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Effectiveness of EU Regional Policy: Evidence from a Natural Experiment in Finland

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Abstract. European Union regional policy is implemented through structural funds, such as the European Regional Development Fund (ERDF), which supports investment in peripheral regions of the EU. We studied the effects of EU regional policy on key economic variables using a rare natural experiment setting. In 2007, parts of regions that were previously covered by the ERDF programme for Western Finland were reallocated to the ERDF programme for Northern Finland, with higher support intensity per capita. This reallocation was caused by the newly adopted EU legislation regulating the classification of regional statistical areas. With a detailed postal code area dataset and a difference-in-differences estimator, we discovered desirable regional policy effects on unemployment and the number of jobs.

Key words: Regional policy, Policy analysis, Microeconometrics

1 Introduction

The long-term growth programme of the European Union (EU), the Europe 2020 Strategy, was adopted in 2010. Following the Lisbon Strategy of the previous decade, the Europe 2020 Strategy aims to: (1) enhance employment; (2) increase research and development; (3) reduce greenhouse gas emissions; (4) improve tertiary education levels; and (5) reduce poverty in Europe. Precise target levels have been set for these objectives, both at the overall EU level and for each Member State. For instance, the employment rate target for the population aged 20-64 is 75%. According to Eurostat, the current (2016) figure for the 28 Member States of the European Union (EU28) is 71.1%[1].

One of the main instruments for achieving these targets is the EU's regional policy. As stated by the European Commission, "EU regional policy is an investment policy. It supports job creation, competitiveness, economic growth, improved quality of life and sustainable development. These investments support the delivery of the Europe 2020 strategy."[2] In 2007-2013 approximately EUR 50 billion was allocated each year for regional policy, a third of the EU's total budget. EU regional policy is implemented through structural funds. These include the European Regional Development Fund (ERDF), the European Social Fund (ESF), and the Cohesion Fund (CF).

Every EU region can benefit from the ERDF and the ESF. However, only the regions that have GDP per capita below 75% of the EU average are eligible for support from the

[1] http://ec.europa.eu/eurostat
[2] http://ec.europa.eu/regional_policy/index_en.cfm.

Cohesion Fund. In the programming period 2007-2013, the ERDF outlays accounted for 58% of the EU regional policy contribution, while the ESF and the CF accounted for 22% and 20%, respectively[3].

The main goal of EU regional policy is to decrease income disparities between Member States. However, instead of pure income redistribution, the aim of the support measures is to enhance investments and achieve higher regional growth rates (Marzinotto 2012). For instance in the programming period 2007-2013, regional support in Northern Finland under the Regional Competitiveness and Employment Objective was allocated along three priority axes. The first of these priority axes is the promotion of business, which finances development and investment projects by start-ups and growth-oriented small and medium-sized enterprises. The second axis is the promotion of innovation, which supports various innovation and networking projects by universities, technology centers, and research institutions. The third priority axis is the improvement of the accessibility of areas, which finances infrastructure-related projects by municipalities, associations, and other public bodies. The total public financing of the ERDF programme for Northern Finland in 2007-2013 was EUR 600 million, of which the EU's contribution was fifty percent.

Despite the significant budget outlays, scientific evidence of these programmes' effectiveness is scarce. In a recent literature review, Mohl, Hagen (2010, p. 353) concluded that empirical evidence has provided mixed and contradictory results. One of the main reasons for this is the fact that the allocation of structural funds depends on economic outcomes: only poorer regions are eligible in the first place. Hence we have a situation of reverse causality, where it is difficult or impossible to identify the causal effects of the policy. Imprecise data, unobserved or omitted variables, and possible spillover effects also hinder identification. In a nutshell, we do not know much about the causal effects of regional policies.

In an ideal situation, we would pick out regions at random, support those regions, and compare economic outcomes to non-supported regions, i.e. use a randomized controlled trial to estimate the causal effect. However, this is not possible in practice. As a next-best alternative, we should look for exogenous changes in programme eligibility, and whether these changes have created circumstances similar to randomization. One candidate for such an exogenous change occurred in Finland in 2007. For legislative reasons (explained in detail in Section 3), parts of regions previously covered by the ERDF Programme for Western Finland were reallocated to the ERDF Programme for Northern Finland. As support levels (EUR/capita) are much higher in Northern Finland, this change created a natural experiment where some regions received a windfall of support. The increase in regional support in the treatment areas was roughly EUR 20 million per year. Those areas within the ERDF programme for Western Finland that did not experience a change in their programme area status will be the control areas.

In this paper, we analyze the economic outcomes of this reallocation, using detailed postal code area data. Using difference-in-differences estimators, we found that the change in programme area status decreased the unemployment rate especially in those areas where the increase in regional support was the most pronounced. An increase in the number of jobs was also detected. However, we were unable to detect any effects on disposable income per capita or population with tertiary education. Our robustness checks included specification tests, pseudo-treatment analysis, and tests for spatial correlation.

The rest of the paper is organized as follows. Previous literature is reviewed in Section 2, followed by our research design in Section 3. Data and methods are detailed in Section 4, and estimation results are presented in Section 5. Various sensitivity and robustness checks are explained in Section 6. Section 7 concludes our discussion.

2 Previous literature

The economic theory of regional development has undergone drastic changes during the last six decades. Seminal work by Solow (1956) presented the neoclassical growth model, which states that constant returns to scale economies with access to the same technology

[3]European commission: Ex post evaluation of the ERDF and Cohesion Fund 2007-13, 19.9.2016.

approach steady state growth automatically. Market forces would therefore ensure income convergence of differing countries or regions and there is no need for regional policy. However, subsequent empirical observations raised fundamental questions about the validity of the neoclassical growth theory; convergence appeared to be much slower than the rate proposed by the theory (Martin, Sunley 1998, p. 220).

Current theories of agglomeration and economic geography are reviewed by Ottaviano, Thisse (2004). Transport costs play a pivotal role in agglomeration: firms are likely to cluster within large metropolitan areas when they sell differentiated products and transport costs are low. At the same time, cities provide a wide array of final goods and specialized labor markets that make them attractive to workers. However, the market can yield agglomeration even for those transport cost values for which it is socially desirable to keep economic activities dispersed. Hence there may be scope for regional policy interventions on both efficiency and equity grounds (Ottaviano, Thisse 2004).

Since its beginning, the EU has aimed at "reducing the disparities between the levels of development of the various regions"[4]. The ERDF was established in 1975. New member states increased regional disparities in the 1980s and 1990s and regional funding was multiplied, as more countries became eligible for funding. Annual regional development projects were replaced by multi-annual programmes. Cohesion Fund measures were aimed at the regions with GDP per capita strictly below 75% of the EU average. ERDF measures were directed at other less developed, sparsely populated, or mountainous regions. Since 1989, there have been four completed programming periods: 1989-1993, 1994-1999, 2000-2006, and 2007-2013. The fifth programming period, 2014-2020, is ongoing.

In theory, ERDF support for small and medium-sized enterprises' investments should increase economic activity in the recipient areas. Increased economic activity should create new jobs, lead to lower unemployment, and increase per capita income and economic growth. The official EU regional policy targets for the programming period 2007-2013 in Finland were:

- Create new enterprises and jobs to increase employment;
- Develop the regional economy;
- Increase the productivity, competitiveness and exports of enterprises;
- Raise the education level; and
- Increase research and innovation to 4% of GDP[5].

The thorough literature review by Mohl, Hagen (2010) summarizes sixteen previous empirical studies that analyzed the impact of structural funds on regional economic growth[6]. Most authors have used regional panel data, mainly at the NUTS-2 level, and standard panel data estimators. Nomenclature of Units for Territorial Statistics (NUTS) is the EU standard for referencing the subdivisions of countries for statistical purposes. There are three NUTS levels. While some studies have included all available EU countries, others have concentrated on single countries. Only three papers have treated structural funds as an endogenous variable. The overall results are inconclusive: some papers have found positive effects, some zero effects, and some even negative effects on growth. Mohl, Hagen (2010) suggest that probable reasons for diverging results include poor data quality, differences in research designs, and unrealistic exogeneity assumptions.

Dall'erba, Le Gallo (2008) argue that the lack of positive regional policy effects may be due to several institutional factors. Funded projects may fulfil EU criteria but are not necessarily growth stimulating. This might even be intentional, for example if the regional governments aim to keep their region within the eligibility criteria for cohesion support. EU funding may also crowd out private investments in the area or the funded project is undertaken by a firm headquartered outside the targeted region. Furthermore,

[4] Treaty on European Union (1992 version).
[5] European Union (2008): Working for the regions. EU Regional Policy 2007-2013.
[6] For references, see Mohl, Hagen (2010).

the principle of additionality requires that national funding at least equals EU support. According to Dall'erba, Le Gallo (2008), the wealthiest regions may provide 2.5-6.4 times the amount committed by EU structural funds and in the end, the total invested may be larger in the wealthiest regions.

Since the aforementioned review, Le Gallo et al. (2011) have performed local impact estimations, where one coefficient is estimated for each region. They utilize panel data from 145 NUTS-2 regions, covering the period 1989-1999. Global estimates for a typical region in Europe do not confirm positive effects on growth. However, using a locally linear spatial model, they estimate highly diverse local impacts, some positive, some negative. They recognize that significant negative impacts of structural funds may seem counterintuitive, and suggest possible explanations for this phenomenon, for instance long-term economic decline of these areas. Hence endogeneity problems are only mentioned and they are left for future research.

Becker et al. (2012) have analyzed panel data at the NUTS-3 level to estimate the effects of regional policy on growth. Using generalized propensity score estimation, they found that transfers enhance growth in the recipient regions. They also conclude that some reallocation of funds would lead to even higher aggregate growth in the EU. Becker et al. (2012) argue that in this case, selection bias is effectively reduced with the propensity score estimator.

Pellegrini et al. (2013) evaluate the effects of regional policy using the regression discontinuity design (RDD). They exploit the allocation rule of structural funds, namely that only regions with GDP less than 75% of EU average are eligible for Objective 1 support. In the regression discontinuity approach, estimation of causal effects is based on the assumption that regions just above the 75% threshold are very similar to those that are just below the 75% threshold. Using a regional dataset for 1994-2006, Pellegrini et al. (2013) found positive growth impacts from regional policy.

Becker et al. (2013) used regression discontinuity design and data on NUTS-2 regions to estimate the heterogeneity of Objective 1 treatment effects. They found that in general, the variance of the treatment effect is much larger than its mean. Only 30 percent of recipient regions are able to turn regional transfers into faster per capita income growth. According to Becker et al. (2013), success depends on the level of human capital and the quality of institutions in the recipient regions. Percoco (2016) and Gagliardi, Percoco (2016) employ similar RDD estimation strategies to explore the confounding effects of local economic structure and degrees of urbanization on cohesion policy effectiveness.

In a recent discussion paper, Breidenbach et al. (2016) study the spatial dynamics of structural funds using NUTS-2-level panel data. They observe negative indirect spatial effects that largely determine a negative overall effect of regional policy on growth. Breidenbach et al. conclude that EU structural funding does not seem to foster income convergence across regions.

Dall'erba, Fang (2017) produced a meta-regression analysis of the impact of structural funds on GDP growth. Their meta-analysis is based on 17 econometric studies which estimated cross-sectional beta-convergence models. The results indicate that several differences in the data characteristics are at the origin of the primary estimates' heterogeneity. Controlling for endogeneity also has an impact on size of the estimates. In contrast, the differences in functional forms do not have a significant impact on the primary estimates.

Cross-sectional convergence models and, more recently, standard panel data estimators have been the mainstay of EU regional policy research. These allow for comparisons and meta-analysis, but endogeneity issues may be difficult to circumvent. Counterfactual (natural or quasi-experimental) approaches to causal inference have been rarely used, in part because suitable cases are scarce. Counterfactual methods may yield more credible estimates of the causal effects, but generalization of the results might be problematic.

Our contribution to the literature can be summarized as follows. To estimate the causal effect of regional policy on various economic outcomes, we exploit a natural experiment arising from an exogenous change in programme eligibility, using a highly detailed postal code area dataset.

3 Research design

Our research design is based on the ERDF programme area reallocation which occurred in Finland in 2007, in the beginning of the new programming period 2007-2013. Behind this reallocation were two recent changes in EU legislation. First, the legal framework for the NUTS classification was established with Council Regulation (EC) No 1059/2003[7]. The classification is outlined in Annex 1 of the Regulation. Secondly, the regulations for the new programming period 2007-2013 required that eligible programme areas follow the NUTS classification adopted four years earlier.

The implementation of the EU's regional policy began in Finland in 1995, when it became a Member State of the EU. During the programming period 1994-1999 the EU's Regional Policy Objectives 2, 5b, and 6 were implemented. During the programming period 2000-2006, Objectives 1, 2, and 3 were implemented[8]. In 1995-2006, the largest urban areas (Helsinki, Turku, Tampere) were non-eligible for support, and in general, support levels increased the farther north or north-east a region was situated from the most populous regions of Southern Finland.

For the programming period 2007-2013, previous Regional Policy Objectives 1, 2, and 3 were replaced with the objectives: *Regional Competitiveness* and *Employment*; and *European Territorial Cooperation*. Council Regulation (EC) No 1083/2006[9] lays down general provisions on the Structural Funds for the period 2007-2013. Recital 16 of the Preamble explains that the identification of eligible areas should be based on the NUTS classification established by Regulation (EC) No 1059/2003. Furthermore, Article 6 regulates that each Member State is required to indicate the NUTS-1 or NUTS-2 level regions for which it will present a programme for financing by the ERDF.

In Finland the previous programme area allocation was based on the EU Accession Treaty, and this allocation did not comply with the NUTS classification. Finland therefore was obliged to alter the ERDF area allocation so that it matched the NUTS-2 regional division. There are four NUTS-2 regions – Southern, Western, Eastern and Northern Finland – and each had its own regional programme during 2007-2013. The largest reallocation took place in the region of Ostrobothnia in Western Finland. Four sub-regions previously included in the ERDF Programme for Western Finland were reallocated to the ERDF Programme for Northern Finland. The largest cities also became eligible for support but their support level is low when compared to the other regions.

The baseline year of our study is therefore 2007. At that time, Finland had 20 regions (maakunta). These regions were divided into 77 sub-regions (seutukunta). Each sub-region consists of two or more neighbouring municipalities, which create a joint employment area.

The area reallocation in Ostrobothnia is especially intriguing because the regional support intensities, measured in EUR per capita, are much higher in Northern Finland than in Western Finland. As a result, the reallocated Western Finland areas received a considerably higher level of support (EUR per capita) in the programming period 2007-2013 than in the previous programming period. Hence the change in programme area status created a natural experiment: since the cause for the change was exogenous, the situation is the same as if these reallocated areas were chosen randomly. As a counterfactual we can use those regions in Western Finland where the programme area status did not change (grey areas in Figure 1). These conditions allow us to estimate the causal effect of regional policy on various economic outcomes.

Of the total ERDF budget of EUR 600 million in Northern Finland for the programming period 2007-2013, 39% was allocated to development projects by start-ups and SMEs, 37% to innovation and networking projects, 20% to infrastructure projects, and 4% to technical support[10]. Note that these are the three priority axes mentioned in the introduction. The idea is that these combined efforts together produce the desired results of the EU regional policy. In the short and medium run, support for start-ups and SMEs entail

[7] Official Journal of the European Union, 21.6.2003.

[8] Note that these Objectives do not correspond to the Europe 2020 Strategy targets mentioned in the Introduction. Objectives 1, 2, etc. were the earlier tiers of EU Regional Policy.

[9] Official Journal of the European Union, 31.7.2006.

[10] Source: Finnish structural funds database.

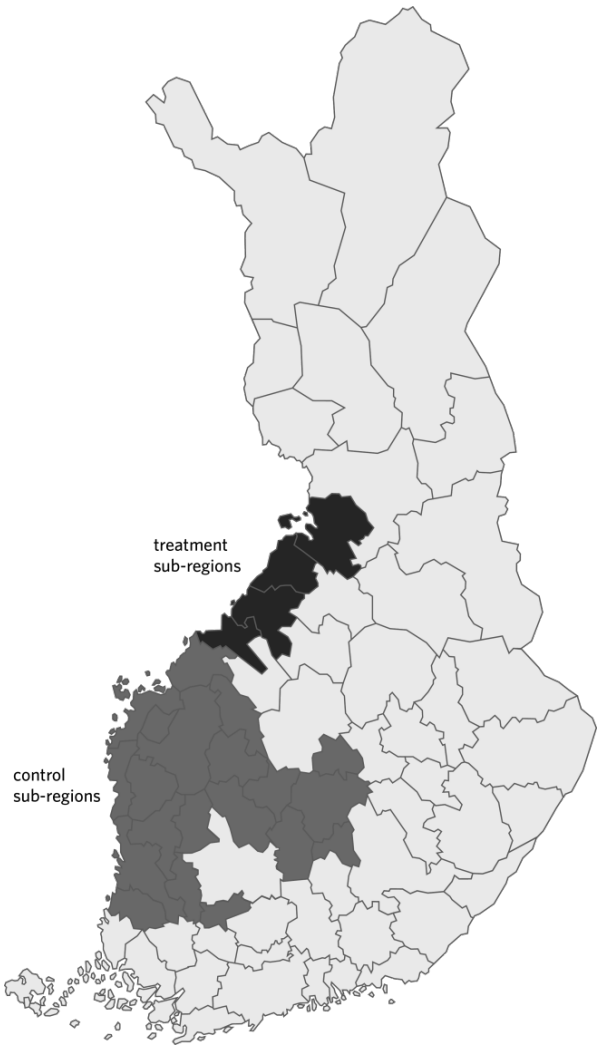

Figure 1: Treatment and control sub-regions

the largest new employment possibilities. The realized allocation of program funding naturally depends on the number and quality of the funding applications, as well as the local and regional priorities of the funding agencies.

The treatment and control areas in Figure 1 had two support categories during the previous programming period in 2000-2006. Objective 2 areas had a higher support intensity (EUR/capita) and so-called transitional areas had a lower support intensity. Transitional areas were areas that had been ERDF Objective 2 or Objective 5b areas during 1995-1999 but did not fulfil new Objective 2 criteria for the programming period 2000-2006. The increase in ERDF support resulting from the area status change in 2007 was largest among those treatment areas that had been transitional areas in 2000-2006 (Table 1). Their support intensity grew from 9.4 EUR/capita to 69.9 EUR/capita, approximately a sevenfold increase. In addition to support from the EU, regional policy programmes always include additional national support of at least the same amount as the EU provides.

It should be noted that the support intensity changed in 2007 in the control areas as well. In the previous Objective 2 areas, ERDF support decreased, while among the previous transitional areas, support levels increased. However, the increase was minor compared to the treatment areas.

The treatment area is defined in our study as (1) the sub-regions of Kokkola and Ylivieska and the municipalities of Oulu and Hailuoto, which previously were Objective

Table 1: ERDF support intensity (EUR/capita/year) in treatment and control areas, 2000-2006 and 2007-2013

Support category in 2000-2006	Treatment and control areas 2000-2006	Control areas 2007-2013	Treatment areas 2007-2013
Objective 2 programme areas	32.8	17.0	69.9
Transitional areas	9.4	17.0	69.9

Source: Ministry of Employment and the Economy
Notes: Population data as of 1.1.2007

2 areas; and (2) the sub-region of Raahe and the municipalities of Liminka, Lumijoki, Muhos, and Tyrnävä in the Oulu sub-region, which were previous transitional areas. Using population data from 2007, the approximate increase in regional support (EU + national) resulting from the area status change was roughly EUR 14.1 million per year in the previous Objective 2 areas and EUR 7.4 million per year in the previous transitional areas. Over the seven-year programming period, this amounts to an increase of EUR 150 million in regional support for the treatment areas.

4 Data and methods

In this Section we first describe our data set and then outline the econometric methodology. Since the treatment area is quite small (see Figure 1), sub-regional or municipality level data would be too coarse for our needs. The treatment area only includes four sub-regions[11] and those sub-regions include 22 municipalities (13 in the previous Objective 2 area and 9 in the previous transitional area). Therefore we use more disaggregated postal code area data. This allows us to analyze 122 treatment area observations, with roughly 700 observations for the control areas. Statistical postal code areas are defined by Statistics Finland and they are based on addresses (postal codes) of firms, government offices and inhabitants. Each municipality has approximately ten postal code areas on average[12].

Our data set was obtained from Statistics Finland and it includes the following variables of statistical postal code areas from the years 2004-2013 (end of each year):

- number of inhabitants;
- share of inhabitants with tertiary education (%);
- unemployment rate (%);
- number of jobs in the area, all industries, part-time jobs included; and
- median disposable income per capita, CPI deflated.

Summary statistics of treatment and control postal code areas for the baseline year are presented in Table 2. Statistics are presented separately for the previous Objective 2 areas and the transitional areas. As a baseline year we use 2007, since the Finnish ERDF programmes were officially approved by the European Commission in September 2007, and their implementation began in late 2007.

Note that the ERDF support payments are not distributed equally to all postal code areas or municipalities in the recipient sub-regions. Postal code area division is used in this study solely to increase the available number of observations in the treatment and control areas.

In Table 2 we observe systematic differences between the treatment and control areas even before the intervention, especially among the previous Objective 2 areas, where the treatment areas are roughly double the size of the control areas. However, the

[11] The sub-region of Oulu only partly.
[12] In 2016 there were 3,037 postal code areas and 313 municipalities in Finland.

Table 2: Descriptive statistics of the study areas in 2007

Variable	Control areas			Treatment areas		
	No. of postal code areas	Mean	Std. dev.	No. of postal code areas	Mean	Std. dev.
Previous Objective 2 areas						
number of inhabitants	440	1,398	2,218	82	2,754	2,937
share of inhabitants with tertiary education (%)	438	6.6	3.8	81	9.9	6.6
unemployment rate (%)	422	9.9	3.9	81	9.2	3.8
no. of jobs, all industries	438	531	1,455	82	1,240	2,246
median disposable income, EUR/cap.	438	16,658	2,561	81	18,120	2,512
Previous transitional areas						
number of inhabitants	272	1,326	2,057	40	1,485	1,757
share of inhabitants with tertiary education	270	7.3	3.5	40	6.1	3.1
unemployment rate	267	5.6	2.8	39	9.9	4.0
no. of jobs, all industries	273	535	1,490	40	464	832
median disposable income, EUR/cap.	270	17,864	2,417	40	18,448	2,487

Source: Data from Statistics Finland.
Notes: Units of observation are statistical postal code areas.

unemployment rates are quite similar. In contrast, the previous transitional areas are comparable in size but have differing unemployment rates. In any case, straightforward statistical tests of the differences in outcomes are not feasible. Systematic differences first have to be accounted for, and this is accomplished using standard econometric methods.

Differencing between two time periods effectively removes unobservable time-invariant characteristics of the postal code areas, such as geographical size, location, distance to large cities, and so forth (Wooldridge 2010). There are also slowly changing variables, such as the demographic and business structure of the postal code area, that are approximately constant during the study period, 2007-2013. These are controlled for by differences as well.

We use two period panel data models throughout, with the year 2007 as the baseline ("before treatment") year, and each one of the years 2008-2013 consecutively as the "after treatment" year. That is, our dependent variable is the difference in the outcome variable Y in 2007-2008, in 2007-2009, etc. Our simple difference-in-differences equation can be written as:

$$\Delta \ln Y_i = \beta_0 + \beta_1 TREAT_i + \Delta\epsilon_i$$

$TREAT$ is equal to one if the postal code area was treated and zero otherwise. As usual, Δ denotes the difference. The coefficient of interest is β_1.

Note that our methodological approach implicitly controls for a multitude of both observable (size, location, etc.) and unobservable (local economic traditions, etc.) time-constant variables. One major drawback is that we are unable to control for time-varying confounders. However, due to the experimental nature of our treatment, we have no reason to assume that these confounders would be systematically related to the treatment. Hence any positive or negative local random shocks that may affect for instance employment are lumped together in the error term. This has no effect on the consistency of our results, as the treatment is exogenous by construction.

Also note that using multiple years of panel data in our estimations would not yield more elaborate results but rather to the contrary. Since $TREAT = 1$ for all treatment

Table 3: Linkages between different policy targets and our outcome variables

Europe 2020 Strategy targets	EU Regional Policy targets for Finland during 2007-2013	Related outcome variables in this study
Increase employment rate	Create new enterprises and jobs to increase employment. Develop the regional economy. Increase the productivity, competitiveness and exports of enterprises	Number of jobs. Unemployment rate. Disposable income per capita
Increase research and development	Increase research and innovation	—
Reduce greenhouse gas emissions	—	—
Improve tertiary education levels	Raise the education level	Share of inhabitants with tertiary education
Reduce poverty	Develop the regional economy	Disposable income per capita

areas and $TREAT = 0$ for all control areas during the whole study period, 2008-2013, its effect is indistinguishable from the fixed effect for each area. Including "before treatment" years (2006, 2007 for instance) in the FE regressions would allow for treatment effect estimation, but the coefficient would then measure the average of the treatment effect across multiple years. Hence our simple two-period approach (before-after) is in fact a more versatile tool in this case. But it also necessitates the use of disaggregated regional data in order to obtain a reasonable number of observations. As mentioned above, the treatment area only includes 22 municipalities.

The crucial assumption in order for the difference-in-differences estimates to be valid is that of common or parallel trends (Meyer 1995, Abadie 2005). Before the treatment, control and treatment units should exhibit a similar trend in the outcome variable. In essence, the control group has to be a convincing counterfactual for the treatment group, and therefore we should observe parallel development ex ante. Common trend assumption can be tested using pre-treatment observations, and in this case, we use postal code area data from the years 2004-2007. If the parallel trend assumption fails, we do not have a credible counterfactual.

Since the Europe 2020 growth strategy has no specific population targets, as outcome variables we use the following:

- share of inhabitants with tertiary education;
- number of jobs;
- unemployment rate; and
- median disposable income per capita.

Outcome variables have been transformed to natural logarithms before taking differences. Results are unweighted and estimated using municipality-clustered standard errors, as observations from the same municipality might be correlated due to municipality level employment policies and decisions.

We use the exogenous treatment dummy as the sole regressor, since including other outcome variables as controls would require considerably more complicated methods. Both the Europe 2020 Strategy and the EU Regional Policy have multiple goals. As most of these goals are not measured at the postal code area level, we are forced to use the best available proxies in our analysis. For instance, GDP growth or poverty levels are not available, so we use disposable income as a proxy for both. Table 3 underlines the linkages between our outcome variables, the EU2020 targets, and EU Regional Policy targets for Finland. Note that the policy targets concerning the R&D outlays or greenhouse gas emissions are left for future research as there are no data or relevant proxy variables available.

