Extended abtract

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EXTENDED ABSTRACT

Title: Technology, geography, and institutions: revisiting evidence for economic development and inequality in European Union

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2. Desigualdad y pobreza de los territorios

Abstract:

The interplay between technology, geography and institutions has been proved to affect not only the ongoing process of globalization, but also past events of profound economic change (Sachs, 2020), and these factors have been alleged to impact on economic development. This fact may be particularly crucial at the regional level, especially for the case of Europe, where several institutional efforts have been taken to reduce disparities between European countries. However, we still find salient and pronounced differences between core and periphery regions between and within European Union Member States. These differences have been widely studied and explained by factors related to geography, recognizing the importance of accessibility,

factor endowments, and being closer to the economic core to explain the growth and economic development of the regions (e.g., Krugman, 1991; Fujita et al., 1999). Digital technologies, which can be applied to low-productivity sectors by small and medium enterprises, and improvements in social inclusion for European citizens are among the drivers that can reduce territorial inequalities (European Commission, 2018, 2020). Finally, it has also been recognized that there exist sharp differences in the quality of government at the regional level (Charron et al., 2014), and that government quality play is an important role in regional prospects (Ketterer and Rodríguez-Pose, 2018).

Despite identifying these determinants, the dynamics of regional inequalities in the European Union tend to persist over time. The most recent report on the effect of national policies and cohesion in the European Union has found between and within-country inequalities that persist in the European Union and different drivers to reduce these inequalities (European Commission, 2017). The traditional and dominant strategies to address territorial inequalities have considered physical and human capital, together with technology, but this has not been successful in reducing territorial inequalities (Rodríguez-Pose, 2020). The simultaneous consideration of technology, institutions, and geography at the subnational level can shed light on how to understand regional development dynamics. In parallel, inequality is particularly relevant, as it may constitute a threat to political stability and social cohesion at the regional level (Iammarino et al., 2019). Concerning previous studies, we acknowledge that the impact of technology (Martínez and Rodríguez, 2009), and geography and institutions (Ketterer and Rodríguez-Pose, 2018, Rodríguez-Pose and Ketterer, 2020) has been studied separately and restricting to economic growth. The literature on regional inequalities in the European Union usually neglects the impact of information and communication technologies (Perugini and Martino, 2008; Royuela et al., 2019), even though the impact of ICT on inequality has been recognized to depend on the type of ICT and the measure of inequality at country level (Richmond and Triplett, 2018). This statement is even more important for subnational level, given the pronounced differences between developed and lagging regions (McCann and Ortega-Argilés, 2015). These findings suggest that evidence is far from conclusive and demand to consider them to shed light on the dynamics of regional development.

This study follows a holistic approach integrating previous studies by assuming that technology, institutions, and geography affect regional economic development and regional inequalities. We use panel data econometric techniques to analyze the determinants of economic growth and study which determinants of regional economic prosperity are also related to the risk of poverty or social exclusion, which constitutes a relevant measure of inequality.

Empirical approaches to study differences in income levels have been proposed in economics using growth dynamics, which brings to a debate between neoclassical economics and the endogenous growth theory. Neoclassical economics assumes that economic growth can be explained by external forces related to the combination of the factors of production, mainly capital and labor (Solow, 1956). On the other hand, endogenous growth theory proposes an alternative explanation of economic growth through endogenous drivers, such as human capital, knowledge, and innovation (Romer, 1994). Both theories have emphasized the combination of physical capital, human capital, and technology, together with a residual that captures other factors that cannot be explained. Institutional quality may be helpful to explain this residual (Rodríguez-Pose and Ketterer, 2020; Rodríguez-Pose, 2020).

For this study, we use a generalized production function approach (e.g., Zellner and Revankar, 1969) combined with growth dynamics, which allows us to measure the impact that technology, geography and institutions exert on regional development. We present our baseline model in equation (1). This equation is theoretically and empirically rigorously founded since we follow the common generalized production functions together with the augmented Solow model from Mankiw et al. (1992). Both cases propose a specification where the logarithm of GDP per capita in levels is the dependent variable. Besides, we also follow the empirical specification from Rodríguez-Pose and Ketterer (2020) to include other geographical, institutional, and economic determinants.

We estimate equations (1) and (2) using a fixed effects model (FEM), random effects model (REM), and Hausman-Taylor (HT). Fixed effects and random effects complement each other, since the latter allows us to estimate the effect of time-invariant

variables, such as accessibility and terrain ruggedness, while the former is more consistent than the random effects and reduces potential problems of bias at the cost of neglecting time-invariant determinants.

