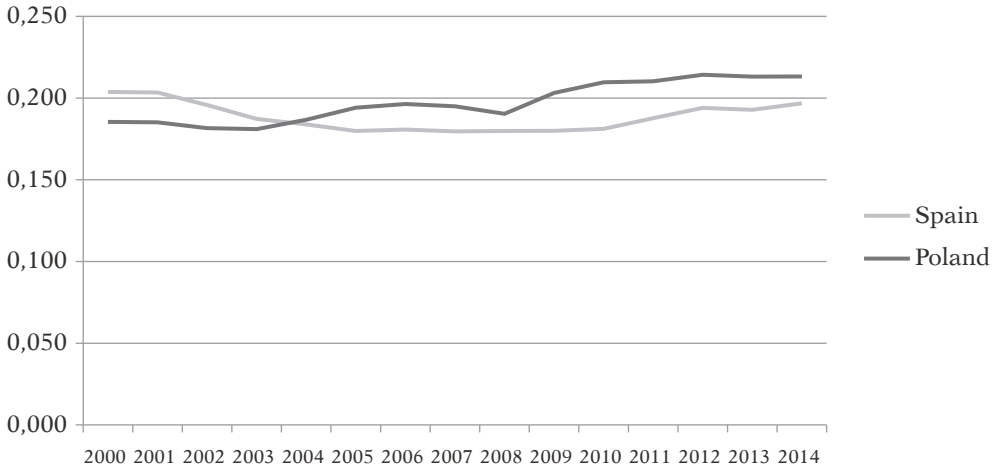

Figure 2. Sigma-convergence of GDPpc in the sample of Polish & Spanish regions

Source: Own elaboration.

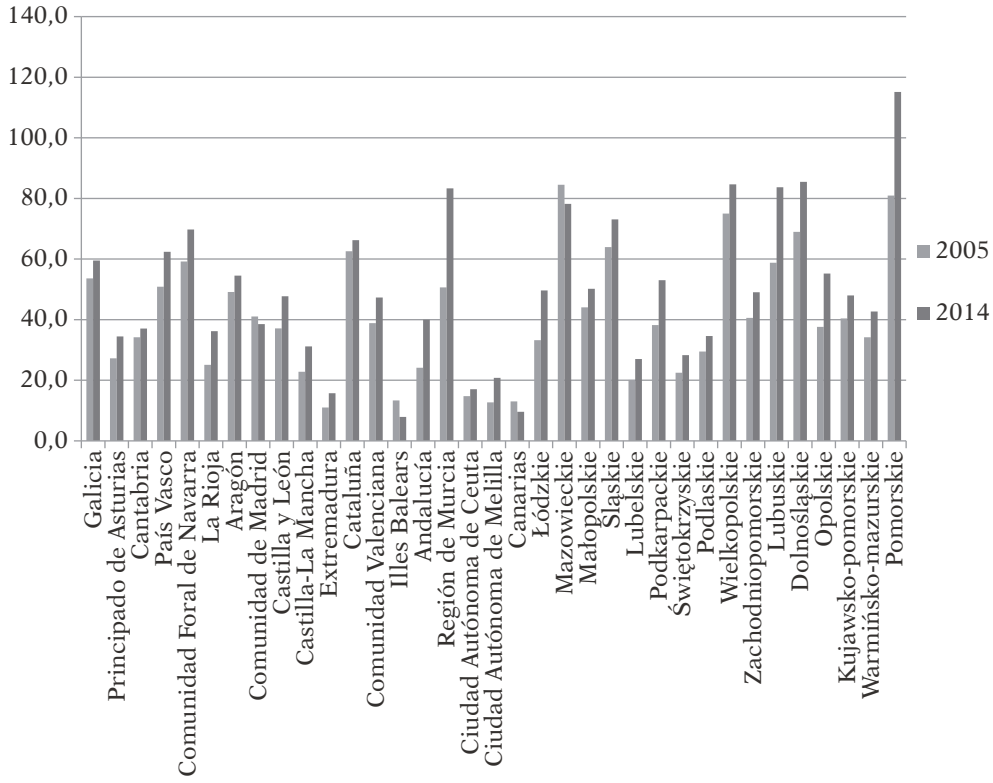

Figure 3. The extent of openness of Polish and Spanish NUTS-2 regions in 2005 & 2014

Source: Own elaboration on the basis of Polish and Spanish regional trade datasets.

* * *

Streszczenie

Przy wykorzystaniu metod estymacji modeli panelowych w artykule szacujemy empiryczny model wzrostu polskich i hiszpańskich regionów poziomu NUTS-2, dwóch europejskich gospodarek o zbliżonej wielkości, niskim początkowym poziomie rozwoju, a jednocześnie głównych beneficjentów funduszy strukturalnych UE. Analizę przeprowadzono dla 16 województw Polski i 19 prowincji i wspólnot autonomicznych poziomu NUTS-2 Hiszpanii w latach 2000–2014. W połączonej grupie regionów obserwujemy wyraźną beta-konwergencję rozwojową i sigma-konwergencję, podczas gdy analizy w obrębie krajów wskazują na dywergencję rozwojową. Szczególnym celem artykułu jest zbadanie wpływu szeroko definiowanej otwartości na proces rozwoju regionalnego. Wstępna analiza przyczynowości między kluczowymi zmiennymi wskazuje na występowanie zależności dwukierunkowej. W kolejnym kroku szacujemy dynamiczny model panelowy za pomocą dwustopniowego estymatora uogólnionej metody momentów ze względu na niestacjonarny charakter kluczowych zmiennych. W procesie estymacji uwzględniamy potencjalne interakcje otwartości z regionalnymi zasobami kapitału ludzkiego oraz innymi ważnymi determinantami postulowanymi przez modele teoretyczne. Uzyskane wyniki są zgodne z podstawowymi postulatami teoretycznymi.

Słowa kluczowe: rozwój regionalny, wzrost gospodarczy, dane panelowe, Polska, Hiszpania