Table 4: Regression coefficients, previous Objective 2 areas (A) and previous transitional areas (B)

	no. of observations (min.-max.)	no. of jobs, all industries	share of inhabitants with tertiary education	unemployment rate	median disposable income EUR/cap.
A. Previous Objective 2 areas					
Treatment period:					
2007-2008	499-520	-0.028	0.017	-0.000	0.004
		(0.028)	(0.013)	(0.040)	(0.004)
		R^2=0.00	R^2=0.00	R^2=0.00	R^2=0.00
2007-2009	498-520	-0.020	0.002	0.011	-0.005
		(0.022)	(0.017)	(0.060)	(0.005)
		R^2=0.00	R^2=0.00	R^2=0.00	R^2=0.00
2007-2010	498-520	0.021	-0.001	0.025	-0.014
		(0.036)	(0.023)	(0.042)	(0.008)
		R^2=0.00	R^2=0.00	R^2=0.00	R^2=0.01
2007-2011	494-520	0.070	-0.013	0.027	-0.005
		(0.044)	(0.034)	(0.048)	(0.012)
		R^2=0.01	R^2=0.00	R^2=0.00	R^2=0.00
2007-2012	496-520	0.058	-0.012	0.030	-0.010
		(0.045)	(0.042)	(0.048)	(0.014)
		R^2=0.00	R^2=0.00	R^2=0.00	R^2=0.00
2007-2013	496-520	0.030	-0.023	0.030	-0.025
		(0.052)	(0.040)	(0.048)	(0.015)
		R^2=0.00	R^2=0.00	R^2=0.00	R^2=0.02
Comparison period:					
2004-2005	504-521	0.134	-0.015	0.049	-0.011*
		(0.108)	(0.021)	(0.033)	(0.005)
		R^2=0.01	R^2=0.00	R^2=0.01	R^2=0.01
2004-2006	501-519	0.145	-0.036	0.082	-0.012
		(0.120)	(0.028)	(0.047)	(0.010)
		R^2=0.01	R^2=0.00	R^2=0.01	R^2=0.01
2004-2007	502-520	0.147	-0.042	0.095	-0.024*
		(0.115)	(0.030)	(0.059)	(0.011)
		R^2=0.01	R^2=0.00	R^2=0.01	R^2=0.02
B. Previous transitional areas					
Treatment period:					
2007-2008	299-312	0.010	0.023	-0.114**	0.005
		(0.020)	(0.017)	(0.043)	(0.007)
		R^2=0.00	R^2=0.00	R^2=0.01	R^2=0.00
2007-2009	299-313	-0.005	0.025	-0.261***	0.012
		(0.032)	(0.030)	(0.065)	(0.008)
		R^2=0.00	R^2=0.00	R^2=0.04	R^2=0.01
2007-2010	299-313	0.009	-0.016	-0.176***	0.005
		(0.036)	(0.032)	(0.045)	(0.011)
		R^2=0.00	R^2=0.00	R^2=0.02	R^2=0.00
2007-2011	299-313	0.080	-0.006	-0.133**	-0.002
		(0.054)	(0.041)	(0.050)	(0.013)
		R^2=0.00	R^2=0.00	R^2=0.01	R^2=0.00
2007-2012	297-313	0.156*	-0.025	-0.114*	-0.008
		(0.067)	(0.055)	(0.053)	(0.013)
		R^2=0.01	R^2=0.00	R^2=0.01	R^2=0.00
2007-2013	297-313	0.172	0.001	-0.171***	-0.022
		(0.097)	(0.062)	(0.046)	(0.014)
		R^2=0.01	R^2=0.00	R^2=0.02	R^2=0.01

Continued on next page

Table 4 – continued from previous page

	no. of observations (min.-max.)	no. of jobs, all industries	share of inhabitants with tertiary education	unemployment rate	median disposable income EUR/cap.
Comparison period:					
2004-2005	305-311	0.089 (0.060) R^2=0.01	-0.004 (0.025) R^2=0.00	0.020 (0.032) R^2=0.00	-0.005 (0.005) R^2=0.00
2004-2006	305-312	-0.027 (0.105) R^2=0.00	0.046* (0.020) R^2=0.01	0.007 (0.041) R^2=0.00	0.006 (0.007) R^2=0.00
2004-2007	301-312	-0.030 (0.106) R^2=0.00	0.034 (0.035) R^2=0.00	-0.006 (0.060) R^2=0.00	0.000 (0.008) R^2=0.00

Notes: Entries are coefficients β_1 from the equation $\Delta \ln Y_i = \beta_0 + \beta_1 TREAT_i + \Delta\epsilon_i$. Standard errors (in parenthesis) are clustered at the municipality level. The coefficients of determination are denoted as R^2. *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$.

5 Results

Our difference-in-differences estimation results for four outcome variables and six different treatment periods are presented in Table 4. Panel A includes results for those treatment and control areas that were Objective 2 areas in 2000-2006, and Panel B includes results for those treatment and control areas that were transitional areas in 2000-2006. The results of three different comparison periods are also presented in Table 4. Each entry in the table is the estimated coefficient for the treatment dummy. For brevity, constants and other summary statistics, except for the coefficients of determination (which are denoted as R^2), are omitted and are available on request.

Results are presented separately for the previous Objective 2 areas and the transitional areas, as the relative change in support intensity in 2007 was distinctly different in those areas (Table 1). In the previous Objective 2 areas ERDF support approximately doubled, whereas in the previous transitional areas ERDF support increased sevenfold.

The number of observations in the four outcome equations for each period is indicated in the first column of Table 4. We have approximately 500 postal code area observations for the previous Objective 2 areas and approximately 300 observations for the previous transitional areas.

The results can be summarized as follows. In Panel A of Table 4 we find no evidence of regional policy effectiveness. The income per capita equation yields mainly negative coefficients, though only two comparison periods (2004-2005 and 2004-2007) are statistically significant. How do we interpret this result? Table 2 indicates that by chance, the median disposable income per capita was lower among the control areas (EUR 16,600) than in the treatment areas (EUR 18,100) in 2007. Therefore, even before the treatment, disposable incomes in the control regions converged towards the income levels of the treatment regions. Similar convergence has seemingly continued after the treatment (p-value for the period 2007-2013 is 0.11). Hence what Table 4 suggests is that there has been micro-level income convergence that seems to be unrelated to the EU regional policy.

In Panel B of Table 4 we do find some evidence of regional policy effectiveness. The unemployment rate has decreased in the treatment areas in all six treatment periods after 2007. We observe no differences in the previous three comparison periods, i.e. before the treatment. We also detect a significant increase in the number of jobs for the period 2007-2012. The coefficient for the longest period 2007-2013 in the jobs equation is also borderline significant ($p = 0.083$). Due to insignificant coefficients of the earlier periods, the evidence of policy impact on total jobs is not as strong as the impact on unemployment. We find no evidence of regional policy effects on tertiary education or income per capita.

Policy impact on unemployment is illustrated in Figure 2, which depicts the mean of logarithmic unemployment rate for the years 2004-2013 in the treatment and control

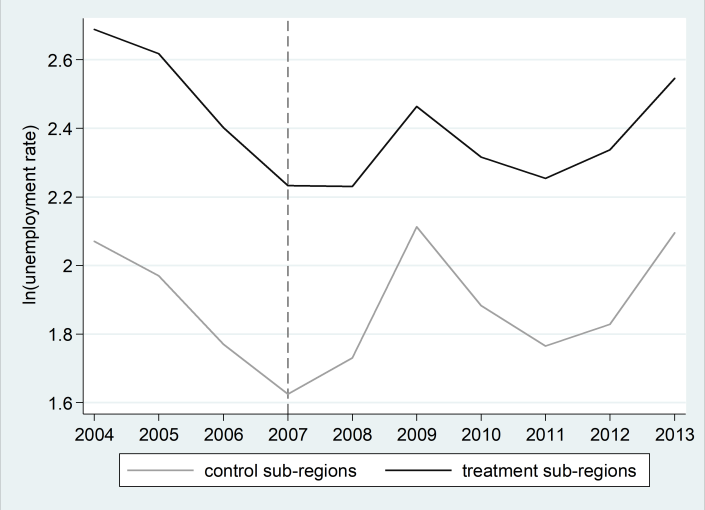

Figure 2: Mean of ln(unemployment rate) in the treatment and control sub-regions, previous transitional areas

sub-regions located in the previous transitional areas (i.e. Panel B of Table 4). The area reallocation year (2007) is marked with a vertical reference line. Immediately after 2007, unemployment starts to increase in the control sub-regions. Additionally, from 2007 to 2009 – due to the global financial crisis – unemployment increases are much more pronounced in the control sub-regions than in the treatment sub-regions. Also in the longer run, 2007-2013, the relative increase in unemployment is larger in the control sub-regions than in the treatment sub-regions. In contrast, Figure 3 depicts the case of no impacts (i.e. Panel A of Table 4), where the treatment and control sub-regions move roughly in unison.

Unemployment rate coefficients in Panel A and Panel B of Table 4 are markedly different. We tested whether this could be due to differing population sizes of control and treatment areas in Panel A by using a trimmed control group, which included only those postal code areas with 500 or more inhabitants (with the trimming, the mean population of control areas is 2,807). This did not have an effect on the results. We conclude that the difference in coefficients may reflect the unequal relative changes in ERDF support intensity: support per capita increased by 113% in Panel A treatment areas, and by 644% in Panel B treatment areas.

In Panel B, why do we observe policy effects only in some outcome variables? When the year-to-year relative changes are small, differences in those changes are difficult to detect. It is instructive to assess the relative changes in our outcome variables after the 2008 global financial crisis. From 2007 to 2009, the total number of jobs in the Finnish economy, part-time jobs included, decreased from 2.21 million to 2.11 million, i.e. a decrease of approximately five percent. Despite the recession, disposable income per capita in fact increased by four percent during the same time[13]. The share of population with a tertiary education increased from 12.7% to 13.9% – an increase of 1.2 percentage points, or a relative change of 9%. The unemployment rate increased from 8.3% to 11.4%, an increase of 3.1 percentage points, or a relative change of 37%.

When these relative changes are compared, we find that the unemployment rate is easily the most volatile among our outcome variables. Therefore when treatment and control areas are compared, possible differences in the unemployment rate changes are easier to detect. Another possibility is that the regional policy measures through the ERDF do not in fact have an effect on some outcome variables. As mentioned above, of the Northern Finland ERDF support for 2007-2013, 39% was allocated to development and

[13]One of the reasons could be the relatively large wage increases of 2008. The index of wage and salary earnings increased over 5% from the previous year.

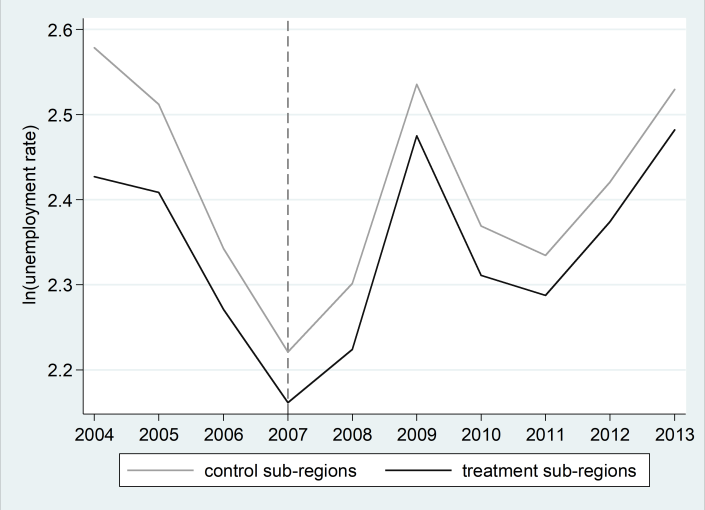

Figure 3: Mean of ln(unemployment rate) in the treatment and control sub-regions, previous Objective 2 areas

investment projects by start-ups and SMEs, 37% to innovation and networking projects, 20% to infrastructure projects, and 4% to technical support. Research institutions and schools engage in innovation and networking projects, while infrastructure projects mainly consist of various transport-related investments that the municipalities are undertaking.

Analyzing the allocation of ERDF support funding suggests that the support measures could in principle have an effect on the number of jobs, unemployment and even income per capita in the treatment regions. However it is questionable whether these measures succeed in increasing the share of population with tertiary education. It appears that reaching this target would require somewhat different support allocation.

Naturally, regional policies could also have effects which take place years after the support programme ended. Our data only covers the programming period in question, i.e. 2007-2013. Unfortunately, we cannot evaluate the long-term effects of the programme, as the next EU programming period 2014-2020 followed immediately after the previous programme concluded. It is probable that the estimated employment effects are at least partly explained by the supported projects' personnel and are therefore temporary.

5.1 Possible complications

Finnish postal code areas may cross municipal boundaries or lie within a single municipality. However, all postal code areas in the data are assigned to one municipality only on the basis of largest population shares[14]. Especially large municipalities sometimes have their own local policies to reduce unemployment and increase employment in their area. Due to collinearity, we cannot use municipality dummies as this would render the treatment dummy obsolete. Furthermore, note that the location of the postal code area (in municipality j) is controlled for by differencing, and if we assume that municipality-level employment policies are more or less fixed during the study period, those policies are controlled for as well. However, postal code areas in a single municipality might be correlated, and this is accounted for by using clustered standard errors in Table 4.

In recent years, there have been many municipality mergers in Finland, and the number of municipalities has declined from roughly 450 at the beginning of the new millennium to 320 in the year 2013. An especially large merger wave occurred in 2009 when 67 municipalities were merged. Behind these mergers is usually poor economic performance of the merging municipalities and the need for cost savings. In the next section we analyze the possible effect of municipality mergers and similar confounding issues that might have an effect on our results.

[14] This was done in order to define treatment and control sub-regions.

Possible displacement effects might be another complication. In a recent discussion paper, Einiö, Overman (2016) study the displacement effects of spatially targeted enterprise initiatives using detailed spatial data. They conclude that the observed positive employment effects close to the eligible area boundaries were offset by negative employment effects just outside the programme area. The unintended displacement of economic activity across the treatment area boundary is problematic and merely shifts employment from one deprived area to another. Their study also suggests that local displacement effects could cause bias when estimating the impacts of regional policy, even in the case of random area assignment.

However, in our data, the treatment and control areas are not neighbouring areas when we analyze previous transitional areas (Panel B of Table 4). Sub-regions bordering on the treatment area are either previous Objective 2 areas, which also experienced an increase in ERDF support (reaching the same level per capita as the previous transitional areas), or the original Northern Finland sub-regions, which had higher ERDF support per capita to begin with. Therefore it is unlikely that local displacement effects cause significant bias in our results.

Spatial correlation is another complication which could cause bias in difference-in-differences estimators (Delgado, Florax 2015). The importance of spatial effects in regional policy analysis was introduced by Dall'erba, Le Gallo (2008). In the case of spatial correlation, the observations are not independent, but the outcome of area i depends on the treatment status of a neighbouring area j (whether in the same municipality or not). This issue is also addressed in the next Section.

6 Robustness checks

To assess the robustness of our results in Table 4, we first take a closer look at the municipality mergers of 2009. It is possible that municipality mergers have affected treatment and control areas differently, and this has had an effect on the results. Secondly, we analyze the confounding effects of so-called abrupt structural changes, where a sub-region has experienced a sudden mass layoff caused by the closure of a paper mill or a similar negative shock. As a third robustness check, we conduct a pseudo-treatment and compare the results to previous estimates. Fourthly, we estimate selected spatial regressions and discuss the effects of spatial correlation.

6.1 Municipality mergers of 2009

As mentioned above, the year 2009 saw a record number of municipality mergers, 67 in total. Some of those mergers took place in the treatment and control areas of this study. We therefore create a dummy variable merger, which equals one if the postal code area was located in a municipality that merged in 2009, and zero otherwise. We then use this dummy variable as an additional regressor in the 72 equations presented in Table 4.

Of the 72 re-estimated equations, only two equations (2.8%) yield a statistically significant coefficient for the merger variable at the 0.05 significance level[15]. In neither case is the treatment coefficient noticeably different from the previous estimates. We therefore conclude that it is unlikely that municipality mergers would be driving our results. Note that the merger dummy could be endogenous if for instance previous disappointing unemployment or income levels caused mergers. In this case we should observe significant merger coefficients in the pre-treatment periods, as merger processes may take two to three years to complete. However, none of those coefficients are significant.

6.2 Abrupt structural changes

Areas of abrupt structural change[16] are sub-regions (or single municipalities) that the government subsidizes more heavily for a fixed period of two or three years. These areas have experienced a sudden negative shock, such as the closure of a paper mill, which is

[15] Results are available on request.
[16] This is the official term for these areas used by the government.

Table 5: Controlling for the areas of abrupt structural change, previous transitional areas

independent variable	ln(jobs) 2007-2012	ln(jobs) 2007-2013	ln(unemployment rate) 2007-2012	ln(unemployment rate) 2007-2013
treat	0.190*	0.216	-0.160**	-0.182***
	(0.075)	(0.122)	(0.059)	(0.048)
structural change	-0.124	-0.159	0.163	0.038
area	(0.080)	(0.133)	(0.085)	(0.076)
constant	0.018	-0.009	0.218***	0.484***
	(0.038)	(0.037)	(0.033)	(0.034)

Notes: Standard errors (in parenthesis) are clustered at the municipality level. N = 297-313. *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$.

expected to increase unemployment sharply. It is possible that this negative effect or the extra subsidies for these areas are confounding factors in our equations.

In our study period and area, there have been only two specially designated structural change areas: the sub-region of Rauma in 2013 and the sub-region of Oulu in 2012-2013. The sub-region of Rauma was part of the previous Objective 2 areas and belonged to the control group. The sub-region of Oulu was in the treatment group and included both previous Objective 2 and transitional areas.

Therefore, we include a structural change area dummy variable in the respective regressions, and re-estimate the job and unemployment equations. In the case of previous Objective 2 areas, we get the same result as in Table 4: no effect. In the case of previous transitional areas, we observe that allowing for the adverse effects of Nokia-related layoffs in the Oulu region has quite a logical effect on the results: we see larger regional policy effects. In Table 5 we present the estimates for the job and unemployment equations for the time periods 2007-2012 and 2007-2013.

In the job equation, the structural change area dummy yields negative coefficients, although they are not significant (the p-values are 0.1-0.2). In the unemployment equation we find that Nokia-related layoffs have increased the unemployment rate, which is not surprising. Controlling for these mass layoffs yields larger coefficients for the treatment. In other words, the treatment is decreasing unemployment as desired, but if we do not control for the mass layoffs in the Oulu sub-region, coefficients for 2007-2012 and 2007-2013 are slightly biased downwards.

6.3 Pseudo-treatment effects

One way to test the robustness of results concerning policy effectiveness is to conduct a pseudo-treatment. That is, we choose a treatment region that was not treated in reality, and compare the effects of the "treatment" to a similar control group as the one used before. In this case, we should not see any statistically significant differences between treatment and control areas, except for some random variation.

For the pseudo-treatment we randomly choose two sub-regions from the previous transitional areas: the sub-region of Lounais-Pirkanmaa and the sub-region of Luoteis-Pirkanmaa. They contain 55 postal code areas in total. Note that in Panel B of Table 4, both sub-regions are control areas. The rest of the Table 4 control areas are used as controls in the pseudo-treatment case. The results are presented in Appendix, Table A1. Comparing the results to those in Table 4, we observe a notable difference, especially in columns 2 (number of jobs) and 4 (unemployment rate). Our pseudo-treatment is not producing the same effects as the real treatment.

6.4 Spatial correlation

In order to estimate spatial correlations, we obtained the X- and Y-coordinates of the geographic centers of postal code areas from Statistics Finland. We restrict our spatial analysis to the unemployment rate equations for the transitional areas (Panel B of Table

Table 6: Moran's spatial correlation measures and spatial regression coefficients, previous transitional areas

	no. of observations	Moran's I	unemployment rate
Treatment period:			
2007-2008	299	0.007	-0.115*
			(0.049)
2007-2009	299	0.124***	-0.168*
			(0.069)
2007-2010	299	0.062**	-0.138**
			(0.048)
2007-2011	299	0.036	-0.112*
			(0.054)
2007-2012	297	0.064**	-0.085
			(0.049)
2007-2013	297	0.063**	-0.133**
			(0.048)
Comparison period:			
2004-2005	305	0.018	0.018
			(0.039)
2004-2006	305	-0.003	0.007
			(0.044)
2004-2007	301	0.037	-0.003
			(0.052)

Notes: Moran's I measures and the treatment coefficients from the spatial lag model were calculated using the row-standardized inverse distance weights matrix with a distance band of 0-30 km. Robust standard errors in parenthesis. *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$.

4), i.e. the only outcome variable which portrayed statistically significant results. First we created the row-standardized inverse distance weights matrix, using a distance band of 0-30 kilometers[17]. For each period, we then measured the degree of global spatial autocorrelation with the Moran's I measure. Finally we estimated the spatial lag models using the inverse distance weights matrix[18]. Results are presented in Table 6.

We do find evidence of spatial correlation in some of the treatment periods, and the regression coefficients of those periods are somewhat smaller when compared to the standard difference-in-differences estimates of Table 4. Note that the spatial regression coefficient for the 2007-2012 period is also borderline significant ($p = 0.084$). We therefore conclude that while spatial correlation is clearly causing non-negligible upward bias to our original results, the bias is not large enough to change our interpretation of the results. That is, the treatment decreased unemployment in the transitional areas.

On the basis of our robustness checks, our main results presented in Table 4 appear robust enough. In the concluding section the findings are summarized and possible caveats of the study design are highlighted. Directions for future research are also suggested.

7 Conclusions

We evaluated the causal effects of EU regional policy on key economic variables using a detailed postal code area dataset and difference-in-differences regression. Our study contributes to the current EU regional policy debate as it is based on a rare natural experiment setting. For legislative reasons, some Western Finland ERDF support areas were reallocated to the programme for Northern Finland in the beginning of the programming period 2007-2013. This change created favorable conditions for a ERDF programme evaluation because ERDF support intensities, measured as EUR per capita, are much

[17] In the sub-regions of our study, the average size of a postal code area is 110 km^2 which corresponds to a rectangle of 10.5 x 10.5 km.

[18] We utilized Stata's spatwmat, spatgsa, and spatreg commands.

higher in the northern regions. Overall, the use of quasi-experimental methods has been remarkably scarce in regional policy evaluations.

Regarding the Europe 2020 Strategy targets listed in the introduction, our results suggest that the regional policy of the European Union has had at least some beneficial effects. The ERDF programme has managed to decrease unemployment, which to a certain extent also helps to achieve Europe 2020 employment targets. An increase in the number of jobs was also observed. Therefore regional policy is not totally without merits. However, we are unable to detect any effects on tertiary education, for instance. Increasing the share of population with higher education is one of the main targets of the Europe 2020 strategy. To achieve all long-term growth strategy targets, other instruments besides regional policy are also needed.

The case under scrutiny is restricted to a certain geographic area in Western Finland and a fixed time period. As is always the case in empirical studies, one could argue that the results obtained are specific to this area and time period and they are not generalizable as such. Our view is that the study design allows for a careful generalization, at least to a degree. The analyzed intervention area was the result of two unrelated incidents, namely the Finnish EU Accession Treaty negotiations in 1994 and the establishment of a common classification of EU regional units for statistics a decade later. Hence the study design is as close to randomization as possible. Our robustness checks allow for alternative specifications, pseudo-treatments, and spatial correlation.

One major drawback of our study is that we are unable to analyze the long-term effects of regional policy. This would require the complete removal of regional aid for a period of several years, so that we could observe the development of key economic variables in its absence. Unfortunately, a "development without aid" scenario is not observable, as the programming period 2007-2013 was immediately followed by the current programming period 2014-2020.

The future research agenda should also include similar study designs from other EU member states. It is highly probable that analogous changes in programme eligibility areas have occurred elsewhere as well. Likewise the availability of highly detailed regional data is bound to improve in the coming years.

References

Abadie A (2005) Semiparametric difference-in-differences estimators. *Review of Economic Studies* 72: 1–19. CrossRef.

Becker S, Egger P, von Ehrlich M (2010) Going NUTS: The effect of EU structural funds on regional performance. *Journal of Public Economics* 94: 578–590. CrossRef.

Becker S, Egger P, von Ehrlich M (2012) Too much of a good thing? On the growth effects of the EU's regional policy. *European Economic Review* 56: 648–668. CrossRef.

Becker S, Egger P, von Ehrlich M (2013) Absorptive capacity and the growth and investment effects of regional transfers: A regression discontinuity design with heterogeneous treatment effects. *American Economic Journal: Economic Policy* 5: 29–77. CrossRef.

Breidenbach P, Mitze T, Schmidt CM (2016) EU structural funds and regional income convergence – A sobering experience. Ruhr economic papers no. 608

Dall'erba S, Fang F (2017) Meta-analysis of the impact of European Union structural funds on regional growth. *Regional Studies* 51: 822–832. CrossRef.

Dall'erba S, Le Gallo J (2008) Regional convergence and the impact of European structural funds over 1989-1999: A spatial econometric analysis. *Papers in Regional Science* 87: 219–244. CrossRef.

Delgado MS, Florax RJGM (2015) Difference-in-differences techniques for spatial data: Local autocorrelation and spatial interaction. *Economics Letters* 137: 123–126. CrossRef.

Einiö E, Overman H (2016) The (displacement) effects of spatially targeted enterprise initiatives: Evidence from UK LEGI. VATT Institute for Economic Research, working papers 71/2016

Gagliardi L, Percoco M (2016) The impact of European cohesion policy in urban and rural regions. *Regional Studies* 51: forthcoming. CrossRef.

Le Gallo J, Dall'erba S, Guillain R (2011) The local versus global dilemma of the effects of structural funds. *Growth and Change* 42: 466–490. CrossRef.

Martin R, Sunley P (1998) Slow convergence? The new endogenous growth theory and regional development. *Economic Geography* 74: 201–227. CrossRef.

Marzinotto B (2012) The growth effects of EU cohesion policy: A meta-analysis. Bruegel Working Paper, No. 2012/14

Meyer B (1995) Natural and quasi-experiments in economics. *Journal of Business and Economic Statistics* 13[2]: 151–161. CrossRef.

Mohl P, Hagen T (2010) Do EU structural funds promote regional growth? New evidence from various panel data approaches. *Regional Science and Urban Economics* 40: 353–365. CrossRef.

Ottaviano G, Thisse JF (2004) Agglomeration and economic geography. In: Henderson V, Thisse JF (eds), *Handbook of Regional and Urban Economics*, Volume IV. Elsevier, Amsterdam, 2563–2608. CrossRef.

Pellegrini G, Terribile F, Tarola O, Muccigrosso T, Busillo F (2013) Measuring the effects of European regional policy on economic growth: A regression discontinuity approach. *Papers in Regional Science* 92: 217–233. CrossRef.

Percoco M (2016) Impact of European cohesion policy on regional growth: Does local economic structure matter? *Regional Studies*: forthcoming. CrossRef.

Solow R (1956) A contribution to the theory of economic growth. *The Quarterly Journal of Economics* 70: 65–94. CrossRef.

Wooldridge JM (2010) *Econometric Analysis of Cross Section and Panel Data* (2nd ed.). MIT Press, Cambridge

Appendix

Table A1: Regression coefficients, pseudo-treatment

period	no. of observations (min.–max.)	no. of jobs, all industries	share of inhabitants with tertiary education	unemployment rate	median disposable income EUR/cap.
Treatment period:					
2007–2008	260–272	0.024	-0.013	-0.047	-0.010
		(0.026)	(0.020)	(0.067)	(0.006)
2007–2009	260–273	0.017	-0.010	-0.131	-0.004
		(0.045)	(0.017)	(0.065)	(0.011)
2007–2010	260–273	-0.064	-0.024	-0.017	0.001
		(0.053)	(0.029)	(0.066)	(0.008)
2007–2011	260–273	-0.017	-0.033	-0.114	-0.001
		(0.046)	(0.031)	(0.078)	(0.010)
2007–2012	258–273	-0.002	-0.024	-0.082	0.011
		(0.055)	(0.032)	(0.078)	(0.010)
2007–2013	258–273	-0.036	-0.020	0.062	0.009
		(0.064)	(0.035)	(0.073)	(0.010)
Comparison period:					
2004–2005	266–271	0.033	0.010	0.030	0.006
		(0.075)	(0.023)	(0.039)	(0.005)
2004–2006	266–272	-0.025	-0.007	-0.051	0.000
		(0.080)	(0.015)	(0.053)	(0.005)
2004–2007	262–272	-0.015	0.004	-0.074	0.003
		(0.080)	(0.026)	(0.085)	(0.009)

Notes: Entries are coefficients β_1 from the equation $\Delta \ln Y_i = \beta_0 + \beta_1 TREAT_i + \Delta\epsilon_i$. Standard errors (in parenthesis) are clustered at the municipality level. The coefficients of determination are denoted as R^2. *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$.

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The Mediterranean Variety of Capitalism, Flexibility of Work Schedules, and Labour Productivity in Southern Europe

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Abstract. Sociology has long been used to highlight the existence of diverse institutional models between geographical areas of Europe in terms of work organization. Based on this, we propose to compare the situation of four representative countries of Southern Europe (Spain, Italy, Greece and Portugal) with that of the rest of Europe, by addressing the number of hours worked and the flexibility of working hours as key elements of their institutional model of work organization, as well as their impact on levels of labour productivity. Taking the model of the varieties of capitalism as a reference, this study compares the behaviour of the Mediterranean (Southern) countries with other European regions. Indicators have been obtained from the 2010 and 2015 iterations of the European Working Conditions Survey (EWCS) that include the number of hours worked, the flexibility in the hours of entry and exit, and the tendency to work the same number of hours per day. After comparing averages in both iterations and applying linear regressions, the following conclusions have been reached: (1) Productivity in Southern countries is on a par with the European average but far from the more corporatist and liberal (northern) areas; (2) the South maintains a high average of hours worked (above the European average) to compensate for the poor productivity of its hours; and (3) the incorporation of flexible schedules is associated with elevated levels of productivity.