Whether the results are driven by endogeneity due to the possible correlation of the percentage of households with access to internet and broadband, the share of the ICT sector in the regional economy, and the institutional quality variables with the unobserved individual random effect is an important fact to addressed. To this end, we follow the approach proposed by Hausman and Taylor (1981), which presents an intermediate position between fixed effects and random effects based on instrumental variables. The HT estimator allows us to include the time-invariant ruggedness variable in our model while controlling for possible endogeneity. The HT estimator has already been used at the subnational level to overcome endogeneity, and the results obtained are consistent (e.g., Albalate et al., 2012).

The analysis is based on an unbalanced panel of 273 NUTS-2 level regions for the 28 European Union countries during the period 2006–2018. Data on gross domestic product, population, investment, education, households' access to the Internet and broadband access, and risk of poverty and social exclusion are taken from the Eurostat Regional Statistics database.

Quality of government data is taken from Charron et al. (2019), which used survey data on citizens' perceptions and experiences of public sector corruption, impartiality, and public sector services quality.

The Terrain Ruggedness Index (TRI) is computed following Riley et al. (1999) and Wilson et al. (2007) using the European Digital Elevation Model (EU-DEM) provided by the Copernicus Programme of the European Environmental Agency. The average TRI for each region is computed by overlapping the computed TRI raster layer with the polygon vector layer of the NUTS-2 regions provided by Eurostat GISCO.

Using a sample of 273 European regions during the period 2006–2018, we find that both the diffusion and quality of information and communication technologies, the quality of institutions, and the geography foster economic development and decrease the risk of social exclusion.

Our results point to the importance of considering territorial disaggregation to study growth patterns in geography and urban planning. We corroborate that country level policies may not be efficient and may need to be replaced by place-based policies that acknowledge the existing interregional and intraregional inequalities (Iammarino et al., 2019; Rodríguez-Pose, 2020). More specifically, our results suggest that the interplay between technology, institutional quality and geography may be important to explain regional growth and inequality in the European Union and demand to be considered for the curse of action when planning regional policies. Place-based policies should consider geographical characteristics of the territories, such as worse accessibility and higher ruggedness, because they increase the cost of building infrastructure and lead to the isolation of the population.

The main policy lesson that emerges from the empirical analysis indicates that greater investment in ICT and policies aiming to promote the digital literacy of the population could help in reducing social exclusion and foster economic development in declining or persistently stagnating regions. Physical and social peripheries could take advantage of ICT to increase their digital connectivity with the rest of the world, attract new entrepreneurs, and bring prosperity to the regions. The curse of geography of being located far from the big economic players must not condemn regions to being disconnected from the digital world and remaining excluded in poor areas. For this reason, institutions can be considered as a key asset to trigger both public and private investments to enhance economic growth.

By taking into account the importance of place-based policies, the Cohesion Policy has led to remarkable initiatives to reduce regional inequalities. Investing in transport infrastructure to connect peripheral regions to the core Europe has been the recipe for many decades, and the Cohesion Policy has dedicated an enormous amount of money to this endeavor. Building new roads, highways, and railways have been the priority of many countries to improve their accessibility, and the Trans-European Transport Network (TEN-T) project aims to build a Europe-wide network connecting all the main European nodes by 2030, and all European regions by 2050. Investments in transport infrastructure help in reducing the peripheral nature of the most distant regions. However, in the context of a New Globalization where the ICT revolution is completely

reshaping the economy through disruptive changes (Baldwin, 2016), a new regional policy is needed. A technological infrastructure policy is needed to connect all European regions through high speed broadband connections. Social exclusion is also an important problem to overcome. Although the Europe 2020 strategy aims to reduce the risk of poverty as its main priority, greater amounts of social investment may be required to reduce regional disparities. However, these investments need to be complemented with high quality institutions that serve as catalysts and boost economic growth and prosperity. We confirm that the interplay between technology, institutions, and geography is expected to reshape economic performance in the following decades. They cannot be considered as substitutes but complements.

Keywords: Regional development, regional inequality, information technology, institutional quality, European Union

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References

Baldwin, R. (2016). *The great convergence.* Harvard University Press, Cambridge.