JEL classification: J81, P52, B52

Key words: Economies of Southern Europe, European crisis, PIGS, Varieties of capitalism

1 Introduction

The development of the political, economic, and social project of the European Union (EU) recently highlighted the historical heterogeneity of Europe. Indeed, from an external point of view, Europe may be something more than a continent: it is a geographical area united by its history, the core territory for the development of the Western society that generated this political, cultural, and economic phenomenon called Eurocentrism (Brennetot et al. 2013). However, such a model gradually declined in front of emergent regions such as the United States (U.S.) since the beginning of the 20th century, and

South-Eastern Asia during the last three decades (Lamo de Espinosa 2010). To what degree has the heterogeneity of Europe contributed to its current situation? Despite the difficulty in responding to such a question, our work looks at some key elements of national organizational cultures. Among the evident economic and cultural differences existing within Europe, we highlight those that – in our opinion – have led to the Southern European countries ('the South') being labelled as a threat to the stability of the European Union. These refer to a specific historical cycle: countries like Spain and Portugal maintained their historical weight during their colonial period, after completing their 'brilliant' cycle during the age of discoveries and mercantilism. Likewise, Italy was a very relevant node for the international economy and commerce between the 14th and the 16th centuries. Afterwards, the Industrial Revolution was a key stage that turned the situation around and favoured Northern countries.

More recently, Spain, Italy, Greece, and Portugal joined the European Union in evident conditions of backwardness when compared with their Northern partners. Nevertheless, the growth of the Italian economy during the 1980s led to its Gross Domestic Product (GDP) per capita being on a par with that of the United Kingdom (U.K.) at various times during that decade. Furthermore, the significant economic growth of Spain between the 1990s and the beginning of the 21st century, suggested that the "European dream" of equilibrating the North-South balance was an achievable goal. By contrast, the fall of both countries (Italy and Spain) after the "Lehmann Brothers" crash in 2008 suggested that the period of prosperity of previous years was based on a temporary favourable situation, betraying – in turn – their shortcomings in terms of innovation, technology, industrialization, and creation of employment. Likewise, Portugal and Greece recently experienced a gradual deterioration in their economies. The Greek situation was particularly critical, due to the country's indebtedness and the consequent threat to the eurozone.[1]

Regarding the labour performance of Southern European countries, evidence corroborates some weaknesses when compared with the North. Portugal and Greece show concerning outcomes in terms of productivity per worked hour: 100 being the average of EU-28, they score 70.1 and 70.6 respectively, while Italy (101.7) and Spain (101.1) are closer to the average. But all these countries are far from the scores of their Northern partners such as Belgium (134.7), the Netherlands (129.5), France (128.0) and Germany (127.0). A report by the McKinsey Global Institute (MGI 2010), assigning 100 points to the current level of labour productivity of the U.S., gives 84 points to Northern Europe, and 73 points to Southern European countries. The report concludes as follows: while the productivity of Europe was closer to the U.S. during the 90s, since the beginning of the new century it continues to decrease, burdened by Southern countries that have embarked on a 'non-sustainable' path.

In addition, the elevated public deficit of the South has led to a conflict with their European partners that are not impressed with the South's governance and economic performance. The most significant criticisms include the following examples: the trend toward the waste of public money, "clientelism", management inefficiencies, overweight of the public administration sector, and – above all – the poor levels of labour productivity. A prominent Spanish sociologist, Lamo de Espinosa (2010, p. 543) affirmed that: "This situation provoked serious concerns about the solidity and the potential of the Spanish economy and, to a lesser extent, about the reaction capacity of both its institutions and political elite. International press condemned Spain to the fellowship of the PIGS (Portugal, Italy, Greece, Spain): a stigma that will last for a long time." (Translation provided by the authors)

Scholars have often recognized that these inequalities rely on the existence of a gap in

[1] Given the difficulties of financing manifested by Southern European countries and their incapability of generating sustainable economic growth, some Northern partners and institutions reported such situation as a waste of their financial contributions to the Union. Did the South create a 'subvention culture'? Public aid to peripheral and convergence regions – justified by rebalancing goals – ended with a positive, but temporary and fictitious effect that dwindled out as aid reduced over time (De la Fuente 2005). More pessimistic scholars have suggested that aid from the European Union to underdeveloped regions had almost no effect on rebalancing structural gaps between Northern and Southern countries in terms of employment, innovation, industry fabric, and technology (González Rodríguez et al. 2000).

terms of production and the occupational model. For instance, Miguélez, Prieto (2009) focused on the construction of an unbalanced labour model diminishing the value of the working class. While Northern Europe consolidated a stable model for employment during the 1950-80 period, "Southern European countries were left behind because of the concentration of low-quality employment and the low levels of inclusion of women in the labour market". Miguélez, Prieto (2009, p. 276; translation provided by the authors) In addition, since the 80s, this framework was subsequently weakened by new factors that jeopardize social rights: "First of all, the strength of the system of labour relations of each country; and then, the inclusion within the employment system of new labour actors that are different from the adult white male, such as the youth, women, and immigrants. [...] In countries like Spain the dualism of the labour model is clearly evident." (Miguélez, Prieto 2009, p. 276; translation provided by the authors)

Regarding the recent application of governmental policies that promote productivity in Southern Europe, we observed two main lines of action: policies to reduce working time and those aimed at flexicurity. Regarding the first case, the promotion of low-wage policies in the European Union since the early 2000s stands out. Its applications, both in the North and in the South, do not work properly, at least from a productivity perspective (Perrons 2005). The model of contracting workers for short periods with low wages is compensated with the incentive of occupying the rest of the day with other dedications and even a second job, in addition to having tax benefits and exemption from Social Security. However, the subsequent results – both in the north and in the south – showed some reinforcement of situations of poverty, lack of worker motivation and feminization of these contracts, which reinforced the figure of the male breadwinner. Among the forms adopted in Europe, the consolidation of the German mini-job model stands out, by finding the right context for its development, as Feld et al. (2015) indicated in a recent work. According to them, "many of those with a mini-job are second earners, students and pensioners [...] and compared to other European countries, Germany's support system is rather generous" (Feld et al. 2015, p. 3). Given those circumstances, to export such a model successfully to Southern countries shows several difficulties. In terms of policies aimed at flexicurity, expectations are somewhat more optimistic. In a study conducted by a mixed team of Spanish and Italian researchers, they focused on the following question: is flexicurity exportable (Leonardi et al. 2011)? Although Italy and Spain are labour markets that are traditionally rigid and conditioned by cultural factors, some steps have been taken in this direction through dialogue between social actors, and there is considerable room for improvement if the work training is adapted to the new times and the mediation between supply and demand.

With these relevant policy issues in mind, we expose in this paper the outcomes of our research into the differences of labour productivity and national models of work organization between culturally and historically similar Southern European countries (Italy, Spain, Portugal, and Greece) and the rest of the EU, giving special attention to Northern countries. We used data from the fifth (2010) and sixth (2015) iterations of the European Working Conditions Survey (EWCS) performed by the European Foundation for the Improvement of Living and Working Conditions (EUROFOUND), located in Dublin, Ireland. We identified a number of measures relating to the flexibility of working schedules as indicators of national organizational models. The second section details the theoretical framework; the third section describes research goals, design, and methodology; the fourth section shows the findings, while the last section details the conclusion of this study.

2 Varieties of capitalism, work organization, and time management

The starting point of our research is the assumption that the national context affects economic factors like organizational and work practices. The influence of the work of Inglehart (1997), who oriented his studies toward the value of interculturalism and toward cross-country differences, was crucial for studying national cultures. Likewise, we should highlight the research performed by Esping-Andersen (1999), connecting national cultures with the socio-political context. This scholar identified three models of development of the

welfare state across western countries since the end of World War II: liberal, conservative, and social democratic. Beyond the public sector, every (public or private) organization is embedded within such models.

Likewise, we should take into account the contributions from the neo-institutionalist research approach. Mauro Guillén (1994), the author of 'Models of Management', tackles such differences according to the economic and labour relations existing internally in each country. The thesis that the traditions of different countries mark their institutional relations and shared ideology is useful in explaining most of the existing organizational and labour conflicts, thereby generating a diversified set of paradigms. For example, it is part of the stream that underlies contrasting conceptual axes such as 'Catholic versus Protestant' or 'liberal versus conservative'. In each country, we find institutional struggles that determine the dominance of a certain paradigm. This approach helps us to understand the different organizational models existing across countries and nations. Specifically, we state that a neo-institutional approach is useful for addressing the socio-political diversity of European countries and its impact on labour productivity. Some empirical studies have included a similar approach, like the global comparative exercise performed by Hall, Jones (1996); the comparative studies about Canadian regions performed by Baldwin et al. (2005) and Maynard (2007) and the analysis of the Spanish economy coordinated by Segura (2006). Such approximations show that institutional relations encompass one of the most relevant components of a national economy in facilitating labour productivity, technological capacity, workforce qualification and internationalization. Therefore, we find several studies connecting labour productivity with the existence of values, norms, and rules (the institutional framework) facilitating the flexibility of the labour system and the cultural value of work organization.

Within the neo-institutional literature, a relevant contribution is provided by the 'varieties of capitalism' literature (Hall, Soskice 2001). These studies highlighted the relevance of national institutions within the economic structure, using conditioning variables such as innovation and performance. The varieties of capitalist models across countries and territories have historical reasons and imply different values and beliefs. The institutional effect primarily manifests itself in the governance mechanisms of industrial relations. These factors condition the capacity of nations (and their firms) to adapt to the challenges posed by globalization and the emergence of the knowledge economy (Castells 1997, Hall, Soskice 2001). Organizational flexibility of markets and firms (e.g. through new models of labour relations or network organizations) stands out as a key factor to foster firms' productivity and competitiveness.

This approach recognizes the existence of different ideal types of organization for the capitalist economy in Europe (Crouch 1998). For instance, some studies highlight the existence of a 'Mediterranean' model of capitalism for countries such as Italy, Spain, Portugal, and Greece (Amable 2003). The idea of a Mediterranean model of capitalism takes its origin from the existence of a large set of family-based small firms, cross-participation in firms' governance and the prominent role of the State in the economy (Moerland 1995, Regini 1995), a system that De Jong (1995, p. 402) defined as a 'pragmatic' one. According to Amable (2003), this variety of capitalism is significantly different to the liberal (or Anglo-Saxon) model that is based on the balance between the limiting and creative effect of institutions on the economy through formal regulation mechanisms. Moreover, some countries of central Europe (e.g. Germany) adopt a 'corporatist' market economy, while Scandinavian countries adopt a social-democratic model (Amable 2003). These models, especially the latter, stand out for their level of long-range planning on national public policies while, at the same time, firms' recruitment strategies do not necessarily rely on close social networks. As Cassano (1996) points out, there are historical and cultural reasons explaining why Mediterranean countries developed a peculiar way of understanding organization, work, and time.

Specifically, the Mediterranean model of capitalism "is similar to the Continental European model, but based on more employment protection and less social protection. Employment protection is made possible by a relatively low level of product-market competition and the absence of short-term profit constraints as a consequence of the centralization of the financial system. However, a workforce with limited skills and

education level does not allow for the implementation of high wages and high skills industrial strategy" (Amable 2009, p. 21), while "Mediterranean countries appear to possess more regulated labour markets than other European economies" (Amable 2003, p. 17). Therefore, the Mediterranean model is more rigid than others are in terms of governance and organization of employment. Formal employment protection prevents quick structural change, while low competitive pressure simultaneously allows employment stability in large firms. This situation also hinders the need for upgrading the competences of the workforce and, therefore, potential pathways for innovation and productivity (Amable 2003, p. 113).[2]

In conclusion, (Amable 2003, 2009) suggested that the rigidity of the labour market in Southern European countries seriously hinders the capacity of their firms to compete and, therefore, he recommended exploring more 'flexible' forms of governance and organization of work. However, as Meardi (2012, p. 58-59) pointed out, this supposed 'rigidity' of Mediterranean countries should be considered according to some dimensions and not others: for instance, Spain (and Portugal) showed very high levels of temporary work for a very long period, in contrast with the situation of Italy and Greece. This difference originated in the different degrees of conflict in industrial relations and strength of unionism. By contrast, rigidity looks to be a common feature of all Mediterranean countries as it comes to the daily organization of work, as it can be exemplified by the rigidity of the working-time schedules.

Drawing from the considerations above mentioned, our research hypothesis is the following: the Mediterranean model of capitalism is less productive because of the low flexibility of the organization of working time and schedules, among other factors. Alongside the theoretical contributions exposed above, there is evidence of significant differences in work schedules between Northern and Southern European countries. For instance, it is well-known that workdays in the north used to end relatively early (usually around 18:00 hours) versus the extensive working evening typical of Mediterranean private firms. In this sense, the work gets more centrality in Southern countries' work schedules. Among the explanations for the overloading of working time we highlight the studies of Paugam (2007) and Halbwachs (2002). They recognize the difficulty of Southern societies in separating working time from private or social time. They also found a historical trend within Southern countries to split the workday in two. This probably derives from diverse factors like climate or the 'moonlighting' tradition that evolved as a consequence of recurrent famines (i.e. an additional evening job to compensate for the difficulties in obtaining income). The 'classic' works of the German sociologist Georg Simmel (1998) went further in its implications by placing Southern Europe as an example of 'integrated poverty': a situation addressing a large part of the population, contagious and reproductive in nature, and weakened by a strong component of "clientelism" and informal economy. Simmel identified family solidarity as the solution adopted by the lower classes for addressing this problem in Mediterranean countries. Familism and 'clan culture' (Banfield 1958, Pizzorno 1966, López-Pintor, Wert 1982) contribute to impeding the separation between work and private space and time. In conclusion, this complex convergence of diverse factors provoked a specific model of adaptation that is no longer relevant to current societies and economies, thereby causing a societal disorder of work organization.

This tendency towards work time overloading worsened after the Great Recession of 2008 with its consequent social cuts to public expenditure in Greece, Spain, and Portugal, causing a fall of salaries and an unbalanced context for negotiation between workers and private firms. Additional problems came from the increase of mandatory working hours in the public sector in these countries that, likewise, reduced the number of temporary workers employed by the public administration.

On the other hand, the low productivity of the countries of the south is also explicable by political science, focusing on the forms of government. In this sense, Migdal (1998) developed his perspective "State in society" that conceives the State as an area of

[2] Another key feature of the Mediterranean model is specialization in light industries and low-tech activities, as well as heavy product-market regulation, hindering technological innovation and entrepreneurship – as confirmed by the lagging position that Southern European countries have in terms of ICTs (Amable 2003, ch. 1).

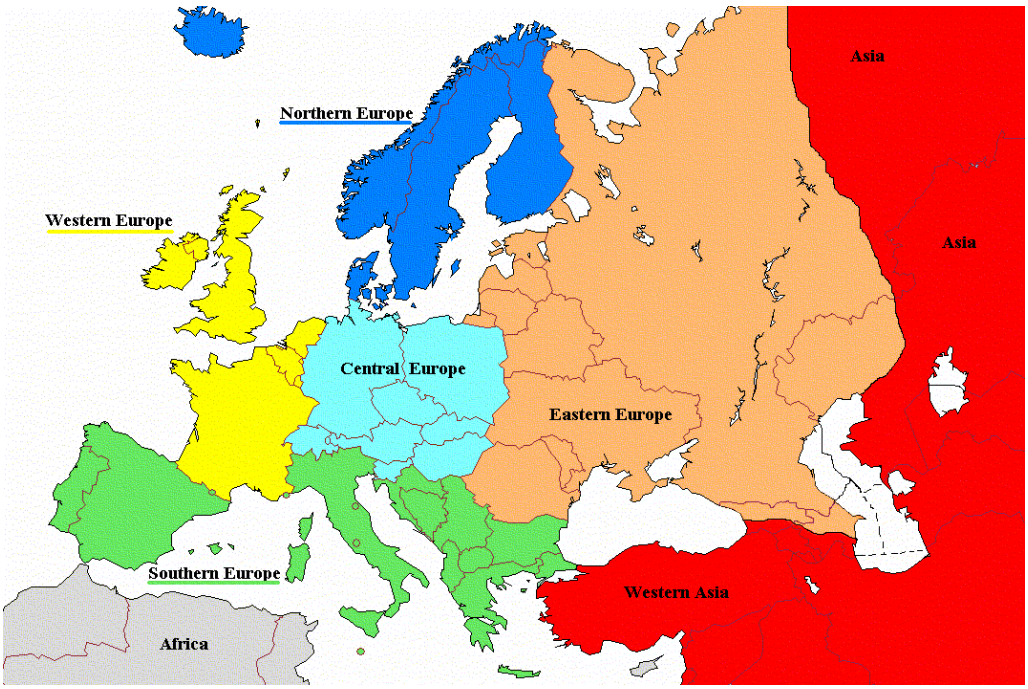
power marked by the use of force, and where the legal and institutional framework is complemented by informal processes and power relations. The State is not only influenced by international and global issues, but also – to a large extent – by social and ideological interests of a local or regional nature. In this same line, the perspective of "neopatrimonialism" helps to explain the dysfunctions of many governments of the planet. The classic work of Bratton, Van de Walle (1997), Democratic experiences in Africa (see also Van de Walle 2005), speaks of a strong transmission of the interests of certain social groups toward government mechanisms that prevented genuine development of democracy. The authors identify as characteristics of a "neopatrimonialist" government: (1) "presidentialism", understood as the concentration of power in a few hands; (2) "clientelism"; and (3) The use of state resources for private interests. Approaching the case of Latin American governments, Bechle (2010) explains that society has not found a way to control political power, since it operates continuously crossing the border between public and private. Weber, according to Bechle, predicted that a patrimonial stage in the governments would give way to the domain of the legal system, but this phase has been completed by a select group of countries (Northern Europe being a reference). In the Latin American case, however, there is a particular context in which private interests and patrimonial forms continue to be active, under the cover of legality. Maya (2016) has reinforced these arguments in her recent work on the decline of "Chavism" in Venezuela. In this sense, the southern European countries correspond to the model only partially, but the theory warns of the existence of strong patronage networks in the environment of their governments (Villena 2017).

Among the most relevant strategies promoted by the policy and management sector to foster labour productivity through a change in the working-time system are those strategies based on time flexibilization. There are two types of initiatives: on the one hand, the so-called passive flexibility (1) that enables the firm to adapt work schedules to workers' demands and needs by offering benefits like free days or salary incentives (Lusa, et 2007); or on the other hand, flexibility policies oriented to the personnel (2) fostering its satisfaction and motivation through improvement in work-family conciliation (Jijena-Michel, Jijena-Michel 2015, Lewis 2003). In both cases, and especially (2), the support perceived by the worker may be translated into positive attitudes with significant impacts on productivity, according to both Perceived Organizational Support Theory and Social Exchange theories (Lambert 2000). In this sense, earlier policies of flexibilization oriented toward the 'when' of the problem, were integrated with others oriented toward the 'where' and the 'to what extent' (Hill et al. 2008). In fact, recent empirical studies show that modifying the working schedule system of firms could improve both family-work conciliation and labour productivity (Basque Governement 2010).

3 Methodology

The aim of this research is to measure the flexibility of work schedules and its impact on labour productivity across Southern European countries by performing a comparison with three other areas previously defined by theory (varieties of capitalism approach). To achieve this aim, we designed a comparative and exploratory study. Our research used data from all EU-28 countries for theoretical and operational reasons (we use the average of European countries as a reference) even if our research design is focused on comparing the performance of the following four blocs of countries:[3]

[3] We excluded from this classification smaller countries (like Cyprus, Luxembourg, or Malta) because their institutional model is not clearly positioned according to the literature. For instance, it is not clear if Cyprus should be considered as a case of the liberal variety of capitalism, or mixed/Mediterranean. Likewise, the disproportionate levels of labour productivity exhibited by Luxembourg, probably due to its peculiar economic structure (e.g. international finance), prompted the exclusion of this country from the classification. Furthermore, almost all of the countries corresponding to the central or eastern part of Europe (following the United Nations's scheme) were not included in any bloc as most of them would correspond to the post-communist variety of capitalism. In this residual bloc, we also included the three Baltic countries (Estonia, Latvia, Lithuania) because these countries, despite the fact that they are part of the natural geographic region of North Europe (Figure 1), are – in our opinion – closer to the post-communist bloc, due to their history, culture, and economy, as also corroborated by their medium-low average levels of labour productivity (see Table 1).



Source: United Nations Organization (UNO)

Figure 1: Classification of European countries by natural regions

1. The four big countries of Southern Europe being representative of the mixed (Mediterranean) model of capitalism: Italy, Spain, Portugal, and Greece. These countries encompass our main research object and show moderate levels of labour productivity.

2. The three countries of Western Europe following a liberal (Anglo-Saxon) model of capitalism: Ireland, the Netherlands, the U.K. These countries show a level of labour productivity higher than the average.

3. The three countries of Northern Europe following a social democratic (Scandinavian) model of capitalism: Denmark, Finland, and Sweden. These countries show a level of labour productivity higher than the average as well.

4. The four countries of western-central Europe following a corporatist (continental) model of capitalism: Austria, Belgium, France, and Germany. These countries show higher levels of labour productivity.

For building these blocs we took into account the diverse geographical areas of Europe according to the natural regions classification by the United Nations Organization (UNO; Figure 1), together with the scheme provided by the varieties of capitalism literature, according to Hall, Soskice (2001) and the extension realized by Amable (2003).[4]

We searched the content of available international surveys on issues like work and social values in order to identify measures for comparing many national varieties of work organization that exist across countries. We selected relevant and updated indicators relating to the EU-28 countries. Finally, we decided to analyse a set of indicators from the 5th and 6th waves of the EWCS (EUROFOUND 2016) as independent variables. Specifically, for each country, we used the percentage of surveyed workers affirming that:

1. Work less than 30/34 hours each week ('underloaded workers')

2. Work more than 40 hours each week ('overloaded workers')

[4]However, Amable (2003, p. 14) pointed out clearly that the geographical correspondence of some models of capitalism in Europe should not be taken too literally, but only for "the sake of simplicity".

3. Have rigid schedules to enter/exit at work ('rigid entry/exit schedule')

4. Work approximately the same number of hours every day ('rigid workday schedule')

The first two indicators refer to the amount of time employed for working, identifying the size of two groups of workers: on the one hand, underloaded workers, working a small number of hours each week (less than 30 in the 2010 survey, and less than 34 in the 2015 survey); on the other hand, overloaded workers, working more than 40 hours each week. Similarly, these data are compared with the real number of hours worked per week as reported by Eurostat for the year 2015. The latter two variables refer to the flexibility of working time, reflecting the rigidity of the national organizational model.

In summary, we analyse the relation between each one of these independent variables with the aggregated productivity at national level for each hour worked (dependent variable) as reported by Eurostat in 2010 and 2014 (data for 2015 are not available at the time of writing this paper). For each pair of variables (one by each wave), we built a scatter plot and estimated the lineal or polynomic slope and the correspondent coefficient of determination. The statistical formula behind this method is the following:

$$Y_{it} = \beta_1 X_{jit}^2 + \beta_0 X_{jit} + K \tag{1}$$

Where:

Y_{it} ... Productivity per worked hour for the country i of year t

X_{jit} ... Independent variable ('j' being the proportion of 'underloaded workers', 'overloaded workers', or 'workers with rigid entry/exit schedule' or 'rigid workday schedule' respectively) for the country i of year t

K ... constant (intercept) of the model

The model has been estimated following a regular least squares regression procedure, performed through the Excel software.

In this way, we try to highlight the diverse outcomes obtained by geographic area, relating indicators of the number of hours worked and the flexibility of work schedules with labour productivity performance.

4 Findings

In this section, we describe the main findings of the study. We first tackle the trends underlying the data on labour productivity per worked hour (the dependent variable). This is followed by the results of the analyses of how productivity is influenced by the selected independent variables.

4.1 Productivity per Worked Hour Within EU-28

Table 1 shows the data on the levels of labour productivity of the 28 countries of the EU. We selected this measure for productivity due to the relation between GDP and the total number of hours that have been worked within the country. In this case, values have been standardized according to the average for the EU-28, which is 100 for each year. Countries have been ranked from higher levels to lower levels of productivity, taking 2010 as the reference year.

Looking at Table 1, we observe a few significant variations in the levels of labour productivity of countries between 2010 and 2014. Following the classification of natural regions, countries showing a higher than average levels of productivity are part of the Western Area (Luxembourg, Belgium, The Netherlands, Ireland, France) with the exception of the U.K., followed by Northern countries (Denmark, Sweden, Finland) and two countries of central Europe (Germany, Austria). Southern European countries occupy positions ranging from the EU-28 average (Italy, Spain) to lower than average levels (Greece, Portugal), along with the U.K., the Mediterranean countries and islands (Cyprus, Malta) and some countries of central Europe (Slovenia, Slovakia, Czech Republic). Eastern countries occupy the lower positions of the EU-28 labour productivity ranking.

Table 1: Comparing productivity between European countries

Country	2010	2014
LU – Luxembourg	173.9	182.0
BE – Belgium	138.4	134.7
NL – Netherlands	132.2	129.5
IE – Ireland	128.9	129.0
FR – France	128.8	128.0
DK – Denmark	129.9	127.1
DE – Germany	126.1	127.0
SE – Sweden	118.1	114.8
AT – Austria	113.5	113.4
FI – Finland	110.0	106.5
IT – Italy	103.7	101.7
ES – Spain	99.5	101.1
EU28 - European Union (28 countries)	*100.0*	*100.0*
UK - United Kingdom	104.8	99.7
CY – Cyprus	86.8	81.9
SI – Slovenia	77.6	79.3
SK – Slovakia	74.8	76.8
MT – Malta	75.9	71.4
CZ - Czech Republic	69.1	70.7
GR – Greece	75.2	70.6
PT – Portugal	68.6	70.1
HU – Hungary	67.3	65.6
LT – Lithuania	58.7	64.8
EE – Estonia	60.7	62.9
HR – Croatia	56.4	60.5
PL – Poland	55.9	58.6
LV – Latvia	49.6	53.6
RO – Romania	43.7	49.4
BG – Bulgaria	41.7	42.5

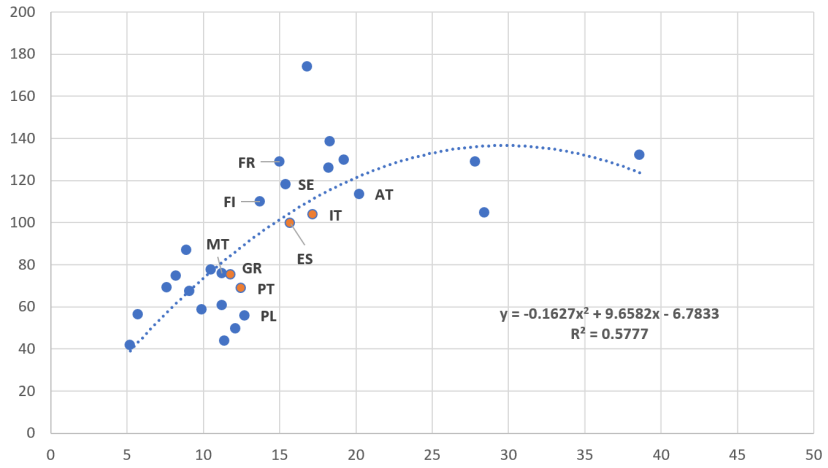
Source: EUROSTAT

By contrast, if we follow the classification of European countries according to the varieties of capitalism scheme, we observe that countries from two groups occupy the higher productivity positions: the corporatist bloc (Belgium, Germany, France, and Austria) and the liberal bloc, excepting the U.K. (The Netherlands and Ireland). These are closely followed by the social-democratic bloc of countries (Table 1). Next we find the bigger countries of the mixed bloc (Italy, Spain) along with some countries of the Anglo-Saxon area. Finally, we find the other two 'mixed' economies down the ranking, together with the post-communist economies.

In summary, differences in the level of labour productivity correspond to both geographical patterns and models of capitalism. Specifically, we may identify a strong cluster of countries in north-western Europe formed by a combination of countries following either a liberal or corporatist model, encompassing a kind of 'productive European heart'. While the Scandinavian countries show similar levels of productivity, the Mediterranean countries recorded lower levels of productivity.

4.2 Labour Productivity and Number of Worked Hours

The analysis of the national behaviour relating to labour productivity implies looking at the differences in terms of time dedicated to the workday. We show the existing relationship between the aggregate levels of productivity per worked hour of each country (the dependent variable) and the percentage of underloaded workers in 2010 (Figure 2) and 2015 (Figure 3). We observe that Southern European countries show a percentage of



Source: EWCS

Figure 2: relation between productivity (y-axis) and percent of underloaded workers (x-axis) 2010

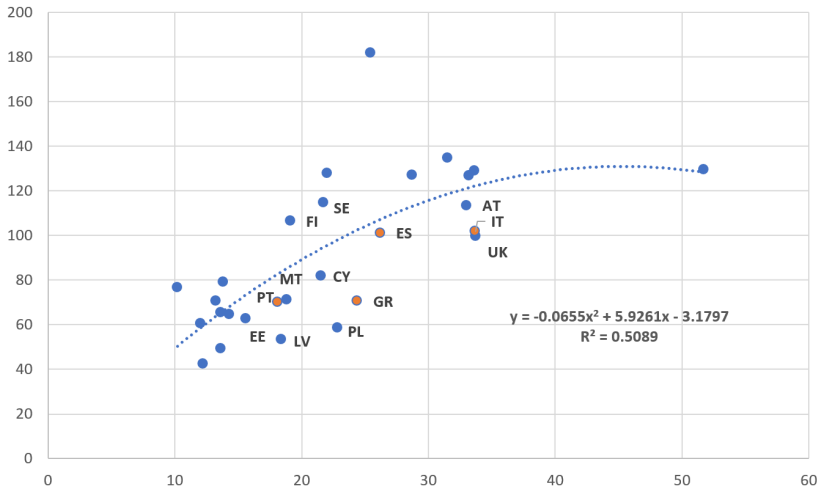
underloaded workers close to the average: between 11% and 18% for 2010, and between 18% and 27% for 2015, excepting in the case of Italy for this year (something more than 30% of its workforce).

Both in 2010 (Figure 2) and 2015 (Figure 3), we observe that there is a significant correlation between labour productivity and the percentage of underloaded workers, as exemplified by the (adjusted) coefficient of determination, higher than 0.5 in both cases. The relation between both variables is illustrated by a positive 2nd grade polynomic slope, growing faster in correspondence with lower levels of the independent variable (underloaded workers), and starting to decrease around a threshold of 30% for 2010 and 45% for 2015 (the difference is probably due to the diverse way of operationalizing the variable). This means that increasing the percentage of underloaded workers has a positive effect on productivity, at least until a certain threshold. In fact, all countries exceeding the European average (100) show a percentage of underloaded workers greater than the average (13% for 2010, 18% for 2015).

Graphs 3 and 4 show the relation between the levels of aggregated productivity per worked hour and the percentages of overloaded workers for each country. Most of Southern European countries show relatively elevated levels for this indicator (between 21% and 25%) while Greece leads the ranking both years with more than 43% of overloaded workers on its total workforce.

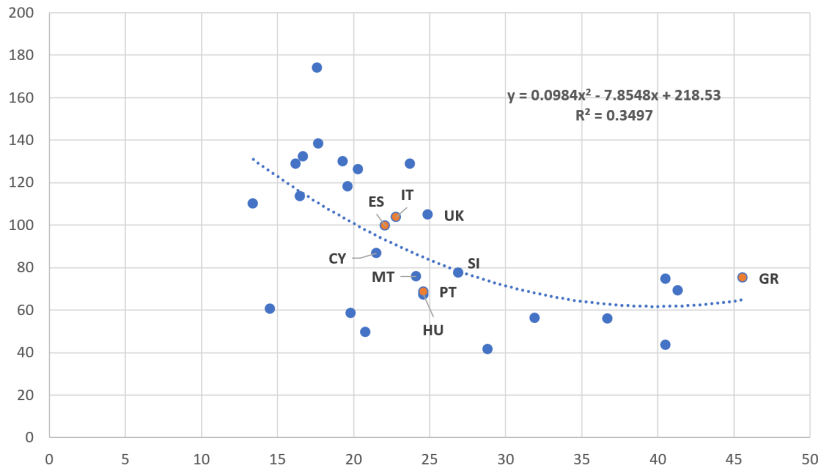
Both in 2010 and 2015 we observe a moderate correlation between productivity and overloaded workers, exemplified by the (adjusted) coefficient of determination, higher than 0.34 for 2010, and higher than 0.43 for 2015. The relation between these two variables is adequately illustrated by a negative 2nd grade polynomic slope, decreasing faster in correspondence with lower levels of the independent variable (overloaded workers) and starting to increase at a threshold of around 35% of the distribution. This means that increasing the percentage of overloaded workers has a negative effect on productivity, at least until a certain threshold. In fact, all countries exceeding the European average (100) show a percentage of overloaded workers lower than the average (around 25-27%).

What do these findings mean for understanding labour productivity in Southern Europe? The most relevant implication is that productivity per hour worked does not seem to increase depending only on the mere number of working hours. In other words, most productive countries are those in which there is a significant percentage of underloaded workers (more than a third of the total workforce) and a low percentage of overloaded workers (less than a quarter of the total workforce). Furthermore, workers of Mediterranean countries spend more time working than their counterparts in Liberal, Corporatist, and Social-Democratic countries. The Southern bloc countries struggle to increase their levels of productivity, given their higher level of extra hours (Table 1).



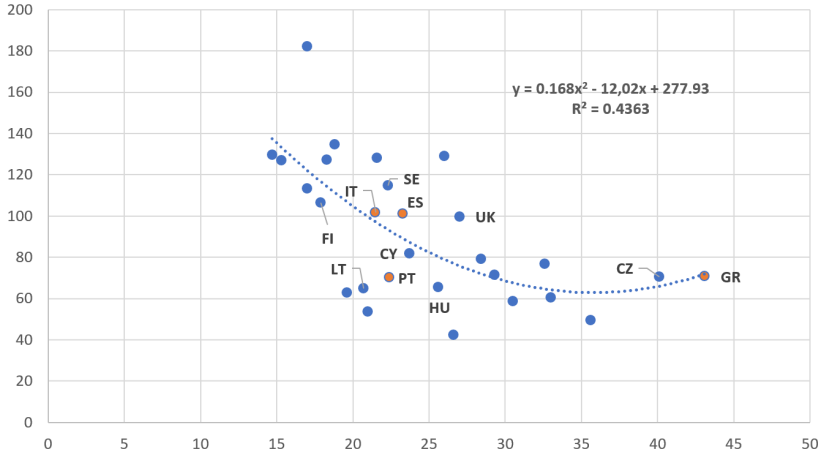
Source: EWCS

Figure 3: relation between productivity (y-axis) and percent of underloaded workers (x-axis), 2015



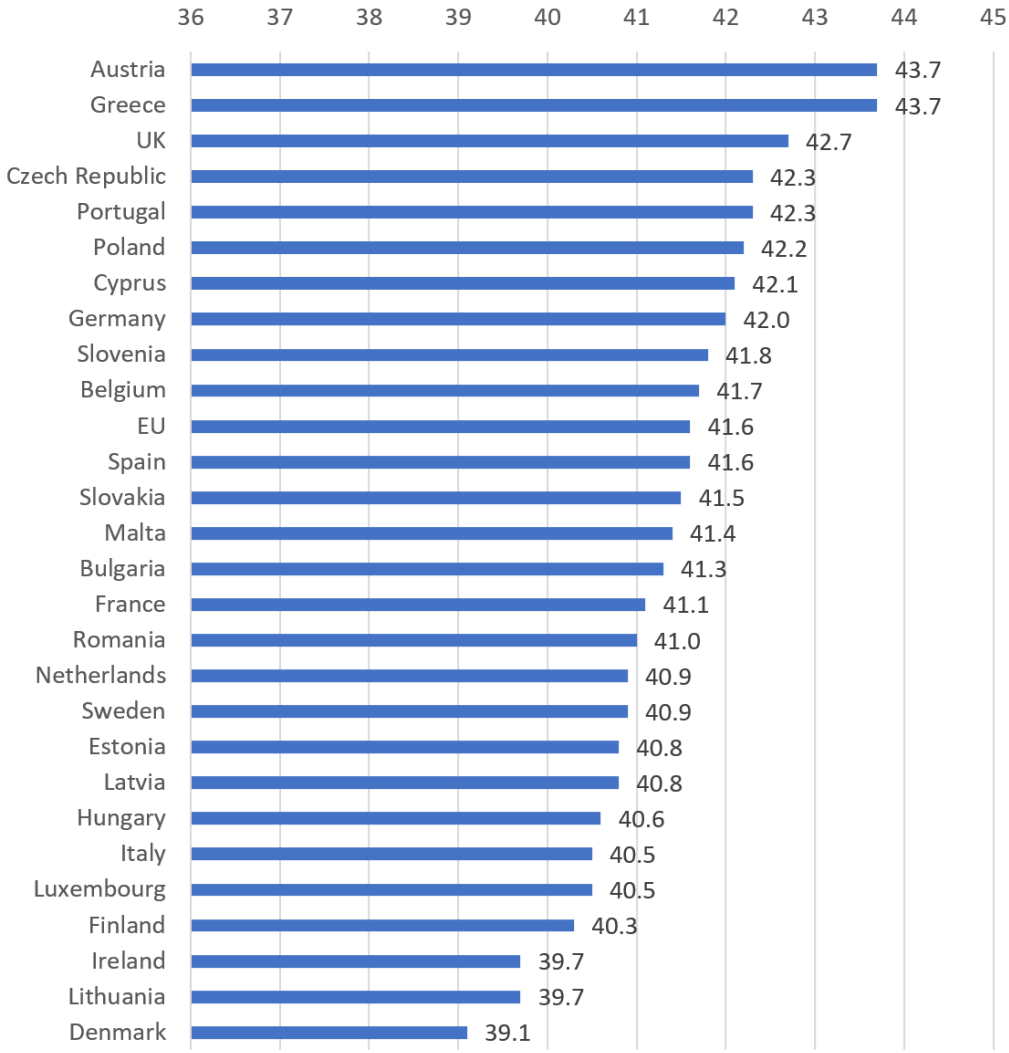
Source: EWCS

Figure 4: Relation between productivity (y-axis) and overloaded workers (x-axis), 2010



Source: EWCS

Figure 5: Relation between productivity (y-axis) and overloaded workers (x-axis), 2015

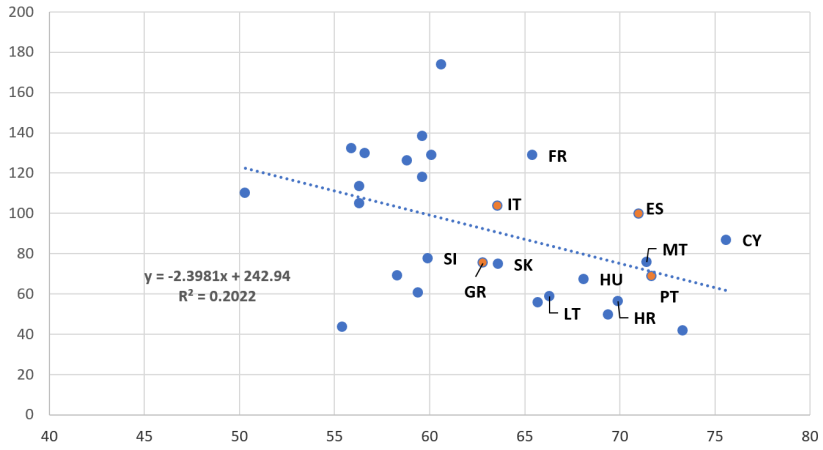


Source: EUROSTAT

Figure 6: Average of real worked hours by European countries, 2012

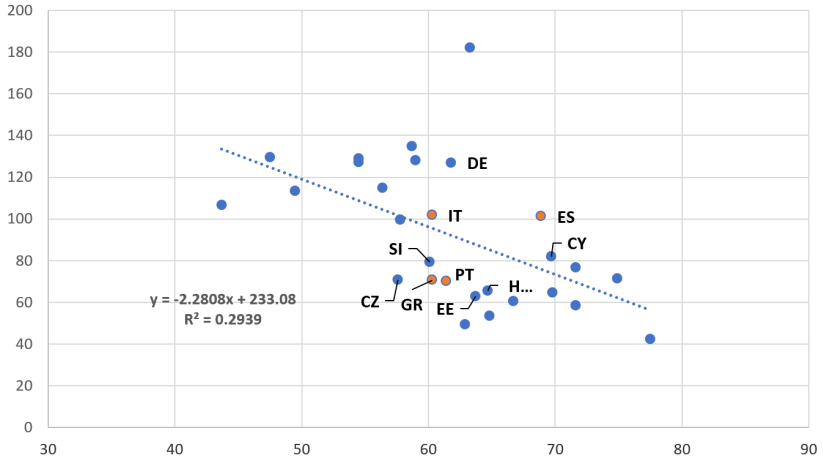
Another illustration of the amount of time spent working in the countries is included in the Eurostat data relating to the average of real worked hours by European countries in 2012 (Figure 6). Excluding the opposite cases of Austria (higher levels of both productivity and worked hours) and Lithuania (lower levels of both), this distribution corroborates our findings. The less productive countries of the Mediterranean area (Portugal and Greece) appear within the top five countries that dedicate most time to work. While Spain occupies a position close to the EU average, Italy exhibits medium-low levels of working hours. In turn, we find four of the most productive countries of the continent (Luxembourg, Ireland, Denmark, and Finland) among the five countries that dedicate less time to work.

Furthermore, the difference in terms of economic performance between Mediterranean countries and the other three blocs is influenced by a higher number of hours dedicated to work. In reality, it seems that a reduction of working time is a kind of 'recompense' for achieving certain levels of productivity. This virtuous relation seems particularly evident in Scandinavian countries. By contrast, we can imagine that the limited productivity of Southern countries implies an extension of their workdays. Such circumstances suggest we focus our attention on the cultural and organizational factors that inhibit productivity. Specifically, we analyse how productivity is influenced by factors such as the flexibility or the rigidness of working schedule.



Source: EWCS

Figure 7: Relation between productivity (y-axis) and rigid entry/exit schedule (x-axis), 2010



Source: EWCS

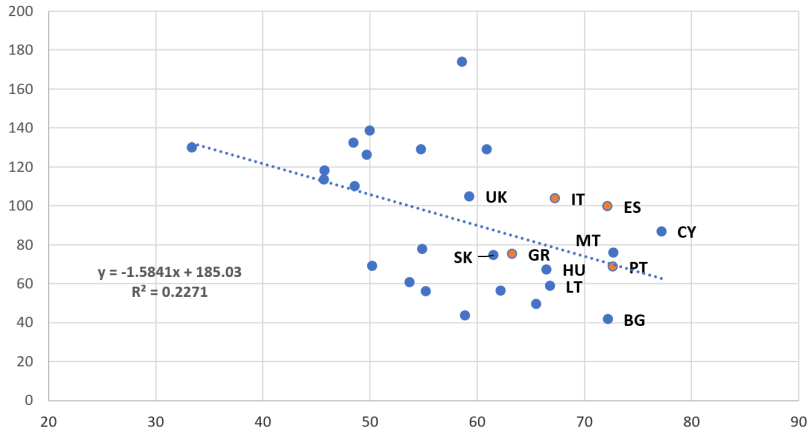
Figure 8: Relation between productivity (y-axis) and rigid entry/exit schedule (x-axis), 2015

4.3 Labour Productivity and Flexible Organizational Models

Figure 7 (2010) and Figure 8 (2015) show the relation between the aggregate levels of productivity per worked hour for each country, and the percentage of workers with a rigid entry/exit schedule. In both years, Mediterranean countries show a clear rigidity of entry and exit times at work when compared with the rest of Europe exhibiting values higher than 60% with even higher percentages for Portugal and Spain (more than 72% of their total workforces in 2010).

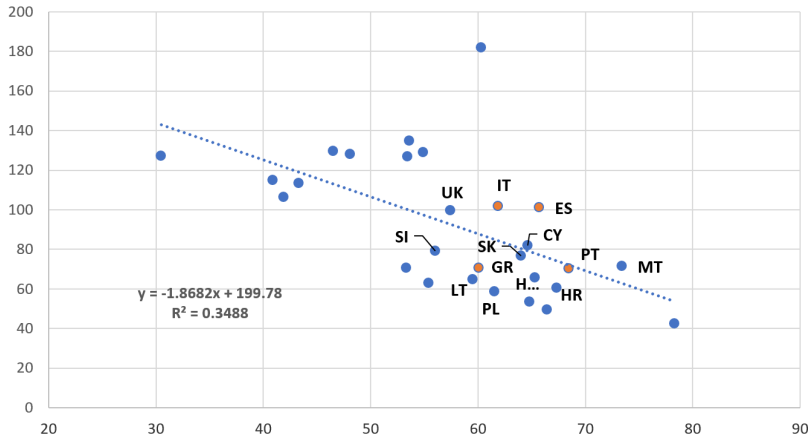
We observe a moderate correlation between labour productivity and the percentage of workers with a rigid entry/exit schedule. The relation between the two variables is exemplified by a negative linear slope. A coefficient of determination of 0.20 is estimated for 2010 (Figure 7) and 0.29 for 2015 (Figure 8). This means that those countries with high percentages of workers on a rigid entry-exit schedule exhibit lower levels of labour productivity. Specifically, we observe that all countries with productivity levels higher than the European average (100) exhibit a more flexible organizational model in terms of entry/exit times at work: their percentages are lower than 60%, excluding France in 2010, and Luxembourg and Germany in 2015.

Figure 9 (2010) and Figure 10 (2015) show the relation between the aggregate levels



Source: EWCS

Figure 9: Relation between productivity (y-axis) and rigid workday schedule (x-axis), 2010



Source: EWCS

Figure 10: Relation between productivity (y-axis) and rigid workday schedule (x-axis), 2015

of productivity per worked hour for each country, and the percentage of workers with a rigid workday schedule. It is clear that Mediterranean countries exhibit a higher level of workers with rigid workday schedules: more than 60% in all cases and more than two thirds of the total workforce of Spain and Portugal.

We observe a moderate correlation between labour productivity and the percentage of workers with a rigid workday schedule. The relation between the two variables is exemplified by a negative linear slope. A coefficient of determination of 0.23 is estimated for 2010 (Figure 9) and 0.35 for 2015 (Figure 10). This means that countries with rigid workday schedules exhibit lower levels of labour productivity. This is the case with Mediterranean countries, exhibiting values higher than 60% both in 2010 and 2015. By contrast, we observe that all those countries with levels of productivity higher than the European average (100) exhibit more flexible organizational models in terms of daily distribution of working hours: their values are all lower than 60% in all cases.

Furthermore, our findings show that the most productive European countries exhibit organizational traits oriented toward shorter workdays and stronger flexibility of schedules. By contrast, Mediterranean countries (Italy, Spain, Portugal, Greece) have longer workdays (less in the case of Italy) and a more rigid organizational model of work time management. The divide between the Mediterranean area and the other three 'leading' varieties of capitalism is clear.

5 Conclusions

We affirm the existence of relevant differences in terms of labour productivity levels between European countries according to geographical areas and national models of work time management. Following the classification schemes proposed by UNO and the varieties of capitalism literature (Hall, Soskice 2001, Amable 2003), we identified the existence of relevant differences in Europe between Western-Central countries (corporatist model), North-Western (liberal), Northern (social democratic), and the South (mixed-Mediterranean). The level of productivity per worked hour is higher in the first three blocs or more specifically, in the European productive heart. In contrast, Mediterranean countries exhibit intermediate (Spain, Italy) or lower (Greece, Portugal) levels of productivity per worked hour.

Furthermore, we observed that those countries with higher levels of productivity also exhibit lower levels of average real worked hours with the Mediterranean countries clearly positioned above the EU average (partial exception: Italy). While Mediterranean workers spend more time at work, their productivity levels are lower. This suggests the existence of a different work performance during the workday that is probably due to its longer extension and the influence of private-family issues on labour dynamics. Phenomena that are likely to have evolved from historical, cultural, and institutional issues such as the high diffusion of split-by-half workdays and the tradition of moonlighting. The resulting organizational disorder that creates 'eternal' workdays (Simmel 1998, Paugam 2007) is likely to create the impression that Mediterranean countries enter into a cycle of 'overloading' to compensate for the waste of less productive work time when confronted with the pressures of global competition and economic recession. A phenomenon that places a very high responsibility on families (and, especially, on adult women) in terms of social welfare as outlined in the Mediterranean organizational model of family care (Pfirsch 2013). In this sense, the forms of governance of the Mediterranean countries, with manifestations close to "neopatrimonialism", have reduced the potential for development of the Welfare State and, therefore, for properly developing their organization of work (Bechle 2010).

The economic performance of the most productive European countries depends on a set of cultural, organizational, and technological factors that foster labour productivity. Among these factors is the development of a flexible organizational model for work time management based on flexible entry/exit times at work and a flexible number of working hours per day. In contrast, the Mediterranean countries have evolved differently by adopting a rigid organizational model for both entry/exit times at work and the number of working hours per day, with negative consequences for productivity.

We conclude this study with a call for positive change. Looking at the recent decline of the European economy, we observe that the recent efforts of EU policies (and its powerful array of public aids) to reduce north-south imbalances have not achieved the expected results (González Rodríguez et al. 2000, De la Fuente 2005). This comparative (even if superficial) analysis of the Southern European economies contributes to a deeper appreciation of some significant factors underlying the recent episode of 'European decadence' within the global system of politico-economic relations. When evaluating future policy initiatives to rebalance the Mediterranean economies, we recommend that consideration should not only be given to the impact on productivity, but also be given to the roles to be played by national institutions in shaping the organizational models for managing work time and other labour issues. Among the various options open to national institutions, we highlight work time flexibility as an organizational strategy and value. As structural and cultural barriers such as the weight of bureaucracy and traditions are overtaken, fostering such flexibility can contribute to an increase in labour productivity in Southern European countries. Furthermore, there are worthwhile incentives to foster an institutional and organizational change in labour practices to adopt flexible work time management strategies including increased workers' satisfaction, greater work-family conciliation and reduced costs due to less work overloading.

References

Amable B (2003) *The diversity of modern capitalism*. Oxford University Press, Oxford, UK. CrossRef.

Amable B (2009) Structural reforms in Europe and the (in)coherence of institutions. *Oxford Review of Economic Policy* 25[1]: 17–39. CrossRef.

Baldwin JR, Brown WM, Maynard JP (2005) Interprovincial differences in GDP per capita, labour productivity and work intensity: 1990-2003. No. 2005011e, Statistics Canada, Economic Analysis

Banfield E (1958) *The moral basics of a backward society*. The Free Press, Glencoe, IL

Basque Governement (2010) Estudio sobre las implicaciones y posibles consecuencias de un cambio horario laboral en el tejido empresarial de la CAPV, de cara a conseguir una mayor conciliación de la vida laboral and familiar. Gobierno Vasco, Departamento de Empleo and Asuntos Sociales. Vitoria

Bechle K (2010) Neopatrimonialism in Latin America: Prospects and promises of a neglected concept. Legitimacy and efficiency of political systems (GICA Research Program). Nr 153

Bratton M, Van de Walle N (1997) *Democratic experiences in Africa. Regime transitions in comparative perspective*. Cambridge University Press, Cambridge, UK

Brennetot A, Emsellem K, Guérin-Pace F, Garnier B (2013) Dire l'Europe à travers le monde. *Cybergeo: European Journal of Geography 630*. CrossRef.

Cassano F (1996) *Il pensiero meridiano*. Laterza, Roma-Bari

Castells M (1997) *La era de la información*. Alianza, Madrid

Crouch C (1998) Esiste una società europea? *Stato e mercato* 2: 167–202

De Jong HW (1995) European capitalism: Between freedom and social justice. *Review of Industrial Organization* 10[4]: 399–419. CrossRef.

De la Fuente A (2005) El impacto de la reducción de las ayudas estructurales europeas: Una primera aproximación. *Presupuesto y gasto público* 39: 173–190

Esping-Andersen G (1999) *Los tres mundos del Estado del bienestar*. Alfons el Magnánim, Valencia

EUROFOUND (2016) European working conditions survey. Acceded in 6th of July 2016, on the web site of: EUROFOUND: http://www.eurofound.europa.eu

Feld L, Otero M, Weigert B (2015) Putting Germany's 'minijobs' in their context. El País (15/10/2015). Available at https://elpais.com/elpais/2015/10/15/inenglish/-1444918067_940829.html

González Rodríguez M, Martín Poveda E, Martínez García S, Santamaría Fidalgo J (2000) La desigualdad Norte-Sur en la Unión Europea. Universidad Complutense de Madrid: VII Jornadas de Economía Crítica

Guillén M (1994) *Models of management: work, authority, and organization in a comparative perspective*. University of Chicago Press, Chicago, IL

Halbwachs M (2002) Les causes de suicide. Coll. Le Lien Social. Paris, originally published 1930. CrossRef.

Hall PA, Soskice D (2001) *Varieties of capitalism: The institutional foundations of comparative advantage*. Oxford University Press, Oxford, UK. CrossRef.

Hall RE, Jones CI (1996) The productivity of nations. No. w5812, National Bureau of Economic Research. CrossRef.

Hill J, Grzywacz S, Allen V, Blanchard V, Matz-Costa C, Shulkin S, Pitt-Catsouphes M (2008) Defining and conceptualizating work place flexibility. *Community Work and Family* 11: 149–163. CrossRef.

Inglehart R (1997) *Modernization and Postmodernization*. Princeton University Press, Princeton, NJ. CrossRef.

Jijena-Michel D, Jijena-Michel C (2015) El rol moderador de la flexibilidad del horario de trabajo en la relación del enriquecimiento trabajo familia y la satisfacción docente. *Horizontes Empresariales* 10[2]: 41–56

Lambert S (2000) Added benefits the link between work-life benefits and organizational citizenship behaviour. *Academy of Management Journal* 43: 801–815. CrossRef.

Lamo de Espinosa E (2010) *Europa después de Europa*. Academia Europa de las Ciencias and las Artes, Madrid

Leonardi L, Martín A, Molina O, Calenda D, Carrasquer P (2011) ¿Es exportable la flexiseguridad? Un estudio comparado de Italia y España. *Cuadernos de Relaciones Laborales* 29[2]: 417–443. CrossRef.

Lewis S (2003) Flexible working arrangements: Implementations, outcomes and management. In: Cooper C, Roberts I (eds), *Annual Review of Industrial Psychology*, Volume 18. Wiley-Blackwell, New York, NY, 1–28. CrossRef.

López-Pintor R, Wert J (1982) La otra España: Insolidaridad e intolerancia en la tradición político-cultural española. *Revista Española de Investigaciones Sociológicas* 19: 292–307

Lusa A, et al (2007) Gestión de los horarios de trabajo en presencia de cláusulas de flexibilidad pasiva. *Universia Business Review* 14[2]: 10–25

Maya M (2016) *El ocaso del chavismo. Venezuela (2005-2015)*. Alfa, Montevideo, Uruguay

Maynard JP (2007) The comparative level of GDP per capita in Canada and the United States: A decomposition into labour productivity and work intensity differences. The Canadian Productivity Review, 15-206

Meardi G (2012) Mediterranean capitalism'under EU pressure: Labour market reforms in Spain and Italy, 2010-2012. *Warsaw Forum of Economic Sociology* 3[1]: 51–81

MGI – McKinsey Global Institute (2010) Más allá de la austeridad: Un camino hacia el crecimiento económico y la renovación en Europa. McKinsey Global Institute. London, UK. Available at http://www.mckinsey.com/insights/mgi/research/productivity_competitiveness

Migdal J (1998) *Strong societies and weak states: State-society relations and state capabilities in the Third World*. Princeton University Press, Princeton NJ

Miguélez F, Prieto C (2009) Transformaciones del empleo, flexibilidad y relaciones laborales en Europa. *Política and Sociedad* 46[2]: 275–287

Moerland PW (1995) Corporate ownership and control structures: An international comparison. *Review of industrial organization* 110[4]: 443–464. CrossRef.

Paugam S (2007) *Las formas elementales de la pobreza*. Alianza, Madrid

Perrons D (2005) Gender mainstreaming and gender equality in the new economy. An analysis of contradiction. *International Journal of Politics* 7[4]: 389–411

Pfirsch T (2013) Une géographie de la famille en Europe du Sud. *Cybergeo: European Journal of Geography. 533*. CrossRef.

Pizzorno A (1966) Amoral familism and historical marginality. *International Review of Community Development* 15: 55–66

Regini M (1995) La varietà italiana di capitalismo. Istituzioni sociali e struttura produttiva negli anni Ottanta. *Stato e mercato* 43[2]: 3–21

Segura J (2006) *La productividad en la economía española.* Fundación Ramón Areces, Madrid

Simmel G (1998) Les pauvres. Coll. Cuadrige, Paris. Originally published 1907

Van de Walle N (2005) Economic reform. Patterns of constraints. In: Gyimah-Boahdi E (ed), *Democratic reform in Africa. The quality of progress.* Lynne Rienner, Boulder, CO

Villena A (2017) *¿Cómo se gobierna España? La estructura de las élites gubernamentales en 2004 y 2016.* Comares, Granada, Spain

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Urbanization in Ecuador: An overview using the Functional Urban Area definition

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Abstract. This paper presents an overview of the urbanization in Ecuador during the period 1950-2010. First, it is shown that Ecuador does not follow a suitable definition of urban areas, then the idea of Functional Urban Areas (FUAs) definition is introduced. In this line, 28 FUAs in Ecuador are analyzed. When Ecuadorian FUAs population evolution over time is explored, it is possible to observe that the urbanization of Ecuador had its peak between 1960 and 1980. Moreover, the highest increase of population in recent decades is mostly driven by the urban growth of small FUAs. In addition, the analysis suggests that the FUAs in Ecuador are in line with the size and structure of the FUAs of a similar developing country, Colombia, and the whole OECD sample of FUAs. Finally, it is pointed that the population of Ecuador is concentrated in the FUAs of metropolitan size (1.5 million of inhabitants or more), which are below the average of the metropolitan areas of the OECD.