Albalate, D., Bel, G., & Fageda, X. (2012). Beyond the efficiency-equity dilemma: Centralization as a determinant of government investment in infrastructure. *Papers in Regional Science*, *91*(3), 599–615. https://doi.org/10.1111/j.1435-5957.2011.00414.x

Charron, N., Lapuente, V., & P. Annoni (2019). Measuring Quality of Government in EU Regions Across Space and Time. *Papers in Regional Science, 98*(5), 1925–1953. https://doi.org/10.1111/pirs.12437

European Commission (2017). *My Region, My Europe, Our Future: Seventh report on economic, social and territorial cohesion.* European Commission, Brussels.

European Commission (2018). *Simplification Handbook: Measures in cohesion policy 2021-2027.* European Commission, Brussels.

European Commission (2020). *Study on National Policies and Cohesion. Final Report Contract No 2017CE16BAT125*. European Commission, Brussels.

Fujita, M., Krugman, P. R., & Venables, A. (1999). *The spatial economy: Cities, regions, and international trade*. MIT press.

Hausman, J. A., & Taylor, W. E. (1981). Panel data and unobservable individual effects. *Econometrica*, *16*(1), 1377–1398. https://doi.org/10.1016/0304-4076(81)90085-3

Iammarino, S., Rodríguez-Pose, A., & Storper, M. (2019). Regional inequality in Europe: evidence, theory and policy implications. *Journal of Economic Geography*, *19*(2), 273–298. https://doi.org/10.1093/jeg/lby021

Ketterer, T., & Rodríguez-Pose, A. (2018). Institutions vs. 'first-nature' geography: What drives economic growth in Europe's regions?. *Papers in Regional Science*, *97*(S1), S25–S62. https://doi.org/10.1111/pirs.12237

Krugman, P. R. (1991). *Geography and trade*. MIT press.

Martínez, D., & Rodríguez, J. (2009). New technologies and regional growth: the case of Andalucía. *The Annals of regional science*, *43*(4), 963–987. https://doi.org/10.1007/s00168-008-0231-1

McCann, P., Ortega-Argilés, R. (2015). Smart specialization, regional growth and applications to European Union cohesion policy. *Regional Studies*, *49*(8), 1291–1302. https://doi.org/10.1080/00343404.2013.799769

Perugini, C., & Martino, G. (2008). Income inequality within European regions: determinants and effects on growth. *Review of Income and Wealth*, *54*(3), 373–406. https://doi.org/10.1111/j.1475-4991.2008.00280.x

Richmond, K., & Triplett, R. E. (2018). ICT and income inequality: a cross-national perspective. *International Review of Applied Economics*, *32*(2), 195–214. https://doi.org/10.1080/02692171.2017.1338677

Riley, S. J., DeGloria, S. D., & Elliot, R. (1999). A terrain ruggedness index that quantifies topographic heterogeneity. *Intermountain Journal of Sciences*, *5*(1–4): 23–27.

Rodríguez-Pose, A. (2020). Institutions and the fortunes of territories. *Regional Science Policy and Practice*, *12*(3), 371–386. https://doi.org/10.1111/rsp3.12277

Rodríguez-Pose, A., & Ketterer, T. (2020). Institutional change and the development of lagging regions in Europe. *Regional Studies*, 54(7), 974–986. In press: https://doi.org/10.1080/00343404.2019.1608356

Romer, P. M. (1994). The origins of endogenous growth. *Journal of Economic perspectives*, *8*(1), 3–22. https://doi.org/10.1257/jep.8.1.3

Royuela, V., Veneri, P., & Ramos, R. (2019). The short-run relationship between inequality and growth: evidence from OECD regions during the Great Recession. *Regional Studies*, *53*(4), 574–586. https://doi.org/10.1080/00343404.2018.1476752

Solow, R. (1956). A contribution to the theory of economic growth. *Quarterly Journal of Economics*, *70*(1), 65–94. https://doi.org/10.2307/1884513

Wilson, M. F. J., O'Connell, B., Brown, C., Guinan, J. C., & Grehan, A. J. (2007). Multiscale Terrain Analysis of Multibeam Bathymetry Data for Habitat Mapping on the Continental Slope. *Marine Geodesy*, *30* (1-2), 3–35. https://doi.org/10.1080/01490410701295962

Zellner, A., & Revankar, N. S. (1969). Generalized production functions. *The Review of Economic Studies*, *36*(2), 241–250. https://doi.org/10.2307/2296840