JEL classification: R12, R23

Key words: Developing economies, Ecuador, FUAs, OECD, Urbanization

1 Introduction

Cities are the engines of a country's economic activity. The global urbanization trend over the last decade shows, without doubt, that the world is more urban than rural (Pesaresi et al. 2016). However, how to define "urban" has been an important concern to different international organizations and researchers. In fact, one of the most ambitious goals of the Organization for Economic Co-operation and Development (OECD) and European Commission is to identify and standardize the international comparability of urban areas around the world on the denomination of Functional Urban Areas (FUAs) (OECD 2013, Brezzi et al. 2012).

The FUAs have opened the international comparison of the urbanization to more than 30 OECD and non-OECD countries, and therefore, they allow analysis of the urban spatial structure and its trend across countries under a standardized definition of urban areas (Veneri 2017). The importance of building the FUAs relies on having a new point of view of the urbanization, which becomes important for developing economies because differences in the urbanization between developed and developing economies is remarkable. The urbanization in developing countries is characterized by extreme poverty and low

quality institutions (Glaeser, Henderson 2017). Thus, the FUAs have allowed international organizations and governments to consider public policies for better urban planning.

As for the FUAs construction, the FUAs require population and commuting data. However, the lack of necessary data, especially in developing countries, has become a barrier in their identification process. In those cases, several approaches have been used to identify them where there is not standard data available. For example, the OECD applies an alternative method to identify the FUAs in China (OECD 2015). Although, the Chinese FUAs identification does not have the standard methodological approach, they allowed understanding of the urbanization system and economic performance of the Chinese functional urban areas. The result shows that the Chinese FUAs are growing more concentrated with 15 urban areas having more than 10 million inhabitants.

Recently, Obaco et al. (2017) also proposed an alternative approach to identify FUAs. This methodology is applied in Ecuador. However, FUAs identified in Ecuador have not been compared with the international FUAs in the OECD database, differing from was has been done for the majority of other cases. The underlying reason is the fact that Ecuador is not member of the OECD. Thus, this paper contributes analysis of the evolution of urbanization in Ecuador under the FUAs definition and compares the FUAs in Ecuador with the international context of the OECD. Additionally, the contribution of this work to the literature of the FUAs is twofold. First, the comparison of the FUAs of Ecuador in the international context will show whether the Ecuadorian FUAs, based on a different methodological approach, have a similar urban structure of the FUAs of the OECD based on its standard approach. Indeed, comparing FUAs allows further analysis when anomalies in the patterns of countries with similar characteristics are found. Second, this paper will also check the evolution of Ecuadorian urbanization applying a different concept of urbanization.

Results suggest that FUAs in Ecuador are in line with the size and structure of the FUAs of a similar developing country such as Colombia, and the whole OECD sample of FUAs. We also show that the share of the population concentrated in the FUAs of metropolitan size (1.5 million or more) in Ecuador is below the average of urbanization of the OECD sample. When the evolution of the FUAs population is explored, we can observe that the urbanization of Ecuador experienced the highest increase of population between 1960 and 1980. Moreover, another interesting finding is that the highest increase in the population during recent decades is mostly driven by the urban growth of small FUAs.

The rest of this work is structured as follows. Section 2 presents the related literature. Section 3 provides introduction to the urbanization in Ecuador, while section 4 introduces the FUA identification in Ecuador. Section 5 presents the data, while Ecuadorian urbanization through the FUAs definition is presented in section 6. Section 7 shows the Ecuadorian FUAs in the international context. Finally, section 8 presents the conclusions of the paper.

2 Related literature

Several approaches have been used to define urban areas. The delimitation of an urban area can be driven by a morphology, demography, or socio-economic point of view (Ferreira et al. 2010). In particular, this work focuses on the economic definition of cities which implies a functional delimitation of urban areas from a socio-economic perspective. In that sense, a city is a dense area that can be considered an independent market in which supply and demand for goods and production factors are traded and an equilibrium price exists.

Commuting flows between cities is, by far, the most popular way to identify a functional city known as Local Labor Market (LLM), which was developed in the US at the beginning of the 90s. Commuting flows are also used for the identification of Metropolitan Areas (Duranton 2015, Puderer 2008, Adams et al. 1999). The use of commuting flows has been widely used in this literature. That is the case of Fox, Kumar (1965) who proposed a method to create local areas based on commuting data, merging spatial areas hierarchically according to workers' daily travels. Similarly, Coombes et al.

(1986), among others, systematized this procedure by developing algorithms that are widely used in many countries and regions in which the idea is to have a minimum of self-containment of commuting flow within the LLMs (Casado-Díaz, Coombes 2011).

However, the international comparability and the collection of statistical data are general problems as most countries use different conceptions to define their metropolitan areas. One of the most ambitious efforts of the Organization for Economic Cooperation and Development (OECD), jointly with the European Commission, is the identification and standardization of the economic urban areas labelled as Functional Urban Areas (FUAs). This methodology identifies 1,251 FUAs of different sizes in more than 31 countries, which produced the OECD metropolitan dataset, which considers close to 300 cities with populations of 500,000 inhabitants or more. Currently, many researchers prefer the use of FUAs to perform economic analyses (OECD 2013, 2016, Schmidheiny, Suedekum 2015, Veneri 2016, 2017) instead of simply geographical delimitations.[1] For example, Veneri (2016) finds a better fitting model for the zip's law using FUAs rather than the administrative boundaries given by the countries, and Veneri (2017) analyzes the urban spatial structure of the FUAs across the world and find that there is an increasing trend in the decentralization of the urban areas. Moreover, Ahrend et al. (2017) and Matano et al. (2018) analyze agglomeration effects on labor productivity using FUAs as units of analysis.

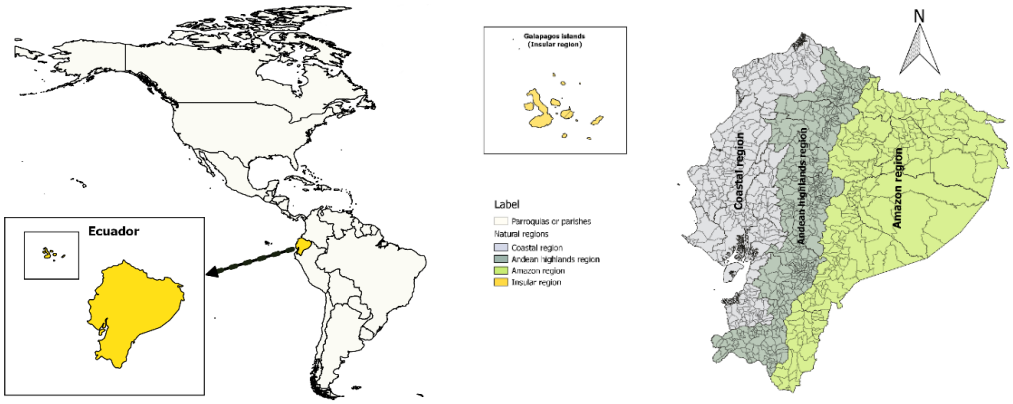
In detail, FUAs involve three identification steps (OECD 2013). First, it explores the population density of the country, looking for grid cells of high population density (grid cells with a minimum of 1,000 or 1,500 inhabitants – set by the researcher – per km2). Next, it identifies clusters of grid cells of high population density. Those clusters should contain a minimum of 50,000 or 100,000 inhabitants to be considered an urban core, depending on the country. These urban cores allow the identification of the municipality of reference (head of the FUAs). However, a minimum of 50% of the population must be contained in the urban core. In the second step, those urban centers are connected as part of one FUA if two urban cores share at least a minimum commuting flow (15%).[2] In a third step, the hinterland is identified, which includes all the surrounded areas that are not urban areas but connected to the urban cores through a minimum commuting flow as well. The minimum is the same that has been applied in the second step.

The OECD concept of FUAs has also been extended to those countries that are not OECD members because generally they do not account for their own economic definition of urban areas. In this case, the FUAs allow to compare, to evaluate, and to elaborate recommendations of public policies and urbanization around the world. However, the lack of adequate data to elaborate the FUAs is a main barrier in these countries. For example, in China (OECD 2015), the very same OECD modifies the FUAs methodology to take advantage of the available information or characteristics of the country. In this case, a different minimum threshold to identify urban cores is applied (550 inhabitants per km2) as this country is not densely populated across the territory. To connect urban cores and determine the hinterland, it is applied a decay function of the expected commuting zone.

Similarly, Obaco et al. (2017) present a different methodology to identify FUAs where there is not commuting data. The approach is based on a varying travel time to connect urban cores and determine the hinterland of each FUA. The final coverage of the travel time will depend on the geographical extension of the urban cores because it is shown that larger urban cores have on average more influence zones. However, this model needs a calibration of the parameters to apply the varying travel time model. The model is based on the estimated parameters from Colombia (For more detail, see Obaco et al. 2017). Then, the model is applied in Ecuador. Following this work, and the simplicity of the model to identify FUAs, the OECD has used the same travel time approach to identify FUAs in other developing countries such as Morocco and Viet Nam (OECD 2018). However, the FUAs identified in Ecuador have not been explored and have not been compared with the international OECD database. In this work, we cover this gap.

[1] For more information and list of countries, see http://www.oecd.org/cfe/regional-policy/functional-urbanareasbycountry.htm

[2] Polycentric FUAs is where there are two or more urban cores within the FUA. In many European countries the minimum commuting flows applied might reach up to 50% (OECD 2012).



Source: INEC-Ecuador, Administrative boundaries based on the year 2010
Notes: Elaboration by the authors

Figure 1: Ecuador

3 Urban definition in Ecuador

Ecuador is a small developing open economy. It lies on northwest coast of South America. It limits with Colombia at the north, Peru at the east and south, and the Pacific Ocean at the west (see panel A of Figure 1). Ecuador has an area of 283,561 km2 and it is formed by four natural regions: The Coast, the Highlands, the Amazon and the Galapagos Islands. Administrative division of Ecuador is based on three levels. From higher to lower: provinces (25), cantons (224), and parishes (1,024), (see panel B of Figure 1)[3]. Provinces are the most aggregated administrative division; meanwhile parishes are the closest to the conceptualization of municipality. Ecuadorian authorities consider urban areas as inhabitants living in the head of each canton, otherwise they are rural areas. Thus, this characterization of urban does not consider peripheral population beyond the head of the cantons.

In terms of population, Ecuador has about 17 million inhabitants in 2018. In terms of ethnicity composition, Ecuador has a variety of self-identification ethnic groups such as mestizo (majoritarian), indigenous, white, black, and others. As for the urbanization, it is considered that Ecuador has faced a rapid urbanization process since 1960 (Villacis, Carrillo 2012). The current urbanization rate is about 65%, being lower than the average of Latin America around 70%. However, Ecuadorian urbanization process is characterized by extreme poverty. It is estimated that around 35% of the urban population in Ecuador lived in slums in 2014 (UN 2015).

Considering the Ecuadorian authority definition of urban as a starting point, most of the population is concentrated in two urban parishes: Guayaquil, which is in the Coast, and Quito, which is in the Highlands. According to the 2010 census, these two cities have 27% of the total population, and the 35% of the total urban population; thus, these two urban areas could be considered as metropolitan cities, however only Quito has this category[4].

4 FUAs identification in Ecuador

As it was mentioned, the urban identification in Ecuador does not follow international standards of urban areas. Thus, we cannot determine the total number of cities existing in Ecuador. We focus only in the FUAs identification to explore urbanization in Ecuador.

We use the FUAs identification made by Obaco et al. (2017)[5]. These authors used

[3]Numbers of administrative divisions according to the 2010 census of population and dwelling.
[4]According to the 2010 census, the four most populated cities are Guayaquil has 2,291,158 inhabitants, Quito has 1,619,146, Cuenca has 331,888 and Santo Domingo has 305,632 inhabitants.
[5]For further detail, see Obaco et al. (2017).

satellite imagery of LandScan data to identify population density and travel time using the road network system of Google maps and Open Street Maps to cover the connection between urban cores and the hinterlands. Data used for the identification is between 2010 and 2014. The novelty of this approach is provided by allowing varying of the travel time according to the parameters of expansion that are calculated on the geographical extension of the urban cores. The parameters for the travel time model are based on the commuting flows of Colombia. Then, it is applied in Ecuador. The preferred identification of FUAs is determined by which allows to verification of more urban cores across the country. As Ecuador is not a densely populated country, authors analyze the 28 FUAs that were identified under a minimum threshold of 500 inhabitants or more per squared kilometer and 25,000 inhabitants in order to be considered as an urban core. The 28 FUAs allow to have representative urban cores in the Amazon (not highly populated region). They are composed by 34 urban cores in Ecuador, allowing for some polycentricity structure. If the thresholds were increased to the minimum applied by the OECD (1,000 inhab. and 50,000 inhab. to be an urban core), 20 urban cores could be identified with a total of 20 FUAs. Thus, we present the main analysis using the 28 FUAs. Moreover, results do not change when the 20 FUAs are analyzed as they are mostly small sized. Thus, the model was validated on sensibility test and robustness checks.

Figure 2 shows the 28 identified FUAs in Ecuador. The Ecuadorian FUAs system is majorly dominated by small FUAs. The two FUAs of metropolitan size are Guayaquil and Quito. There are 11 FUAs in the Coastal region, 13 in the Highlands, and 4 in the Amazon. Thus, we have a sample that covers urbanization even in the less populated zones of Ecuador. In Galapagos, the population density is much lower than in the Amazon, thus the Galapagos Islands are not included in the final list of FUAs. The Ecuadorian FUAs show the heterogeneous composition in terms of administrative boundaries because they are very small in the Highland, and large in Coastal and Amazon regions. However, the administrative boundaries are relatively large compared with the urban core extension in most of the cases. The FUAs cover around 7% of the total country extension and the two metropolitan areas around 3% of the total country's extension.

5 Data

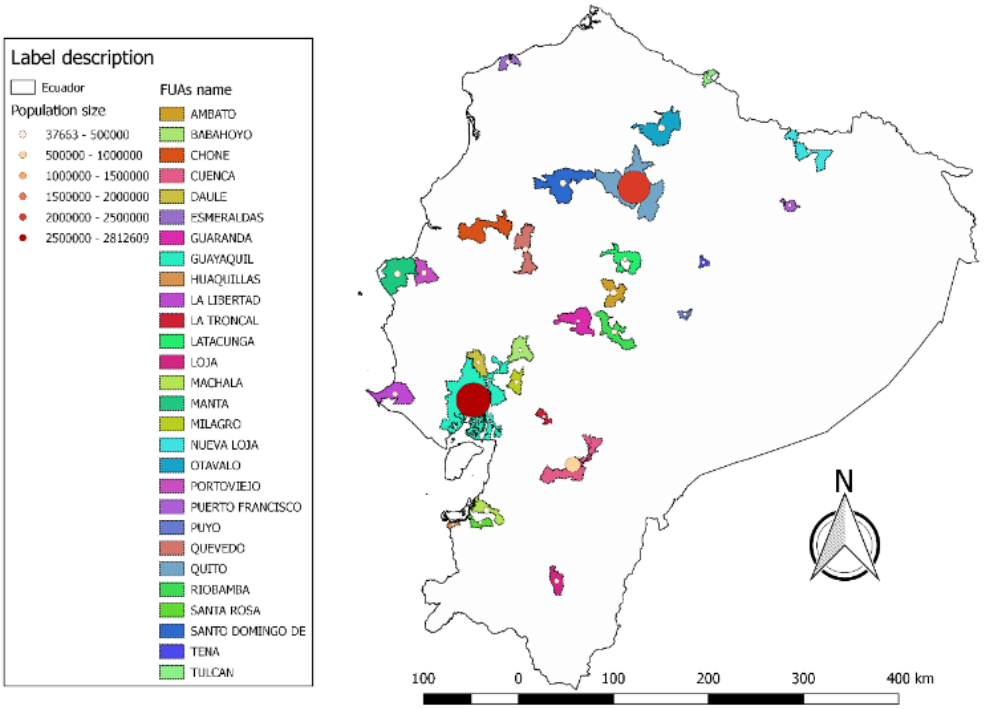
We use information from the Ecuadorian censuses in order to explore the urbanization process over time. The first census was in 1950. The historical population comes from the National Institute of Statistical and Census (INEC)[6]. To compare the FUAs of Ecuador with the international OECD dataset, we divide the OECD's FUA in four groups: OECD, Europe, Colombia and Ecuador.

6 Urbanization in Ecuador

Figure 3 shows the total FUAs population according to their respective Ecuadorian censuses. The number of people living in FUAs has rapidly increased between 1950 and 2010. In 1950, the total FUAs population was around 40% of the total population, being mostly settled in the rural area. In 1972, the population living in FUAs reached around 50% of the total; and, in 1990, the population living in FUAs reached 60%. For 2010, the total population living in FUAs is around 63%. Thus, the highest increase in the urban population is presented from 1962 to 1982, around 0.77% per year.

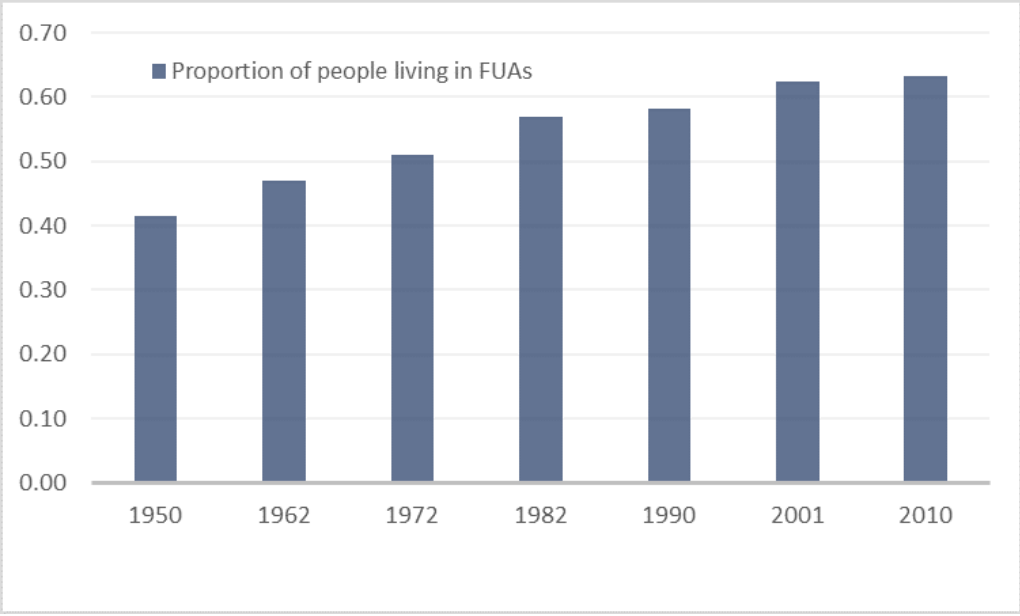
Table 1 shows the average of the FUAs size distribution of the 28 FUAs according to the information gathered in the censuses. In 1950, the FUAs size distribution was below 0.5 million, composed of 26 FUAs below 0.2 million and 2 FUAs between 0.2 and 0.5 million. In 1990, the first FUAs of large metropolitan size appear, with one FUA between 0.5 and 1.5 million, 3 FUAs between 0.2 and 0.5 million, and 23 FUAs below 0.2 million. In 2010, the distribution was: 2 FUAs larger than 1.5 million, no FUAs between 0.5 and

[6]The data from Ecuador is available at http://www.ecuadorencifras.gob.ec/banco-de-informacion/. Moreover, we assume that the geographical extension of the FUAs identified through the period 2014-2010 are the same and fixed over time, because there is not information of the historical boundaries of the parishes over the time. The OECD database is available at http://www.oecd.org/cfe/regional-policy/-functionalurbanareasbycountry.htm.



Source: INEC-Ecuador, and Obaco et al. (2017). Administrative boundaries and population based on the year 2010-2014
Notes: Elaboration by the authors

Figure 2: FUAs in Ecuador



Source: INEC, Ecuador
Notes: Elaboration by the authors

Figure 3: Population living in the FUAs

Table 1: FUAs size distribution in Ecuador (Average size)

FUAs	1950	1962	1974	1982
FUAs greater than 1.5 M				
FUAs between 0.5 and 1.5 M		544,506	812,374	1,173,644
FUAs between 0.2 and 0.5 M	292,986	458,255		253,454
FUAs less than 0.2 M	28,577	42,476	65,218	79,505
no FUAs	1,873,765	2,368,872	3,201,281	3,472,337
Total Population	3,202,757	4,476,007	6,521,710	8,060,712

FUAs	1990	2001	2010
FUAs greater than 1.5 M	1,611,884	2,028,966	2,436,027
FUAs between 0.5 and 1.5 M	1,376,630		
FUAs between 0.2 and 0.5 M	245,632	284,534	291,813
FUAs less than 0.2 M	80,529	91,241	86,048
no FUAs	4,070,608	4,566,649	5,316,535
Total Population	9,648,189	12,156,608	14,483,499

Source: INEC, Ecuador
Notes: Elaboration by the authors

1.5 million, 10 FUAs between 0.2 and 0.5 million, and the remaining (16 FUAs) were below 0.2 million.

Figure 4 presents the average of the urban primacy of the FUAs in Ecuador for the period 1950-2010. We can observe the primacy of the two largest FUAs, Guayaquil and Quito during the whole period of time. However, in the most recent decades, the urban population has been mainly driven by the small FUAs, while the largest cities have grown slowly. For example, from 1962-1982, the largest urban population change was experienced in the Amazon and Coastal cities.

7 The international context

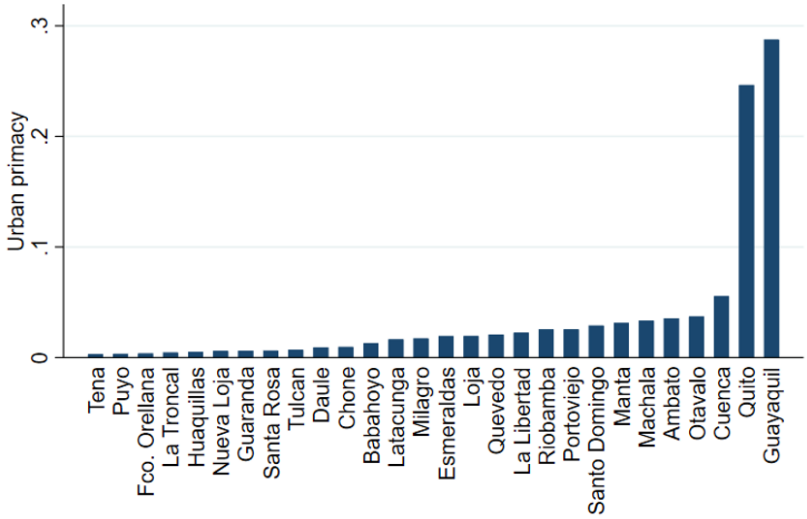
Figure 5 shows the composition of the Ecuadorian FUAs system and a comparison to OECD countries, Europe, and Colombia in the year 2014. The comparison to Colombia is relatively important because Ecuador and Colombia share borders[7]. 53 FUAs were identified in Colombia. As we can see, both systems are quite homogeneous. The Ecuadorian urban structure is still growing, and this growth is based on the small and medium sized FUAs (lower than half million inhabitants). If we compare the FUAs in Ecuador identified with the minimum threshold applied by the OECD, the same structure of these FUAs is based on the small FUA size. Additionally, a weak composition of metropolitan size (between 0.5 and 1.5 million inhabitants) is observed.

Clearly, Ecuadorian FUAs structure follows the international pattern. Europe is the exception since it has a more diverse composition. Furthermore, like Ecuador, Colombia has larger administrative boundaries compared with the real extensions of the urban cores.

Figure 6 shows the share of population contained in the FUAs of metropolitan size with respect to the total population by country. When the FUAs of metropolitan size (Guayaquil and Quito) in Ecuador are compared with 290 FUAs of metropolitan size of 32 countries, the Ecuadorian metropolitan areas are below the global average, and even below their Latin America partners (Colombia, Chile, and Mexico)[8]. The same results are obtained when we compared with the 20 FUAs of different threshold.

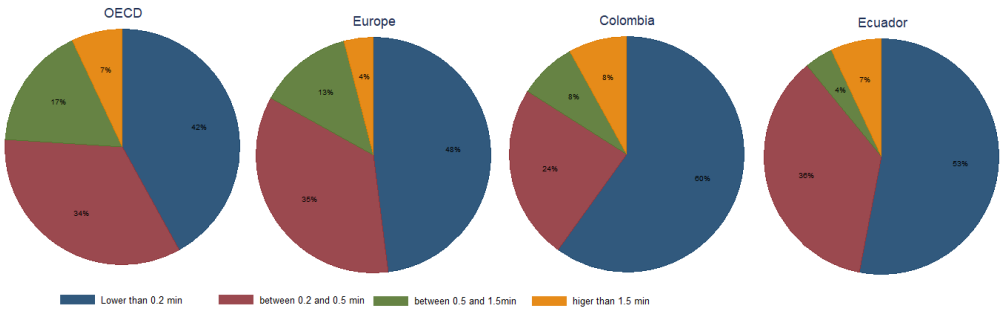
[7] The Latin America sample of FUAs considers Mexico, Chile, and Colombia. We use this year because the FUAs of Ecuador and Colombia have full information for this year. The OECD sample does not present information either for the FUAs of Ecuador and Colombia.

[8] Information of the FUAs was gathered from https://measuringurban.oecd.org/#story=0, the Information of Ecuador was taken from Obaco et al. (2017). Information about Turkey and China are not



Source: INEC, Ecuador
Notes: Elaboration by the authors

Figure 4: Ecuadorian Urban Primacy Structure (average of all censuses)



Source: Information taken from OECD and INEC, Ecuador
Notes: Elaboration by the authors

Figure 5: FUAs size classification in the year 2014

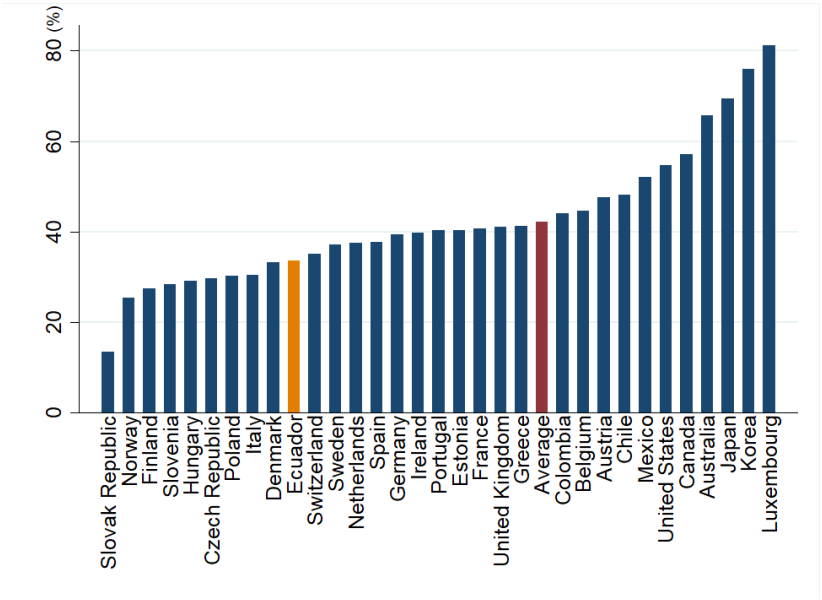
8 Conclusions

This work presents the urbanization process of Ecuador using the concept of Functional Urban Area and also compares with the international context. As for the urbanization in Ecuador, we part for two main considerations. First, the Ecuadorian official definition of urban, which is basically the population living in the head of the canton, does not approach an international conceptualization of urban areas nor FUAs. Second, the lack of commuting data does not allow application of any standard functional delimitation of urban areas in this country. These two important facts are limitations for and adequate planning of urban areas.

Later, we analyze 28 FUAs identified in Ecuador. Most FUAs are small size, one of medium size, and two of large metropolitan sizes in Ecuador. The largest increase of the urban population was during the period of 1962-1982. Additionally, the two largest cities, Guayaquil and Quito, remain larger over time, although the urban growth is mainly driven by the small FUAs in the last decades. This is important because it could show some trend to the decentralization of the urban system.

Next, we compare the data of Ecuador with the international database of the OECD. The FUAs of Ecuador also follow the composition of the urban structure of Colombia

available yet.



Source: Information taken from OECD and INEC, Ecuador
Notes: Elaboration by the authors

Figure 6: Share of metropolitan areas in overall population in the year 2014

and the whole sample of the OECD composed mainly of small FUAs size. Moreover, the largest two Ecuadorian cities are below the average of the metropolitan FUAs of the OECD.

Finally, we highlight the importance of standardizing the concept of urban areas to give a better comparison among countries. In this line, the OECD presents an important advance in the collection of data shown in this work.

References

Adams JS, VanDrasek BJ, Phillips EG (1999) Metropolitan area definition in the United States. *Urban Geography* 20[8]: 695–726. CrossRef.

Ahrend R, Farchy E, Kaplanis I, Lembcke A (2017) What makes cities more productive? Evidence from five OECD countries on the role of urban governance. *Journal of Regional Science* 57[3]: 385–410. CrossRef.

Brezzi M, Piacentini M, Sanchez-Serra D (2012) Measuring metropolitan areas: A comparative approach in OECD countries. In: Fernández Bazquez E, Rubiera Morellón F (eds), *Defining the Spatial Scale in Modern Regional Analysis: New Challenges from Data at Local Level*. Advances in Spatial Science, Springer, 71-89. CrossRef.

Casado-Díaz JM, Coombes M (2011) The delineation of 21st century local labour market areas: A critical review and a research agenda. *Boletín de la Asociación de Geógrafos Españoles* 57: 7–32

Coombes MG, Green AE, Openshaw S (1986) An efficient algorithm to generate official statistical reporting areas: The case of the 1984 travel-to-work areas revision in Britain. *Journal of the Operational Research Society* 37: 943–953. CrossRef.

Duranton G (2015) A proposal to delineate metropolitan areas in Colombia. *Desarrollo y Sociedad* 75: 223–264. CrossRef.

Ferreira JA, Condessa B, Castro e Almeida J, Pinto P (2010) Urban settlements delimitation in low-density areas. An application to the municipality of Tomar (Portugal). *Landscape and Urban Planning* 97[3]. CrossRef.

Fox KA, Kumar TK (1965) The functional economic area: Delineation and implications for economic analysis and policy. *Papers and Proceedings of the Regional Science Association* 15: 57–85. CrossRef.

Glaeser EL, Henderson JV (2017) Urban economics for the developing world: An introduction. *Journal of Urban Economics* 98[1]: 1–5. CrossRef.

Matano A, Obaco M, Royuela V (2018) What drives the spatial wage premium for formal and informal workers? The case of Ecuador. AQR-IREA working paper (6): 35

Obaco M, Royuela V, Vítores X (2017) Computing functional urban areas using a hierarchical travel time approach: An applied case in Ecuador. AQR-IREA working paper (5): 46

OECD – Organization of Economic Cooperation and Development (2012) Redefining urban: A new way to measure metropolitan areas. OECD Publishing, Paris

OECD – Organization of Economic Cooperation and Development (2013) Definition of functional urban areas (FUA) for the OECD metropolitan database. OECD Publishing, Paris

OECD – Organization of Economic Cooperation and Development (2015) OECD urban policy reviews: China. OECD Publishing, Paris

OECD – Organization of Economic Cooperation and Development (2016) Making cities work for all. Data and actions for inclusive growth. OECD Publishing, Paris

OECD – Organization of Economic Cooperation and Development (2018) OECD urban policy reviews: VietNam. OECD Publishing, Paris

Pesaresi M, Melchiorri M, Siragusa A, Kemper T (2016) Atlas of the human planet 2016: Mapping human presence on earth, with the global human settlement layer. European Commission, EUR – Scientific and Technical Research Reports

Puderer H (2008) Defining and measuring metropolitan areas: A comparison between Canada and the United States geography. Geography working paper series defining, 92, 1-12

Schmidheiny K, Suedekum J (2015) The pan-European population distribution across consistently defined functional urban areas. *Economics Letters* 133: 10–13. CrossRef.

UN – United Nations (2015) World urbanization prospects: The 2014 revision. Department of Economic and Social Affairs, Population Division, (ST/ESA/SER.A/366)

Veneri P (2016) City size distribution across the OECD: Does the definition of cities matter? *Computers, Environment and Urban Systems* 59: 86–94. CrossRef.

Veneri P (2017) Urban spatial structure in OECD cities: Is urban population decentralising or clustering? *Papers in Regional Science*. CrossRef.

Villacis B, Carrillo D (2012) Estadística Demográfica en el Ecuador: Diagnóstico y Propuestas. Instituto Nacional de Estadística y Censos (INEC) Quito, Ecuador

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Governance of metropolitan areas for delivery of public services in Latin America: the cases of Bogota, Lima and Mexico City

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Abstract. One of the key issues at metropolitan level is the provision of public services and this paper highlights the importance of understanding the governance of public services in the context of increasing urbanization and decentralization. This paper provides a comparative analysis on metropolitan governance in Latin America by analysing specific case studies. The objective is to identify how the governance setting in metropolitan areas shapes the process and the results of providing public services to wider population. We examine metropolitan governance by employing a 3x3x3 model as a framework for addressing key issues about urban services delivery. Bogota, Lima and Mexico City are the metropolitan areas selected. Secondly, we focus on three sectors: transport, solid waste collection and water. Finally, the analysis focuses in three aspects of governance: coordination, financial sustainability and coverage and quality. The data collection process involved field research in Bogota, Lima and Mexico City.

1 Introduction

The urban transition in Latin America throughout the twentieth century was relatively rapid, and the move to urban living continues at an accelerated pace in several countries in the region. One of the most striking recent features of urbanization in Latin America has been the emergence of metropolitan areas: cities that have surpassed the limits of their immediate outermost periphery, expanding beyond their administrative boundaries. In some cases, urbanization and urban expansion have led to the emergence of megacities that are national centers of economic or political power, such as Sao Paulo and Mexico City. Metropolitan areas face significant economic, social, political and environmental challenges that extend beyond the borders of local governments, including different administrative divisions across the territory. The provision of public services has become one of the most critical and pressing metropolitan concerns. While the theory and praxis of providing services in metropolitan areas have been subjects of great interest in advanced countries, they have been largely downplayed in low- and middle-income countries (Bahl 2013). Furthermore, some normative discussions about metropolitan areas in Latin America have focused on ideal government models, yet there is very little in the existing literature on the problems of providing public services at the metropolitan level. This paper highlights the importance of knowing and understanding how public services are provided in the context

of increasing metropolitanization and decentralization due to the hypothesized negative impact of politico-administrative fragmentation. According to some studies, fragmentation translates into weak governance, creating substantial difficulties in providing services. Despite this predominant assumption, the body of knowledge on the key governance challenges in metropolitan areas, especially in less developed countries, is not robust and lacks empirical work and comparative studies. This study contributes to the literature by implementing a comparative analysis of public service provision in metropolitan areas in Latin America.

Our general research question refers to the characteristics and outcomes of governance for delivering public services in metropolitan areas, and how, in practice, governance schemes accommodate different contexts. More specifically, the paper deals with the following questions: What are the underlying characteristics of metropolitan governance and organization in Latin American countries? How do metropolitan areas organize the provision of public services? What is the performance of services delivery in terms of financial sustainability, coverage and quality? How do governance and outcomes vary across different services and metropolitan areas?

We employed a 3x3x3 model of comparative analysis with three metropolitan areas (Bogota, Lima, and Mexico City), three services (public transport, solid waste collection, and piped water), and three aspects of governance (coverage and quality, financial sustainability, and coordination). Analyzing the provision of public services in different metropolitan areas in the Latin American region, we discuss how variation in metropolitan organization translates into specific outcomes across the selected cases. A variety of governance structures are identified, a few of which attempt to reverse some of the negative effects of jurisdictional fragmentation. The collected data includes secondary sources (statistics, reports, and documents), and field research in Bogota, Lima, and Mexico City, where a number of focus groups, interviews and technical visits took place. The paper includes a synthetic literature review, a description of the methodological design, an overview of the metropolitan organization and structures in the three selected areas, the research results and discussion. We conclude with a number of final remarks that can be useful for metropolitan level public policies.

2 Metropolitan Governance and Provision of Local Public Services

Metropolitan areas are huge and complex urban areas whose functional scope extends beyond their jurisdictional boundaries. There is commonly political-administrative fragmentation, and policy implementation resides with individual autonomous local authorities. This is a challenge for urban planning, management and policy design. Because of their scale, complexity and fixed government structures, metropolitan areas conduct their planning and policy tasks in difficult environments. Metropolitan areas must provide services and infrastructure in sophisticated ways because the structure of land use is more diverse, the magnitude and complexity of expenditure is much greater, and the size and concentration of the population is larger than in other urban areas (Slack 2007). One of the key areas of public action at the metropolitan level is the provision of services. As metropolitan areas extend to multiple local jurisdictions, there is an increasing need to expand service provision to fulfill the population's social needs. Inadequate provision of basic services translates into significant gaps between demand for and supply of urban services. Large intra-urban disparities can develop. Given the intricacy of metropolitan areas, governance plays an important role in the effective delivery of services. Governance defines the quantity and quality of services provided, their efficiency, and their equitable cost sharing (Jones et al. 2014, Slack 2007, Bird, Slack 2007).

The long-standing debate on how to govern and manage metropolitan areas, whether via decentralized or consolidated structures, has been framed mostly in the theoretical discussion around government decentralization and its consequences for efficiency and equity (Bird, Slack 2007, p. 730). According to the subsidiarity principle, subnational levels of government achieve greater welfare gains by adjusting the provision of public goods and services to citizens' preferences and local costs (Oates 1997). Decentralization favors accountability, and horizontal competition triggers a better supply of public

goods (Tiebout 1956). On the other hand, consolidation facilitates the exploitation of economies of scale, the management of externalities, and the quest for equity (Treisman 2000). Consolidation can also contribute to minimizing the dangers of elite capture and corruption, especially in developing countries (Prud'homme 1995).

Echoing the principles above, the Public Choice School argues that decentralized metropolitan governments spur effective and efficient service delivery by promoting competition (Yaro, Ronderos 2011), whereas Regionalism and New Consolidationist supporters argue in favor of metropolitan governments (Lowery 2000). In practice a variety of metropolitan structures have been implemented, based either on the fragmented version or on different forms of government consolidation. Slack (2007) and Bird, Slack (2007), for instance, identify the one-tier fragmented model, the single-tier consolidated model, the two-tier model, and the one-tier model with voluntary cooperation.

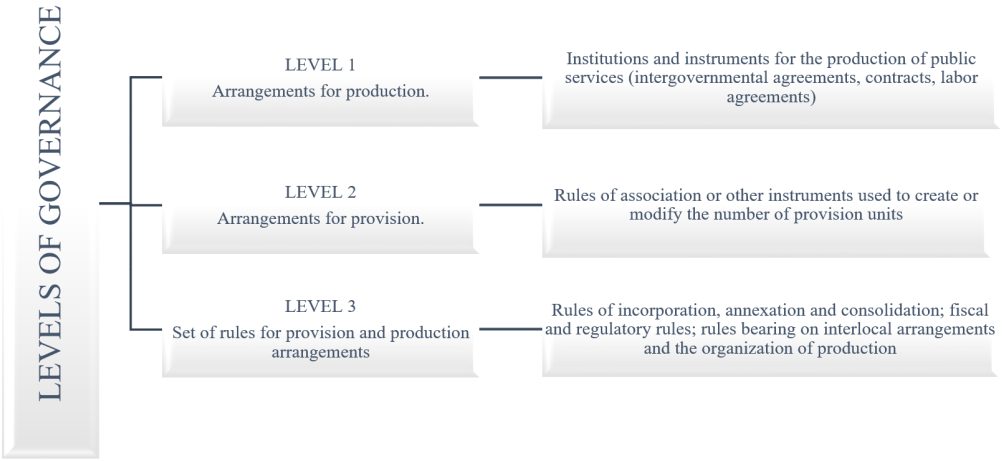
According to Storper (2014), fragmentation is an inevitable condition in metropolitan areas, and the regulation of the resulting interdependent relations in the absence of an overarching political authority is highly problematic. The enduring gaps between functional and administrative boundaries mean that there will always be governance problems at hand, and neither complete consolidation nor fragmentation is likely to resolve these fundamental metropolitan issues. Rather than a single government, metropolitan areas require structures of governance that are sufficiently open to allow for diverse solutions in an environment characterized by variable conditions (Parks, Oakerson 1989). Following Parks, Oakerson (1989), jurisdictionally fragmented metropolitan areas are complexly organized. However, organizational diversity and complexity do not necessarily imply institutional failure and can in fact lead to higher efficiency. By means of agreements and associations, local governments, civil society, and the private sector acting together in a coordinated manner can achieve acceptable governance structures (Feiock 2004). Therefore, there is no single correct way to organize metropolitan areas, and no single geography or organization of governance, and arrangements for service provision are place- and time-specific (Bahl 2013, Slack 2007, Parks, Oakerson 1993, 1989). In the particular case of public services, efficient scales and preferences can be multiple and heterogeneous, and evolve over time (Slack 2007, Parks, Oakerson 1989). Public services also have diverse production functions and financial and cost structures (Parks, Oakerson 1989).

The fundamental distinction between the provision and the production of public services makes the case for organizational structures that allow for a more complete depiction of metropolitan governance and its complexity. Local governments are provision units that use a variety of alternative production arrangements: direct production, private contracting, coordinated or joint production, or franchising. Therefore, metropolitan areas comprise multiple provision units that are linked in numerous ways to a variety of production units. This variety usually represents rational accommodations to diversity. The choice of governance arrangements is contingent upon a multiplicity of environmental factors, yet governance depends, above all, on the capacity to elaborate on, change and enforce the rules within which provision and production occur (Parks, Oakerson 1989). Governance structures can transcend municipal boundaries and allow problem solving, rule making and efficiency on a metropolitan basis. However, when close voluntary organization and cooperation are not achieved, metropolitan governance weakens (Parks, Oakerson 1993). Accordingly, the different levels of governance (provision and production arrangements and the sets of rules and institutions) are what matter (Figure 1).

3 Methodological Framework and Data Collection

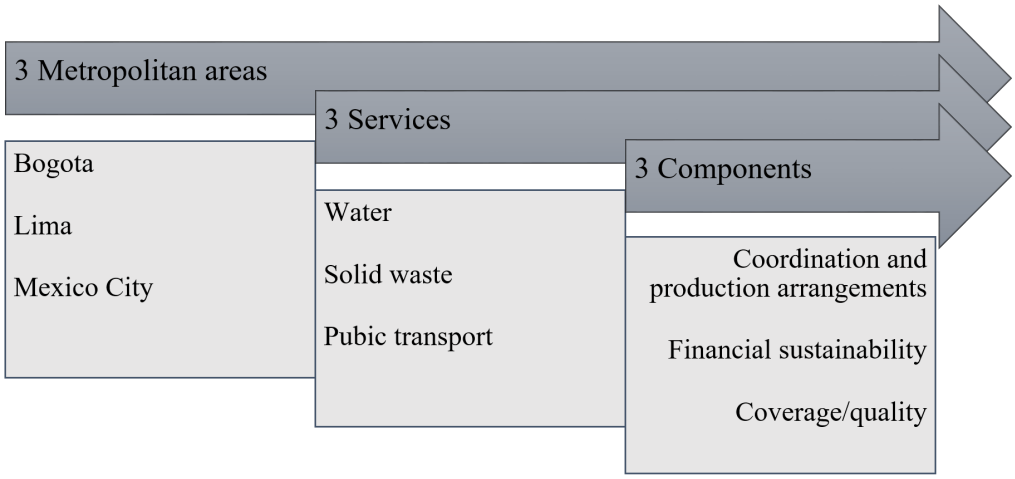
As a methodological strategy for this research we employed a comparative case study analysis implemented by means of a 3x3x3 model. The first 3 in the model refers to the selected metropolises, the second indicates the number of services and the third relates to specific aspects of governance (Figure 2). This approach is a useful starting point for an international and comparative analysis of metropolitan governance in the highly-urbanized countries of Latin America with its varying city sizes, metropolitan structures, and outcomes.

The metropolitan areas of Bogota, Lima, and Mexico City are the subjects of this



Source: Authors' elaboration based on Parks, Oakerson (1993)

Figure 1: Metropolitan governance organization



Source: Authors' elaboration

Figure 2: Components of the 3 x 3 x 3 model of analysis

analysis. All three metropolitan areas have undergone processes of rapid metropolization which have engendered important challenges for the provision of public services and infrastructure. They all belong to the Latin American region and have some cultural background and colonial roots in common. The three metropolitan areas are capital cities that have special political-administrative status. Even though their countries operate under different political systems, with unitary governments in Colombia and Peru, and a federal government in Mexico, they have undertaken important decentralization processes. These metropolitan areas also offer the possibility of illustrating variability in governance structures. In addition, they present different historical forms of metropolitan expansion and institutionalization.

Although the number of public services provided in metropolitan areas is extensive, we focus on three of the most critical sectors in the urban context that are generally provided at the local level: transport, solid waste collection, and water. These sectors are strategic in urban planning and affect the day-to-day life of the population. Moreover, they denote the kinds of service that pose unique challenges in metropolitan environments (Boex et al. 2013, Jones et al. 2014). Jones et al. (2014) suggest that governance plays an important role in the effective delivery of services in urban areas through coordination

mechanisms, finances, and technical operation. This analysis includes these three areas: coordination and production arrangements; financial sustainability; and service coverage and quality. Given the scope of this project, the analysis does not include elements such as civil society participation, transparency, and accountability.

The data collection process included desktop and field work. Documental and secondary statistical information from international, national and local sources was gathered. The results and discussion in this paper also rely on the data collected during the fieldwork period. In 2016, we conducted field research in the three selected cities and organized a final seminar and a conference in Mexico City. The fieldwork included workshops, interviews and technical visits. Nine workshops were organized: one for each sector (transportation, water, and waste collection) in each city. The participants at these workshops were actors or experts in the governance of public service provision: the academic sector, civil society, local government and private suppliers. We located sources of potential participants based on their location and willingness to participate. The workshops were designed as small focus groups where participants reported on and discussed the situation and the challenges to each public service that different actors perceived at the metropolitan level. There was a number of guiding questions about the three categories of analysis, and we allowed other issues to emerge (see the guiding questionnaire and participants in the methodological appendix). The workshops lasted approximately two hours each, and took place in small auditoriums.

Furthermore, twelve semi-structured interviews were carried out. The sample universe was composed of local authorities such as municipal mayors or specific local officials (in the urban services area), community leaders, and sector-specific managers or providers who were unable to participate in the workshops but were relevant actors in some area of urban public services. Although this was a small-scale interview project, it provided enough scope for identifying and developing cross-case evidence rather than generalities. We assessed the adequacy of the sample in terms not of size, but of the sample's ability to supply key information needed for the analysis.

Six technical visits to the metropolitan peripheries were incorporated as part of the field research. Due to time and budget constraints the number of technical visits was restricted. The criteria for choosing a location were access to some local informants, a big and a small municipality outside the central city, and the presence of important formal or informal housing development expansion. The assumption was that these municipalities would experience emerging and persistent governance issues. Technical visits involved observation, interviews and informal conversations with residents. The results were presented and discussed at the final seminar.

Based on analysis of the transcripts and reports on the interviews, visits and workshops, major issues were identified and reported. A contextual characterization of the governance of each metropolitan area was developed. This was followed by an analysis based on the different services (transport, solid waste collection and water). The comparative approach allowed us to evaluate variations across metropolitan areas and services. This paper's size limit precludes a full in-depth analysis of each case; nonetheless, valuable findings are discussed for an initial assessment of metropolitan governance.

4 Overview of Metropolitan Structures in Mexico City, Lima and Bogota

On a larger scale, Latin American cities are expanding rapidly and frequently faster than population growth elsewhere in the country. The result has been the emergence of urban areas of a large territorial size comprising multiple jurisdictions. Alongside territorial and functional restructuring, metropolitan areas have faced political decentralization aimed at producing new spaces for participation, reducing fiscal imbalance problems, and organizing the local and territorial levels of the State in order to implement social policies and deliver services efficiently. Despite these generalized trends, metropolitan areas in each country have highly diverse features. This section presents background on the institutional and territorial structures in the metropolitan areas of Mexico City, Lima and Bogota.

Source: Authors' elaboration

Figure 3: Mexico City Metropolitan Area

4.1 Mexico City Metropolitan Area

Mexico City Metropolitan Area (MCMA), one of the largest metropolitan areas in the world, is the result of the explosive growth and expansion of the urban center during the twentieth century. Due to the displacement of industrial activity and housing towards the periphery, the city began its expansion into other jurisdictions outside its administrative boundaries in the 1940s (Trejo 2013). At the time of the 2010 Population Census, MCMA comprised over 20 million inhabitants, and had a land size of almost 8,000 square kilometers and an average population density of 2,557 inhabitants per square kilometer (SEDESOL et al. 2012). In 2013, MCMA accounted for 18% of the national population and around 25% of total gross domestic product.

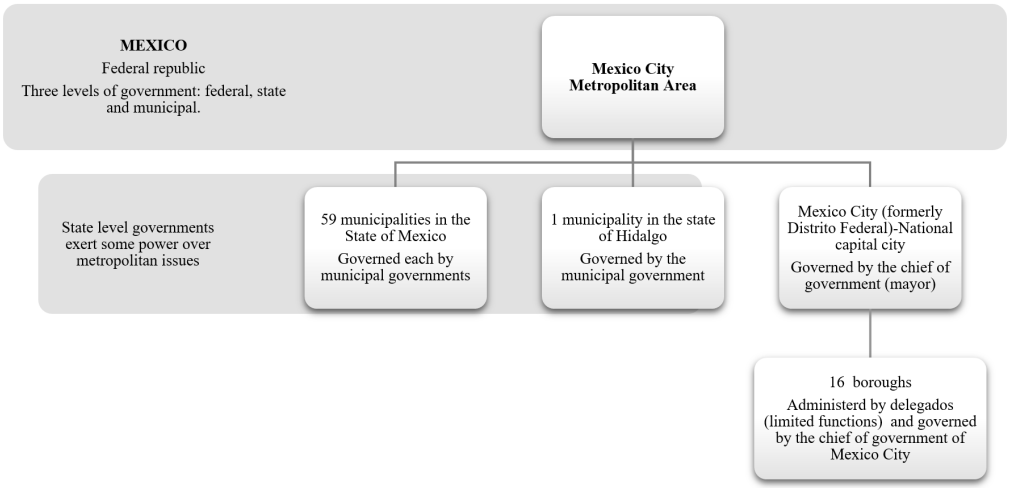
MCMA includes the administrative area of Mexico City[1], formerly called the Federal District, 59 adjacent municipalities in the State of Mexico, and a municipality in the state of Hidalgo (Figure 3). Mexico City proper, itself composed of 16 boroughs, is the political and economic seat of power. Prior to the approval of a political reform in 2015, it was governed by special statute. In contrast to states, it did not have full autonomy, and until 1997 its head of government was not elected directly by the inhabitants, but appointed by the President. Furthermore, the head of government had no constitutional or regulatory capacity and boroughs had neither the autonomy nor all the functions of municipalities.

Metropolitan areas in Mexico do not have legal status as official jurisdictions, but the constitution allows intermunicipal cooperation on a voluntary basis. Several governments operate on different levels, leading to the evolution of different and frequently clashing policies and rules. The administrative powers of 60 municipalities overlap with the government of Mexico City, which in turn interacts with the powers of two different states, Mexico and Hidalgo, as well as with the power of the central government (Figure 4). Politico-administrative fragmentation, measured as the number of jurisdictions with more than 100,000 inhabitants, indicates that 39 municipalities and boroughs have populations of over that figure. This fragmentation decreases if we consider Mexico City proper as a single local government (24 jurisdictions with populations of over 100,000 inhabitants).

Legal planning, coordination and political structures have not been conducive to metropolitan-scale organization. Attempts at constructing effective metropolitan agreements and commissions have been largely ineffective, due to the lack of financial, regulatory and decision-making authority (Cenizal 2015)[2]. Thus MCMA entails a complex set of

[1] Mexico City proper.

[2] Article 115 in the Mexican Constitution allows for the coordination of states and municipalities to address urban problems. Two or more municipalities and their respective states are also allowed to create a conurbation commission. Article 122 allows cooperation between Mexico City and its neighboring municipalities.



Source: Authors' elaboration

Figure 4: Government structure, Mexico City Metropolitan Area

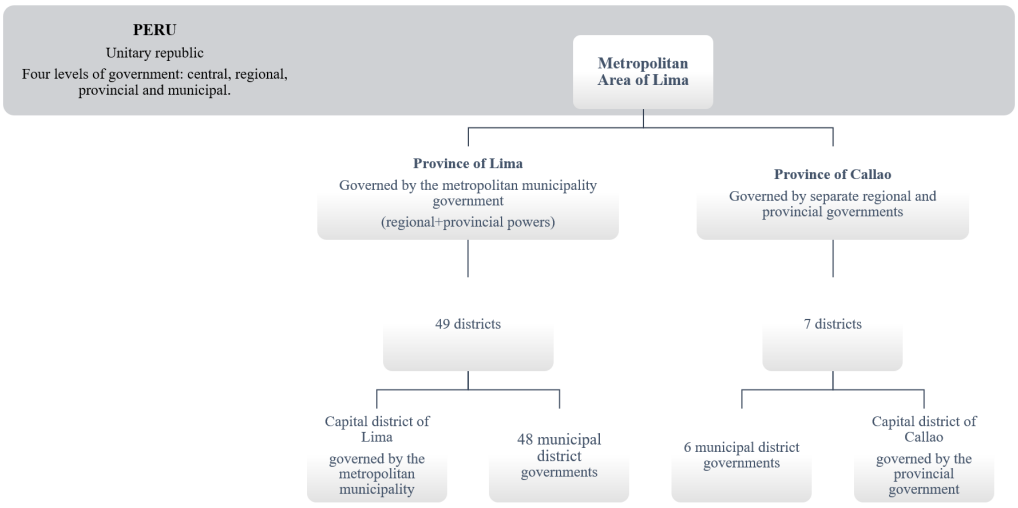
governmental entities with overlapping federal, state, and local powers and an intricate organizational structure that complicates metropolitan governance arrangements, in particular planning schemes seeking to deliver services efficiently (Perlman et al. 2011).

4.2 Lima

The Metropolitan Area of Lima includes the provinces of Lima and Callao. In the province of Lima, the metropolitan municipality assumes the functions of both regional government and provincial municipality. In the province of Callao, regional and provincial government are separate; this means that the Regional Government of Callao and the Provincial Municipality of Callao exercise their respective functions over the same jurisdiction. The province of Lima covers 49 districts governed by 48 district municipalities, whereas the capital district is governed by the Metropolitan Municipality of Lima. In turn, the Province of Callao has seven districts governed by six district municipalities, and the capital district of Callao is governed by the Provincial Municipality of Callao (Figure 5). The population has grown rapidly since the mid-twentieth century. In 1940, Lima and Callao had a population of 645,000 inhabitants; in 1972 this had risen to over three million, and in 1993 it was over six million. In the 1970s the two provinces became a conurbation (Figure 6). In 2013, the population was 9,752,000, of which one million were in Callao (INEI 2014). A total of 25 of the 49 districts have a population of over 100,000.

Lima not only has special arrangements as a capital district; it also has been treated differentially in the decentralization process. While other regional governments, including the regional government of Callao, have taken on functions such as health and education, the process has been discriminatory against the Metropolitan Municipality of Lima, where central government remains the provider of various public services (Diálogos de Políticas Pública 2015). The Organic Law of Municipalities allows the use of coordination mechanisms between municipalities to ensure the efficient use of public resources. Municipalities can create associations with other municipalities called mancomunidades. In order to provide services and implement joint infrastructure projects, seven such associations have been created. They have developed efforts to coordinate and provide services in security and waste management[3]. However, mechanisms for coordination between the municipalities of Lima and Callao have been weakly implemented.

[3] http://www.limacomovamos.org/boletines/las-7-mancomunidades-de-lima/#!prettyPhoto[inline]/-0/



Source: Authors' elaboration

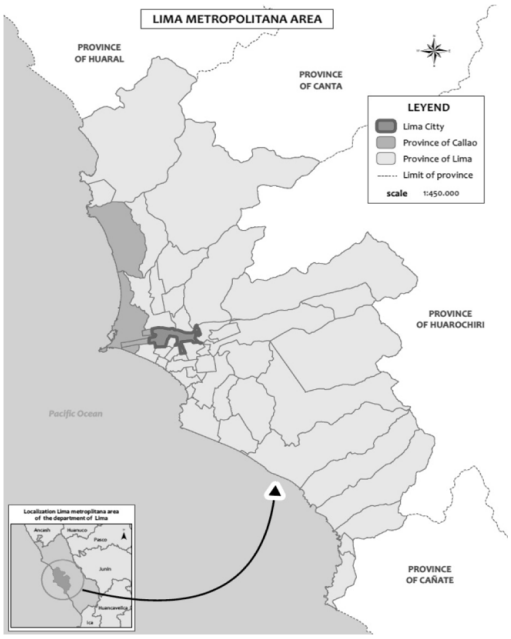
Figure 5: Government structure, Metropolitan Area of Lima

4.3 Bogota

According to the National Administrative Department of Statistics (DANE 2017) the Metropolitan Area of Bogota includes Bogota District and the municipalities of Bojacá, Cajicá, Chía, Cogua, Cota, El Rosal, Facatatíva, Funza, Gachancipá, La Calera, Madrid, Mosquera, Nemocón, Soacha, Sibaté, Sopó, Subachoque, Tabio, Tenjo, Tocancipá and Zipacón (Figure 7). It had a population of 7.8 million inhabitants in 2005 rising to 9.3 million in 2015[4], making Bogota the largest metropolitan area in Colombia, one of the largest in South America, and one of the 33 most-populated metropolises in the world (Smith 2014). The Bogota District was the product of Decree 3640, approved in 1954, which annexed the surrounding municipalities of Engativá, Fontibón, Suba, Usme, Usaquén and Bosa through the Seventh Ordinance of the Administrative Council of Cundinamarca. The territory of Sumapaz was annexed in 1955. According to Article 199 of the 1986 political constitution, administration of the district is the responsibility of the municipal council. Therefore, the city of Bogota is organized as a special district, without subjection to the ordinary municipal regime, under the conditions fixed by the law. With the approval of the Colombian political Constitution of 1991, Bogota became a Capital District with special status. The new Constitution, which includes an Organic Statute for Bogota, redefines the Capital District and eliminates the concept of annexed municipalities to introduce the concept of localities.

The Organic Law of Territorial Ordering sets the principles of good governance in the metropolitan area. This law recognizes that metropolitan areas are territorial associative schemes and that the national government should promote metropolitan cooperation. Article 15 allows associations between metropolitan areas. These can take place between two or more metropolitan areas to jointly organize the provision of public services, the implementation of regional projects, and the fulfillment of administrative functions. Such projects may be developed through contracts, agreements or plans. There are also municipal associative bodies, as in the case of Savannah Centro and Northern Savanna and an agreement of cities in the periphery. Although the Bogota metropolitan area is fragmented, unlike in Mexico City and Lima the dynamics of the metropolitan area are strongly concentrated in Bogota District (Figure 8).

[4]For more information about the census in the metropolitan area: http://www.dane.gov.co/files/-censo2005/resultados_am_municipios.pdf



Source: Authors' elaboration

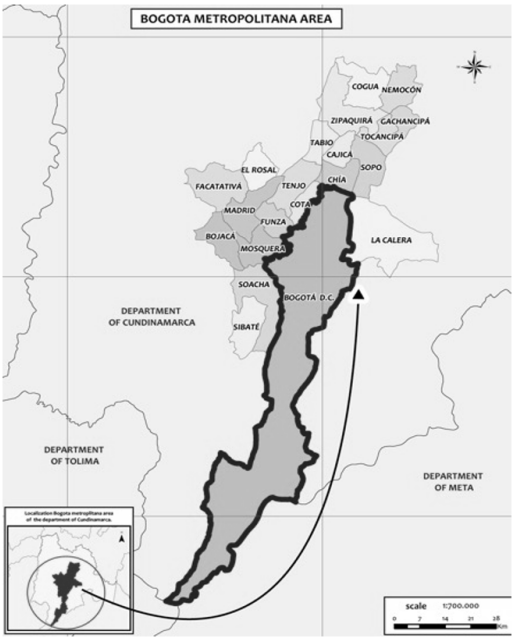
Figure 6: Metropolitan Area of Lima

5 Metropolitan Governance of Public Services: An exploratory examination

In this section we analyze the governance structures in place in our three metropolitan areas according to the explicit and implicit constituent elements of service supply. The main findings regarding coordination, financial sustainability and coverage/quality are discussed. Considering the issue of coordination contributes to understanding governance organization, whereas looking at the financial aspects and coverage help to illustrate efficiency and equity. The approach suggested by Parks, Oakerson (1993) and summarized in Figure 1 is a useful guiding scheme to identify the different arrangements and levels of metropolitan governance that operate in each service and metropolitan area: arrangements for production (level 1), arrangements for provision (level 2) and the set of rules for production and provision (level 3).

5.1 Waste collection

Each metropolitan area has a more or less complex governance organization and operation depending on the diversity of actors involved in its regulation, management and production. According to Article 115 of the Mexican Constitution, solid waste management is provided by the municipalities. In Mexico City proper each borough must provide the service (level 2). Three schemes of production are: public; private; and public-private (level 1). In some boroughs, participatory budgeting projects for local waste collection is a supplementary formal mechanism for providing the service. In both the State of Mexico and Mexico City proper there is a large informal sector (waste pickers, burreros -pickers that use donkeys to transport waste- or carretoneros -pickers that transport waste by carts-) who have historically had strong unions and powerful leaders. Some municipalities have a Councilman (regidor) and in municipalities with greater organizational complexity there is a Director of Public Services. Regarding level 3 of governance – where the rules for provision and production arrangements for service delivery are made – the government of the State of Mexico formulates waste management policy through the Ministry of Environment. In Mexico City proper the Ministry of the Interior, the Ministry of Works and Services through its General Directorate of Urban Services, the Ministry of the Environment and the Environmental Attorney of Land Management participate in urban solid waste regulation and management.

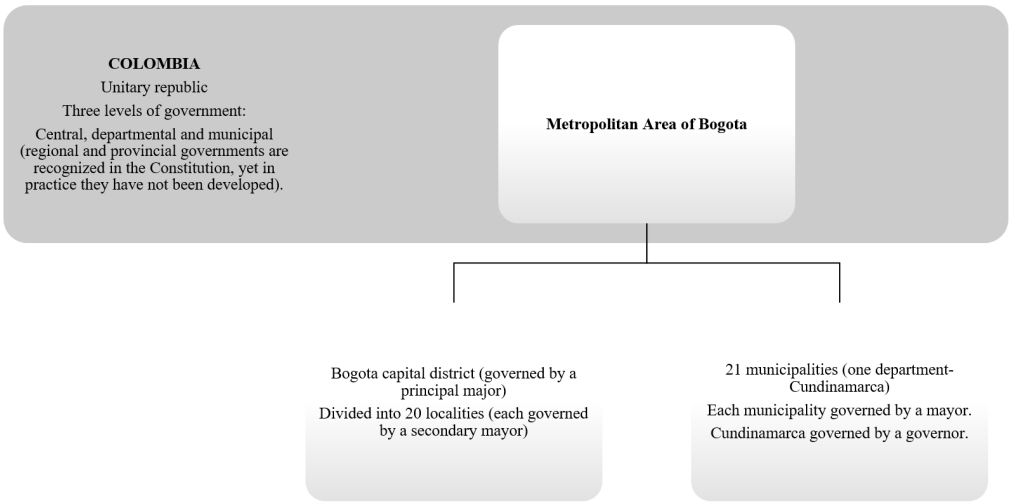


Source: DIRNI, recovered by Mayor of Bogota (2015)

Figure 7: Metropolitan area of Bogota according to DANE (2005 census)

In Lima, provincial municipalities are responsible for waste disposal whereas district municipalities are in charge of the collection and transportation of solid waste. In the capital districts of Lima and Callao, the provincial municipalities are responsible for the collection and transport of solid waste (Durand 2012). Service provision operates under a two-tier arrangement throughout fifty districts and two provinces (level 2). Cleaning and waste collection are supplied directly by municipalities or by private companies contracted to municipalities (level 1). Two large private companies, Petramas and Innova Ambiental, provide the service for several municipalities. There are also municipalities with mixed production schemes. Provincial municipalities regulate the disposal of solid, liquid and industrial discharge. The Metropolitan Municipality of Lima has a special legal regime with special functions in sanitation. It organizes the Metropolitan System of Solid Waste Treatment and Disposal, signs concession contracts for waste management services, and controls their operation. The district municipalities decide on areas for landfill and waste accumulation (Organic Law of Municipalities Nr 27972). The Ministry of Health's General Directorate of Environmental Health controls landfill and authorizes the work of companies that collect municipal waste. The Direction of Environmental Quality formulates national policy on solid waste management; however, it conducts waste management policy with limited normative prerogatives (level 3) (Durand 2012).

According to Law 142, normative control of the waste collection service in Colombia is the responsibility of the National Regulatory Committee for Drinking Water and Basic Sanitation, which regulates competition between service providers to avoid monopolies. The National Superintendence of Domestic Utility Services controls and inspects the efficiency of the service. There is a Municipal Special Administrative Unit of Public Utilities which directs, controls and supervises the provision of road-cleaning services and the collection and final placement of solid waste. The District Department of Environment regulates and promotes environmental sustainability. Lastly, the municipal intercapital consortium supervises the administrative, technical, operative, commercial, economic, and financial aspects of solid waste management and collection (level 3) (Ciudad Limpia 2017). The service is provided by Bogota Capital District and the rest of the municipalities (level 2). In recent years, Bogota's solid waste service has been supplied by the Water Company. There are also other companies involved, such as Ciudad Limpia, which deals with waste in Bosa and Kennedy, and a number of recycling companies that collect, transport, and



Source: Authors' elaboration

Figure 8: Government structure, Metropolitan Area of Bogota

separate, where appropriate, solid waste. The city administration has implemented a new sanitary scheme which assigns five areas of service to five private enterprises (level 1).

Coordination is weak or altogether lacking, depending on the city. In Bogota there is no horizontal coordination between Soacha and Bogota, but service providers and recyclers cooperate at the local level. In Lima, incipient horizontal coordination is sought through the formation of associations of municipalities, but Callao is excluded. Provision and production in MCMA lack mechanisms for coordination between boroughs and municipalities.

In Bogota, operative costs are financed from fees that are subject to differentiation, and provision is self-sustainable. Financial sustainability in this case is facilitated by one specific characteristic of the administrative organization in Bogota which is stratification[5]. Domiciliary public services operate under a cross-subsidy system, the so-called estratos. This system provides an important administrative function by which the upper classes pay higher rates for services or utilities, subsidizing the cost of services for the lower classes.

Half of the municipalities in metropolitan Lima have financial deficits due to low payment rates and collected fees that do not cover expenditures, and provision has to be financed by intergovernmental transfer.

In MCMA, unlike Bogota and Lima, there are no formal fares for this service. Instead, citizens tip drivers and waste pickers who collect, sort and transport waste. Other than labor costs, the operation is highly subsidized and is funded by local governments on a shared-costs basis. Financial capacity is weak in general, and there is great variation in between jurisdictions.

Official data show more than 90% service coverage in all three cities, yet these figures often exclude informal settlements. In Bogota, for instance, official coverage is informed by the stratification system, which omits informal housing. In Lima, the mean coverage figure, 90% (MINAM 2014), hides the important variation across municipalities. In MCMA coverage is usually based on Census registrations that are limited in including informal housing. As in other cases peripheries tend to receive lower coverage and quality. Similarly, in MCMA there are important spatial disparities, with lower coverage in the northeast periphery, and there are significant problems of frequency and quality in the service. Table B.1 in Appendix B summarizes the main findings on this service.

[5]This cross-subsidy system consists of six 'estratos' based on socio-economic criteria: Stratum 1 includes the lowest income population and stratum 6 the highest income population.

5.2 Water delivery

Providing an adequate water supply in metropolitan areas is technically and politically very complex. Market and state failures have resulted in intricate arrangements for service provision that involve four broad actors: public, informal, community-based, and private operators that participate as part of public-private partnerships (Jones et al. 2014). In MCMA the federal government is involved in water regulation through the National Water Commission (CONAGUA), which is in charge of authorizing the use of national water, the bulk supply of water, the construction and operation of the infrastructure, and the preservation of aquifers. There is the Federal Basin Agency for the Valley of Mexico (Aguas del Valle de Mexico) and the Water and Sewer Metropolitan Commission. Piped water services must be provided by local governments. Municipalities decide whether to manage and operate their water systems directly or through decentralized public bodies. In Mexico City proper, SACMEX is the decentralized body responsible for providing water to the sixteen boroughs. In addition, four private firms attend to some segments of the water service across the boroughs[6]. In the states of Mexico and Hidalgo, 48% of municipalities operate mixed provision schemes where the state, the municipality and neighborhood committees overlap; 28% of municipalities have their own decentralized company; 10% of municipalities have water services operated by community/neighborhood bodies; and 14% of municipalities are direct producers. Informal mechanisms, the resale of water and clandestine connections are the only sources of water available to residents in several areas of the city (Rosales 2015).

In Metropolitan Lima, water is provided by Potable Water and Sewerage Service of Lima (SEDAPAL), a public company operating under a private legal regime. SEDAPAL depends on the National Ministry of Housing and is regulated by the National Superintendence of Sanitation Services (SUNASS), a public decentralized organization. SUNASS, in turn, regulates and supervises water and sanitation provision and pricing. The National Authority of Water (ANA) administers and monitors natural sources of water and authorizes the volumes of water that service providers can take. According to Law 28696, SEDAPAL provides water and sanitation services to Lima and Callao provinces. Other areas can be included through a housing-sector Ministerial Resolution if there is territorial continuity and the service can be technically provided by SEDAPAL.

Bogota's Water Enterprise (Aguas de Bogota) provides services to Bogota and eleven nearby towns. The company operates at a regional level as a private corporation. Aguas de Bogota is subject to Law 142 and to all other norms that modify this law. The company is regulated by the Commission for the Regulation of Drinking Water and Basic Sanitation (CRA), which also sets the fares. Aguas de Bogota is the subsidiary company of a public enterprise, Acueducto, which provides water and sewerage services. Acueducto's service model in Bogota is based on division of the metropolitan area into five zones. Acueducto provides the service to the whole metropolitan area, not as a public but as a private firm.

Even though the Constitution allows voluntary cooperation, the supply of water services in MCMA lacks intergovernmental, horizontal and institutional coordination. Asymmetries in provision are significant because small municipalities are unable to benefit from economies of scale or to internalize positive spillover effects. The provision of water is a municipal function in Bogota, but the same company delivers the service to the whole metropolitan area. This provision, however, is determined by the private legal status of the producer rather than by formal horizontal coordination between Soacha and Bogota DC. Likewise, in metropolitan Lima, horizontal coordination lacks relevance because SEDAPAL is a central entity that supplies the whole metropolitan area (see Table B.2 in the appendix).

In MCMA as a whole, tariffs cover only 64% of operating costs and the rest of the cost has to be subsidized by the government. Only in Mexico City proper are subsidies based on geographic location and depend on the socioeconomic characteristics of each

[6]Mexico City is divided into four zones receiving commercial and maintenance services. Zone A includes three boroughs in the northwest and is served by SAPSA. Zone B comprises four boroughs and is served by Industrias del Agua de la Ciudad de México. Zone C incorporates four boroughs which are serviced by Tecnología y Servicios del Agua. Zone D covers five boroughs and is provided by Agua de México.

neighborhood. Payment rates are sufficient to maintain some financial stability. In contrast, municipalities in the State of Mexico show significant heterogeneity depending on the provision scheme and the capacity to collect tariffs. Small jurisdictions that do not meet the requirements for establishing their own operator are the worst-off financially because they lack access to specific public resources. As with other services, tariffs in Bogota are determined according to the cross-subsidy system. Operational costs are covered by fares and the company is considered financially healthy. The situation in Lima is similar, with the operation financed by collected tariffs. There are some consumption subsidies, and a transition to socioeconomic stratification is under way.

Official coverage data focuses on formal provision. The available data shows 100% coverage in formal neighborhoods of Bogota DC and around 82% in Soacha. In Lima, coverage is approximately 89%, with running water provided 24 hours a day in central Lima and between 19 and 22 hours a day in the rest of the metropolitan area. The quality of the service and the water itself accomplish minimum standards. In MCMA 79% of the population live in houses with a piped water connection; however only 72% of the population has daily access to water. In this metropolitan area daily access to water is highly unevenly spatially distributed and most peripheral municipalities and boroughs have extremely low availability. In these peripheries not only the service, but also the water itself is poor quality. The service is severely affected by aging and poorly-maintained pipes which can result in the loss of more than 25% of the water.

5.3 Public transport

In MCMA, public transportation is provided under varied government and concessional supply schemes. Public transport consists of the following systems: subway (Metro), rapid transit bus (Metrobus and Mexibus), light train, trolleybus, the Passenger Transport Network (RTP), a suburban train (Suburbano), Eco-bici (a public bicycle-sharing system), and private bus concessions (colectivos). According to the latest origin-destination survey (INEGI 2007), approximately 50% of the 22 million daily journeys in the metropolis are covered by buses and microbuses (as transport concessions), but Bus Rapid Transit (BRT) systems that combine public and private participation, have experienced the largest expansion in recent years. Some of these systems – subway, light train, trolleybus, the RTP and Eco-bici – operate only or mostly in Mexico City proper. The governance of public transport involves the following stakeholders: federal, state and local transport authorities, private transport companies and, at least on paper, a transportation metropolitan commission. In addition, there is a large informal sector. Despite the local nature of the service, public transport is generally provided by intermediate level governments (Fernández 2002). Intermediate level governments operating the public transport is the prevailing situation in Mexican municipalities which, despite holding institutional powers that allow them to intervene in the formulation and implementation of public passenger transport programs, have delegated the task to state governments due to their lack of the human, technical and financial resources needed to fully assume regulation and service management (IMCO 2012). In Mexico City proper the local Ministry of Mobility is in charge of planning and managing public transport. In the municipalities of the State of Mexico, planning and regulation of public transport concessions is the responsibility of the Ministry of Mobility, while the Ministry of Communications runs the mass-transit system, Mexibus. In the state of Hidalgo regulation and planning is based on the Transport Law and undertaken by a decentralized agency dependent on the Ministry of the interior (OECD 2015). Some municipalities have a transport and transit agency that is responsible for regulating local traffic and the building and maintenance of roads. The Metropolitan Commission (COMETRAVI) was created in 1994 through an agreement signed by the Federal Ministry of Transport and Communications and the governments of the State of Mexico and Mexico City proper. However, COMETRAVI is a non-operating agency.

In Bogota, the BRT Transmilenio and local buses form the core of public transport services and cover over 50% of journeys taken, with walking and motorcycles as significant modes of transport in the peripheries. The Ministry of Transportation is in charge of formulating and adopting policies, plans, programs and projects at the national level. The Ministry of Mobility operates at the municipal level in Bogota and Soacha. These

two local ministries are advised to work in coordination to solve mobility and transport problems. The rest of the municipalities do not have such local ministries.

In Lima, provincial municipalities are in charge of regulating public transportation, but in the 1990's Peru adopted a public transportation model with little regulation and dominated by private supply. Since 2010 a BRT line, COSAC, has connected the north and the south of the city. A group of private companies run the COSAC service by means of a concession. In 2012 the first metro line was inaugurated to connect the east with the south, and a second line is under construction. The operation of metro lines is also given as a concession to private companies. These two systems represent only 4.4% and 3.4% of journeys in the metropolis respectively (Survey, Lima Como Vamos, 2015). Most metropolitan trips are taken on private bus lines that obtain authorization for specific routes from the municipalities of Lima and Callao and "rent" these authorizations to bus owners and drivers. This system is known as the commission-affiliation system. Since the companies receive a payment per vehicle operating and not per passenger, there is an excess of vehicles competing for passengers. There are 561 authorized routes with 38,000 vehicles in Lima and Callao (Ministerio de Transportes y Comunicaciones 2016).

The different public transport alternatives in MCMA do not operate as an integrated system. There is significant institutional and vertical as well as horizontal fragmentation. Efforts to better integrate or coordinate transportation systems are limited to the integration of the subway, Metrobus and Ecobici payment systems, but these only cover Mexico City proper. In the State of Mexico there is a predominance of 'colectivos'. A suburban train has operated between downtown Mexico City and some of the municipalities since 2008. The project was formulated and implemented mainly by the federal government, with some State of Mexico and Mexico City government involvement.

In metropolitan Lima, an agreement was reached to allow Callao and Lima to grant permits to private companies to operate across both provinces. However, lack of provincial coordination has resulted in overlapping routes. Institutional coordination is also problematic, and there are three different payment systems in the city. Metro and Metropolitano do not operate in Callao.

In Bogota, the 2016–2020 Development Plan seeks to strengthen an integrated system of public transportation including the collective public transportation and individual public transportation services (Bogota 2015). The program is also pursuing improvements to regional connectivity by inter-jurisdictional cooperation. However, the initiative has remained limited, and for instance Transmilenio has only four stations in Soacha. There is a consolidated model of infrastructure development, but this model is controlled by the central government.

In the MCMA, the financial sustainability of government-operated transport systems is precarious. They are heavily subsidized and their cost-revenue structures are not subject to technical analysis, leading to significant inefficiency. Excessive subsidization has contributed to local governments' financial burden. 'Colectivos' face financial constraints for investment, maintenance and operation. The system with the highest prices and in the best financial situation is the suburban train, but it requires significant funding for investment and maintenance. Bogota's BRT system has been sustainable due to resources injected by the district government, otherwise the tariffs would be insufficient to keep it running. The intermunicipal buses are self-sustainable in the sense that they operate on their own revenue. And in Lima, the Metropolitano system operates at costs while the subway is subsidized by central government. The rest of the services are private and self-sustained.

In MCMA official public transport coverage is above 90%, but peripheral areas exhibit deficits which are often compensated for by informal supply. The same applies in Bogota and Lima, whose official statistics do not reveal significant disparities. According to interviewees' perceptions, substantial inefficiencies, poor quality, low capacity, poor safety, low frequency and high prices are critical problems that require attention in all three of the metropolises.

Overall, services in MCMA are the most fragmented and have the lowest performance in terms of efficiency and equity. Public transportation is the service with the weakest governance and poorest performance in the three metropolises.

Table 1: Classification of service provision schemes

	MA Bogota	MA Lima	MA Mexico City
Piped water	In consolidation	Consolidated	Fragmented
Waste recollection	In consolidation	In consolidation	Fragmented
Public transport	In consolidation	Fragmented	Fragmented

Source: Authors' elaboration

5.4 The models of service provision

Despite the established structures of government, intergovernmental relations and decentralization processes, metropolitan governance structures differ not only across metropolises, but also across sectors within the same metropolis. Arrangements for service provision and production and the related legal structures and rules vary depending on the local context and the service to be provided. The multiple forms of organization for the provision of services illustrate the diversity of governance structures and their evolution. We use the concept of consolidation to classify different governance schemes. Consolidation is understood here as a condition in which the supply area of a service is metropolis-wide. Metropolis-wide supply areas can be achieved by means of production arrangements or by annexation. Metropolitan governance can be classified into three categories: i) fragmented, where provision and production organization preserve the administrative structure of the metropolitan area, and there are no coordination arrangements or other formal or informal efforts to deliver metropolitan wide services; ii) consolidated, where a service is provided and produced completely or mostly by one entity; and iii) in consolidation, where different schemes, public or private, formal or informal, are aimed to build a metropolitan approach for service supply, with metropolitan zones gradually incorporated into the service supply area. See Table 1 for a summary.

The three services in the Metropolitan area of Bogota are classified as in consolidation. Transmilenio provides public transportation services in part of Soacha, and the Water Enterprise of Bogota also increasingly provides services outside the capital district. The consolidation of metropolitan area-wide service supply is explained to a good extent by the fact that the main political jurisdiction contains more than 80% of the population and covers most of the urban area. Actually, the metropolitan area as such has been in consolidation due to the historic process of annexation of surrounding municipalities. New areas beyond Bogota DC have been incorporated into the capital district and to the service delivery area over time. However, Soacha remains outside Bogota DC even though it is a rapidly-growing territory in demographic terms and has strong functional relations with Bogota.

In Lima, the water service is consolidated because the public company SEDAPAL provides water to the whole metropolitan area. Waste collection services are in consolidation with intermunicipal agreements seeking to coordinate and cooperate to deliver the service by means of associations of municipalities. However, so far, such initiatives have made slow progress. The transport service is fragmented. However, in the near future proposals may arise, since the subway service is expected to cover the province of Callao.

In Mexico City, piped water, waste collection and public transportation services are fragmented because they are mainly provided by multiple local governments and organizations with almost a complete lack of arrangements for metropolitan cooperation and coordination.

We find that the three models have implications for coordination, financial sustainability and coverage. Inter-jurisdictional coordination and cooperation and central government schemes are not observed in fragmented services. Services in consolidation relate to diverse arrangements for integrating or expanding the service area. Consolidation has depended mostly on national government initiatives and structures, although some form of cooperation or coordination may be necessary at lower levels. Fragmentation entails greater financial difficulties, especially when small governments and municipalities

with low financial and fiscal capacity are unable to achieve economies of scale or their administrative structures lack the necessary resources. The more consolidated a service governance structure is, the better its financial capacities appear to be. Generally, the greatest difficulties in all cities and sectors are related to expenditure on infrastructure and investment. Consolidation contributes to better coverage and quality, and also to more equal access to services.

6 Final Remarks

This study has responded to the relative gap in understanding the specific empirical experiences of metropolitan governance of the delivery of public services in Latin America. Given that jurisdictional fragmentation is an inherent characteristic of metropolitan areas, distinguishing between provision and production/supply has helped us to identify variations across services and cities. In this comparative analysis of metropolitan governance in Mexico City, Bogota and Lima we have found not only that governance structures differ, but also that in some instances service supply is adapted to accommodate specific needs and sociopolitical contexts, even if such arrangements do not necessarily correspond to local rationalities. Such is the case of water provision in Lima, where the service is supplied by a public company that depends on the national government. In the metropolitan area of Bogota, institutional arrangements have been modified to gradually expand the supply of transport services to areas beyond the capital district as far as the municipality of Soacha. Although this has been a slow and problematic process, Transmilenio has established a few stations in Soacha. Another example is the water company in Bogota, which supplies the capital district as a public service and supplies other municipalities as a private company via arrangements with local governments. Also in Lima, some effort has been made towards intermunicipal coordination in the waste-management sector by means of associations of municipalities.

Even though the water service in Lima is the most consolidated governance structure discussed here, water services are provided by an agency which depends on the national government. Locally-guided projects or initiatives are weaker. Secondly, the consolidation processes in Bogota are strongly related to the historic annexation of territories to the main city. Third, the relatively good financial performance in service provision in Bogota is due to the cross-subsidy system. Fourth, despite the absence of metropolitan governments, governance can solve problems. The quality of that governance in turn affects technical, financial and social outcomes and performance. These cases exemplify how service supply with a metropolitan approach is not necessarily a process in which fragmented areas are governed by a single entity that provides all services to the wider territory, but can be a slow process of consolidation led by various arrangements and actors across sectors and jurisdictions.

On the other hand, the metropolitan area of Mexico City is a case in which coordination, financial sustainability and equity in every public service is strongly affected by high fragmentation which overpowers any approach to interjurisdictional coordination and cooperation for economic and social efficiency. Despite constitutional autonomy for voluntary intermunicipal cooperation, there are very few instances of coordination. It is not possible to conclude, however, that the lack of coordination and poor governance derive purely from the administrative fragmentation of the territory. In this specific metropolitan area, political economic factors appear to play a determining role in explaining the weak metropolitan governance structures including party and political competition between states and between municipalities; three-year municipal government terms; a culture of all-embracing political power and others.

We argue that fragmentation creates substantial difficulties in providing urban services. Yet empirically, governance for service provision is place-specific and depends on local political culture and overarching state legal frameworks. In the absence of formal metropolitan government, the operating structures of governance can reverse the negative impact of fragmentation. Lastly, metropolitan structures can vary to accommodate the characteristics of the services provided.

While these findings are not generalizable, they illustrate the significant empirical

variation to be found across metropolises and sectors. They also illustrate the need, in less developed countries, for a debate on metropolitan governance that goes beyond the traditional approach to jurisdictional fragmentation and metropolitan governments. These findings can be used as a basis from which to identify questions for future comparative research or further in-depth case studies either by sector or by metropolitan area. Future work in our research will include in-depth analysis by sector to deal with questions that include the historical evolution of metropolitan configurations; the way politics have shaped metropolitan bureaucracy and government; how civil participation and transparency are embedded in metropolitan governance organization; and private actors' role in the production of services.

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References

Bahl R (2013) The decentralization of governance in metropolitan areas. In: Bahl R, Linn J, Wetzel D (eds), *Financing metropolitan governments in developing countries*. Cambridge, MA, Lincoln Institute of Land Policy, 85–106

Bird R, Slack E (2007) An approach to metropolitan governance and finance. *Environment and Planning C: Government and Policy* 25[5]: 729–755. CrossRef.

Boex J, Lane B, Yao G (2013) An assessment of urban of urban public service delivery in South Asia: An analysis of institutional and fiscal constraints. Urban Institute Center on International Development and Governance Research Report. Washington, D.C. The Urban Institute

Bogota (2015) Proyecto plan de desarrollo 2016-2020. Available in: http://www.sdp.gov.co/sites/default/files/20160429_proyecto_pdd.pdf

Cenizal C (2015) Governing the metropolis: The evolution of cooperative metropolitan governance in Mexico City's public transportation. Master dissertation. Massachusetts Institute of Technology, Cambridge MA, USA

Ciudad Limpia (2017) Tarifas aplicadas para los usuarios no aforados. Available in: http://www.ciudadlimpia.com.co/site/index.php?.option=com_content&view=article&id=17&Itemid=159

DANE (2017) Boletín técnico. Available in: https://www.dane.gov.co/files/investigaciones/boletines/transporte/bol_transp_IVtrim16.pdf

Diálogos de Políticas Pública (2015) Nota de política pública de descentralización

Durand M (2012) Waste management in a developing city: Capitalising on current difficulties in Lima? *Flux* 87[1]: 18–28

Feiock R (2004) Introduction: Regionalism and institutional collective action. In: Feiock R (ed), *Metropolitan Governance: Conflict, Competition, and Cooperation*. Georgetown University Press, Washington, DC, 3–16

Fernández J (2002) Servicios públicos municipales. Instituto Nacional de Administración Pública (INAP), México

IMCO (2012) Propuestas transversales. Acciones urgentes para las ciudades del futuro. Instituto Mexicano para la Competitividad, México

INEGI (2007) Encuesta origen-destino 2007. Instituto Nacional de Estadística y Geografía, México

INEI (2014) Una mirada a lima metropolitana. https://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib1168/libro.pdf

Jones H, Clench B, Harris D (2014) The governance of urban service delivery in developing countries. Report overseas development institute. march, 2014. available in: https://www.odi.org/publications/8329-urban-services-poverty

Lowery D (2000) A transactions costs model of metropolitan governance: Allocation versus redistribution in Urban America. *Journal of Public Administration Research and Theory* 10[1]: 49–78. CrossRef.

Mayor of Bogota (2015) Somos un territorio metropolitano. Available in: http://www.sdp.gov.co/imagenes_portal/documentacion/OficPrensa/Cartilla_Somos_Un_Territorio_Metropolitano.pdf

MINAM (2014) Sexto informe nacional de residuos solidos de la gestion del ambito municipal y no municipal 2013. Ministerio del Ambiente, MINAM. Lima, Peru. http://redrrss.minam.gob.pe/material/20160328155703.pdf

Ministerio de Transportes y Comunicaciones (2016) Autoridad de transporte urbano para Lima y Callao: propuesta conceptual, Cooperación Alemana. https://www.mtc.gob.pe/estadisticas/Autoridad de Transporte Urbano para Lima y Callao-144dpi.pd

Oates W (1997) On the welfare gains from fiscal decentralization. *Journal of Public Finance and Public Choice* 2-3: 83–92

OECD (2015) Getting mobility in the Valle de México on the right track, in OECD territorial reviews: Valle de México, Mexico. Technical report, Paris. CrossRef.

Parks R, Oakerson R (1989) Metropolitan organization and governance: A local public economy approach. *Urban Affairs Quarterly* 25[1]: 18–29. CrossRef.

Parks R, Oakerson R (1993) Comparative metropolitan organization: Service production and governance structures in St. Louis (MO) and Allegheny County (PA). *Publius: The Journal of Federalism* 23[1]: 19–40

Perlman B, J. J, de D, Pineda G (2011) Rethinking a megalopolis: A metropolitan government proposal for the Mexico City metro area. *State and Local Government Review* 43[2]: 144–150

Prud'homme R (1995) The dangers of decentralization. *The World Bank Research Observer* 10[2]: 201–220

Rosales A (2015) Economía política del servicio de agua y saneamiento en la Ciudad de México. PhD thesis. CEDUA, El Colegio de México, México

SEDESOL, CONAPO, INEGI (2012) Delimitación de las Zonas Metropolitanas de México 2010. Secretaría de Desarrollo Social. Consejo Nacional de Población. Instituto Nacional de Estadística, Geografía e Informática

Slack E (2007) Managing the coordination of service delivery in metropolitan cities: The role of metropolitan governance. Policy research working papers. CrossRef.

Smith D (2014) World city populations 1950-2030. Available in: http://luminocity3d.org/WorldCity/#3/-7.36/-75.94

Storper M (2014) Governing the large metropolis. *Territory, Politics, Governance* 2[2]: 115–134. CrossRef.

Tiebout C (1956) A pure theory of local expenditures. *Journal of Political Economy* 64[5]: 416–424. CrossRef.

Treisman D (2000) Decentralization and the quality of government. Unpublished paper, University of California, Los Angeles. available in: https://www.imf.org/external/-pubs/ft/seminar/2000/fiscal/treisman.pdf

Trejo A (2013) Las Economías de las Zonas Metropolitanas de México en los Albores del Siglo XXI. Estudios Demográficos y Urbanos, 28(84), pp. 545-593. Distrito Federal. Centro de Estudios Demográficos, Urbanos y Ambientales. El Colegio de México

Yaro R, Ronderos N (2011) International metropolitan governance: Typology, case studies and recommendations. Developed for the Colombia urbanization review. The World Bank Group, Regional Plan Association

A Appendix: Fieldwork

Guiding questions (focus groups and interviews)

1. What is the role or what place does the service occupy in the metropolitan/urban agenda?
2. What is the general diagnosis (depending on the case) of the main problems faced by the provision of (water provision, waste recollection and public transport) at the metropolitan level and in the metropolitan periphery in particular?
3. In terms of coverage, to what extent can we speak of an accessible and universal service?
4. What is the assessment of the frequency and quality of the service?
5. What is the appreciation of the characteristics and the physical support of the service?
6. Are there infrastructural or operational deficiencies?
7. To what extent do authorities worry about improving the provision of the service?
8. What are the perspectives, limits and opportunities for the expansion of the service to reach metropolitan coverage?
9. What are the possibilities for an Integrated Metropolitan Service System?
10. What are the challenges for local governments in providing te service?
11. What are the general characteristics of the tariff system and the cost of provision?
12. What is the general evaluation of the financial sustainability in the provision of the service?
13. What is the evaluation of the current institutional and operational coordination between different jurisdictions and levels of government?
14. What efforts are developing at different tiers of government to improve the service?
15. What is the role of political factors in the operation and provision of the service?

Technical visits

Ecatepec (Mexico City)
Melchor Ocampo (Mexico City)
Puente Piedra (Lima)
Soacha (Bogota)
Ciudad Bolivar (Bogota)

Interviews

1. Bogota

Municipality of Soacha (director of public services)
Community leader (Ciudad Bolivar)

Table A.1: Focus groups: schedule and participants

City	Actors	Water	Waste	Transport
Bogota	Academia	—	—	—
	Civil society	Recicle Colombia (NGO)	TECHO (ONG)	—
	Local government	Local secretary of the environment	Local secretary of the environment	Transmilenio
	Provider	Empresa de Agua de Bogotá-"Acueducto"	Empresa de Agua de Bogotá-"Acueducto"	Transmilenio
Lima	Academia	—	—	—
	Civil society	Ciudad Nuestra, Lima Como vamos, Contribuyentes por respeto (NGOs)	Alternativa, AFIN (NGOs)	Luz Ambar, Transitemos (NGOs)
	Local government		Waste management office (municipalities of Lima, Miraflores, San Miguel and Puente Piedra)	Urban development office (Ate)
	Provider		Waste management office (municipalities of Lima, Miraflores, San Miguel and Puente Piedra)	
Mexico city	Academia	Expert on metropolitan water governance (Centro Interdisciplinario de Estudios Metropolitanos)	Expert on solid waste managment (Universidad Nacional Autonoma de Mexico)	Expert on urban transportation and mobility (El Colegio de Mexico)
	Civil society	Isla Urbana (NGO)	Agencia de Gestión Urbana-AGU (Urban Management Agency)	Institute for Transportation and Development Policy (ITDP) and ASIICSO Habitus (NGO)
	Local government	Local secretary of the environment	Local secretary of the environment	—
	Provider	Sistemas de Agua de la Ciudad de Mexico-SACMEX	Local authorities of street cleaning (Servicio de limpia, Cuauhtemoc)	Passenger Transport Network System (RTP)

2. Lima

Municipality of Puente Piedra (manager of urban development)
Autoridad Autónoma del Sistema Eléctrico de Transporte Masivo de Lima y Callao – AATE (agengy in charge of the Metro Project in Lima and Callao)
Transport office, Municipalidad de Lima
SEDAPAL (public company of water and sanitation)

3. Mexico City Metropolitan Area

Ecatepec (They had accepted the meeting, but refuse to answer the questions)
Melchor Ocampo Municipality (Mayor)
Melchor Ocampo (director of urban services)
Melchor Ocampo (director of water provision)
Melchor Ocampo (coordinator or public transport)
Consultant of Ferrocarriles Suburbanos (Suburban train)

B Appendix: Summary of findings

Table B.1: Aspects of metropolitan governance in the waste collection service

			Bogota	**Lima**	**Mexico City**
PROCESS	Coordination		* There is no coordination for the provision of the service. Each municipal entity chooses a public or private operation. * Before the absence of horizontal coordination, small municipalities sometimes allowed the Cundinamarca department company to provide the service. * There is some institutional coordination, mainly with the Association of Bogota Recyclers.	* The Metropolitan System of Treatment and Elimination of Solid Waste does not include Callao. * Despite strong normative incentives for coordination and cooperation, there are no adequate mechanisms to ensure institutional coordination. * Advancement in horizontal coordination through mancomunities.	* There is some institutional coordination within the Federal District. * In municipalities of the State of Mexico some public-private coordination takes place when private companies provide the service as concessions. * An environmental metropolitan commission focuses mainly on air pollution problems. * There is no metropolitan institutional action and an absence of horizontal coordination among jurisdictions.
RESULTS	Supply	Financial Sustainability	* Fees are subject to the socioeconomic classification of properties (estratos). This creates the possibility of cross-subsidies. * Fees vary from 3,096 to 28,508 Colombian pesos. * Total fees include sweeping and cleaning,commercialization, collection and transport. * Financially sustainable.	* Significant differences in payment rates across municipalities. * Reliance on intergovernmental transfers to provide the service where there is a low payment rate. * 17 districts have a 50% deficit in expenditure coverage. * Generally not self-sustainable, but there are significant differences across districts.	* No official tariffs or fees. * Payment is made via tips to drivers and waste pickers. * Costs shared between waste management and other areas of municipal public services. * Operation under a subsidy scheme. * Variation across jurisdictions. * Weak financial capacity and unsustainable provision.
	Demand	Access, coverage and quality	* Coverage of more than 90% in the majority of municipalities, both in Bogota and in the metropolitan area (official data collected only in formal settlements) * Success in reaching all socioeconomically vulnerable areas via the stratification transfer system.	* Estimated 90% coverage * Problems of low quality * Variation across areas depending on socioeconomic conditions	* Covers between 88 and 98% of households * Lower coverage in the Northeast periphery * Highly inefficient in quality and frequency but with great variation across jurisdictions.

Table B.2: Aspects of metropolitan governance in water provision

			Bogota	**Lima**	**Mexico City**
PROCESS	Coordination		* There is coordination between the municipalities. Even though water provision is a municipal function, the Bogotá company (EAAB) competes as a public society but with private logic. Provision to the area of Soacha next to Bogota.	* Intermunicipal coordination is not an issue since all municipalities are serviced by SEDAPAL. * Weak vertical coordination between SEDAPAL and municipalities in Lima and Callao.	* A multiplicity of actors and jurisdictions translates into fragmented models of provision. * Rare cases of municipal association; weak intermunicipal coordination. * Weak vertical coordination with Federal institutions.
RESULTS	Supply	Financial sustainability	* Tariffs are fixed according to six levels of "estratos" defined by the socioeconomic status of households. * $6m^3$ of water is provided to each household of estrato 1 for free. * Operational costs are covered by tariffs. * The company is considered financially healthy.	* Operational costs covered by tariffs. * Infrastructure investments not covered by tariffs. * Large infrastructure projects financed by central government transfers. * Tariffs have subsidies based on consumption. * SEDAPAL is transitioning to a subsidy based on socioeconomic status. * Overall, SEDAPAL is a financially healthy company.	* Tariffs cover 64% of operating costs, government subsidizes the rest. * Subsidies in Mexico City based on geographic criterion depending on the socioeconomic classification of neighborhood. * There is significant heterogeneity in the financial situation among jurisdictions depending on the provision scheme. * Provision in Mexico City appears to be relatively stable financially. * Small municipalities in the State of Mexico that do not meet the criteria for establishing their own service operator have worse financial conditions.
	Demand	Access, coverage and quality	* Almost 100% in legalized neighborhoods. * In Bogotá 98.6% of neighborhoods; in Soacha 82.8%; in Sabana 96.3%.	* Around 89% of households have a water connection inside their house. * Availability of the service is not a problem. * 24 hours of running water on average in Lima Centro. * Between 19 and 22 hours in the periphery.	* Piped water connection inside the houses of approximately 79% of metropolitan population. * 72% of population has daily access to water. * Highly uneven spatial distribution of access to the daily water service. * Most peripheral municipalities and boroughs have lower availability.

Table B.3: Aspects of metropolitan governance in public transport

			Bogota	**Lima**	**Mexico City**
PROCESS	Coordination		* There is a consolidated model for the construction of infrastructure, but without a real metropolitan approach. * Intermunicipal transportation is Departments' responsibility. * Transmilenio offers a service to only four stations outside of Bogota's borders, in Soacha	* The system is fragmented, but there have been efforts to integrate it jurisdictionally. * Integration with private operators is necessary. * Lima and Callao have agreed that both can provide permission to private companies to operate in both provinces. * There is no integration nor coordination between systems. For instance, different payment systems operate in the city for the Metro, the Metropolitano and secondary routes.	* Provision is fragmented 'administratively' between different transport systems and jurisdictionally between Mexico City and metropolitan municipalities. * There have been projects towards the integration and coordination of systems but the initiative has not developed successfully, with the exception of some elements such as payment methods (Metro and Metrobus).
RESULTS	Supply	Financial Sustainability	* The system is sustainable due to financial support, but is not self-sustainable. * Transmilenio is funded directly by the District Government of Bogotá. * The SITP has problems with being financially sustainable based on fares taken. * In the rest of the municipalities, intermunicipal metropolitan buses are run privately, and most are financially sustainable.	* After almost six years the Metropolitano has reached equilibrium point where the outgoings of the operation are covered by customer fares. * The Metro is subsidized by central government which allows people to access the service; otherwise fares would increase and become unaffordable for some population groups.	* Transport systems operating only in Mexico City are heavily subsidized. * Lack of technical analysis of costs and income structures. * Variability between systems and jurisdictions. * The commuter train, Suburbano, represents a case of uncertain financial sustainability. * Consession services face important financial investment, maintenance and operation problems.
	Demand	Access, coverage and quality	* Good coverage in general. * Problems in terms of quality in municipalities outside the city of Bogotá.	* High coverage but low quality. * 54% of Limeños think that transportation is one of the main problems in the city. Satisfaction with public transport is very low across the city	* Coverage is high in general, but peripheral areas experience problems with frequency or even lack formal transport services. * Concession service is highly inefficient, with poor quality, poor safety and low environmental sustainability. * The BRT system, Metrobus, and the Metro operate beyond capacity, affecting quality. * The suburban train is best rated in terms of frequency, safety and quality, but is also the most expensive.

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Regional dynamics of economic performance in the EU: To what extent do spatial spillovers matter?

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Abstract. This paper investigates the main determinants of economic performance in the EU from a regional perspective, covering 253 regions over the period 2001-2008. In addition to the traditional determinants of economic performance, measured by GDP per capita, the analysis accounts for spatial effects related to externalities from neighbouring regions. The spatial Durbin random-effect panel specification captures spatial feedback effects from neighbouring regions through spatially lagged dependent and independent variables. The social-economic environment and traditional determinants of GDP per capita (distance from innovation frontier, physical as well as human capital and innovation) are found to be significant. Overall, our findings confirm the significance of spatial spillovers, as business investment and human capital of neighbouring regions have a positive impact – both direct and indirect – on economic performance of a given region.

JEL classification: 017, 031, 018, R12

Key words: Spatial Durbin Models, spatial spillovers, economic performance

1 Introduction

The declining trend in potential growth in most advanced economies started well before the Global Financial Crisis and the debate on 'secular stagnation' has gained further importance recently[1]. The evidence is even stronger in Europe where not only potential growth has gradually declined over the past decades, but also the trend of output per capita has been lagging behind the United States. In the literature, weaker growth in Europe is explained to a large extent by productivity differences, in turn related to the lag in technological diffusion. Given the heterogeneity in Europe, not only across countries but also across regions, understanding the process of growth and innovation requires taking spatial dynamics into account. Notably, spatial spillovers may matter to explain concentration effects, agglomeration economies and industry clusters.

In 2010 the European Commission launched a strategy – "Europe 2020" – to "deliver smart, sustainable and inclusive growth" (European Commission 2010a). The European regional policy finds its the origins in the Treaty of Rome, which founded the European

[1] See e.g. L. Summers, Why stagnation might prove to be the new normal, December 15, 2013. http://larrysummers.com/commentary/financial-times-columns/why-stagnation-might-prove-to-be-the-new-normal/

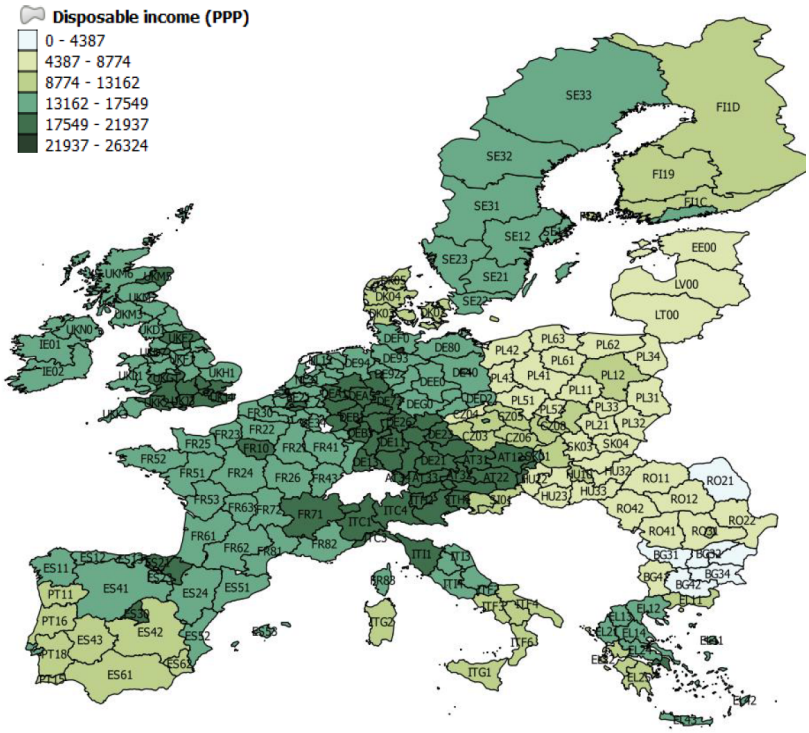


Figure 1: GDP per capita (EUR) – 2008

Economic Community in 1947. The strategy designed in 2010 aims at reforming regional policy to encourage measures to "unlock the growth potential of the EU by promoting innovation in all regions (...) by creating favourable conditions for innovation, education and research thereby encouraging R&D and knowledge-intensive investment and move towards higher value added activities" (European Commission 2010b). Overall, such policies aim at fostering market integration within Europe, while alleviating regional fragmentation. With a more integrated European market, economic growth in one region enlarges the market capacity and stimulates the mobility of factors of production and the process of innovation diffusion.

The knowledge and innovation capacity of the European regions depends on many factors including education, the availability of a skilled labour force and R&D intensity. However, it appears that performance in R&D and innovation varies markedly across EU regions (European Commission 2010b) (see Figure 1). The way innovation affects economic performance in traditional economic models has been recently questioned by empirical analyses. Indeed, the diffusion of innovation appears more complex than the traditional linear innovation model, whereby research leads to innovation, in turn creating economic growth (Bush 1945, Maclaurin 1953). These linear approaches have been challenged by recent empirical work considering research and innovation together with social and structural conditions in each region (Rodriguez-Pose, Crescenzi 2008, Usai 2011). The diffusion of innovation also depends on cross-regional spillovers and recent empirical analyses departs from pure knowledge spillovers (as in Jaffe et al. 1993) to also consider socioeconomic spillovers (as in Crescenzi et al. 2007).

Unlike our research question, most of the empirical studies focus on specific aspects of regional growth heterogeneity. For instance, some contributions focus on the link between technological innovation and regional growth (Evangelista et al. 2018), on the role of transport infrastructure endowment (Crescenzi, Rodriguez-Pose 2012) or the quality of financial institutions as determinants of regional growth (Hasan et al. 2009).

Two papers, like this paper's research focus, study the determinants of economic performance at the EU regional level from a broader perspective. First, Rodriguez-Pose, Crescenzi (2008) combine R&D, spillovers, and innovation systems approaches in one

model through a multiple regression analysis conducted for all regions of the EU-25. They included measures of R&D investment, proxies for regional innovation systems, and knowledge and socio-economic spillovers. The authors find significant contributions of innovation and innovation spillovers across regions to economic performance, but do not find any significant impact of long-term unemployment levels. Secondly, Wagner, Zeileis (2017) assess heterogeneity of growth and convergence processes based on economic growth regressions for 255 EU NUTS2 regions from 1995-2005. The starting point of the analysis is a human-capital-augmented Solow-type growth equation. Spatial dependencies are taken into account by augmenting the OLS regressions with a spatial lag. Initial GDP and the share of the working age population with high education significantly explains economic development. However, they find that the investment share in physical capital is only significant for coastal regions in the EU peripheral countries. Finally, although accounting for spatial dependencies changes the estimated coefficients, regional spillovers remain very small in their study.

This paper brings new evidence to the recent literature by investigating the main determinants of economic performance, measured by GDP per capita, in the EU from a regional perspective. In addition to the traditional determinants (such as investment, human capital development and innovation), our analysis accounts for spatial effects related to externalities from neighbouring regions. As in previous research, we develop specifications for economic performance depending on three main factors : internal innovative efforts, local socio-economic factors conducive to innovation and spatially-bound knowledge spillovers. Compared to existing work, the value added of our research is twofold. First, we take advantage of granular information by using a new database, the European Cluster Observatory dataset, covering 253 EU regions in 2001-2008 including new variables on innovation, physical and human capital. To our knowledge, no available studies use the dataset for similar purposes, wherein lies the originality of our contribution. Second, we exploit both the spatial and temporal dimensions of the dataset through the estimation of a spatial Durbin random-effect panel model, which captures spatial feedback effects from neighbouring regions through spatially lagged dependent and independent variables.

Our results show that the social-economic environment and traditional determinants (e.g. initial economic conditions, investment, human capital) have a significant impact on economic performance. Overall, our findings confirm the existence of significant spatial spillovers. In addition, business investment and human capital in the neighbouring regions are found to have a positive impact – both direct and indirect – on economic performance of a given region.

The paper is organised as follows : Section 2 presents the dataset and some derived stylised facts which will be explained by the empirical work. Section 3 gives the empirical specification used in this paper and the econometric approach followed to estimate it. Section 4 presents the empirical results and compares them with the existing literature. Section 5 concludes.

2 Dataset and stylised facts

2.1 The European Cluster Observatory dataset

The data used in this research comes from the European Cluster Observatory, an initiative of the European Commission in the context of the Europe 2020 strategy, which provides statistical information and analyses on clusters in Europe. The concept of clusters, first introduced by Porter (1990), refers to the "regional concentration of economic activities in related industries, connected through multiple types of linkages" (Ketels, Protsiv 2014), which support the development of new competitive advantages in emerging industries. Cluster policies are part of the Europe 2020 strategy to rejuvenate EU's industry. In this context, the European Cluster Observatory provides an EU-wide comparative cluster mapping with sectoral and cross-sectoral statistical analysis of the geographical concentration of economic activities and performance. The associated dataset covers a large range of series on economic performance (GDP per capita, GDP growth, productivity) as well as on its different drivers, including investment, employment, skills,

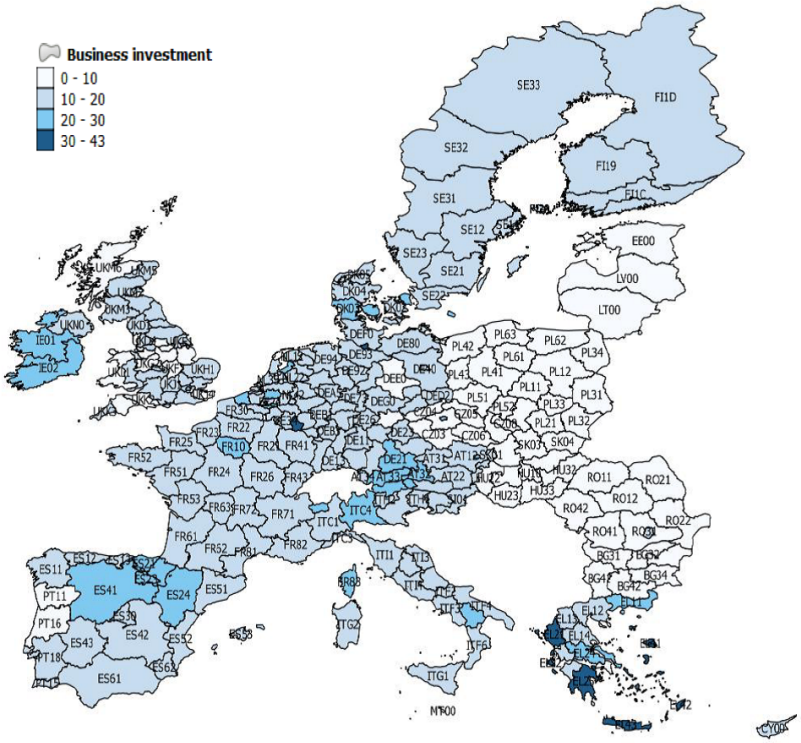


Figure 2: Business investment per employee (thousand EUR/employee) – 2008

education, R&D and innovation. The time series are available at the NUTS 2 level for the EU over the period 2001-2008.

Although the period covered may appear outdated, we justify its use for two main reasons. First, the European Cluster Observatory dataset is an exclusive database and the information details make this data unique and useful for research purposes. Indeed, compared to alternative European regional datasets (like Eurostat's regional statistics), the dataset used in this paper includes broader and more detailed information on a regions' business environment, such as labour quality, research and education, and access to venture capital and advanced infrastructure. The variables useful for our empirical analysis include in particular business investment (whereas Eurostat regional statistics mix public and private investment), skilled migrants and long-term unemployment. Such variables are key determinants of economic performance and are exclusively included in the European Cluster Observatory dataset. Second, working with pre-2008 financial crisis data makes the empirical work more stable and more meaningful to study long-term issues such as trend growth or convergence.

2.2 Stylised facts on economic performance at the European regional level

We start our analysis of the dataset with some choropleth maps and scatter plots of simple correlations. Figure 1 shows the geographical distribution of GDP per capita in 2008 (at the end of the sample) across the EU regions. Low-income regions are concentrated in the Central, Eastern and Southeastern Europe (CESEE) countries, as well as in Southern Italy and the south of Spain and Portugal. By contrast, we can identify a concentration of high-income regions in a band going from the London area to Northern Italy, including South-Western Germany, Austria and the South-East of France. The largest European cities are also among the regions with the highest income levels, although more dispersed geographically (e.g. Paris, Madrid, Brussels, Hamburg, Manchester, Edinburgh). Figure 2 provides a similar representation for data on investment per employee. Again, regions in the CESEE countries registered the lowest levels of investment, while the highest levels are in Southern Germany, Austria and Northern Italy. This gives some preliminary evidence

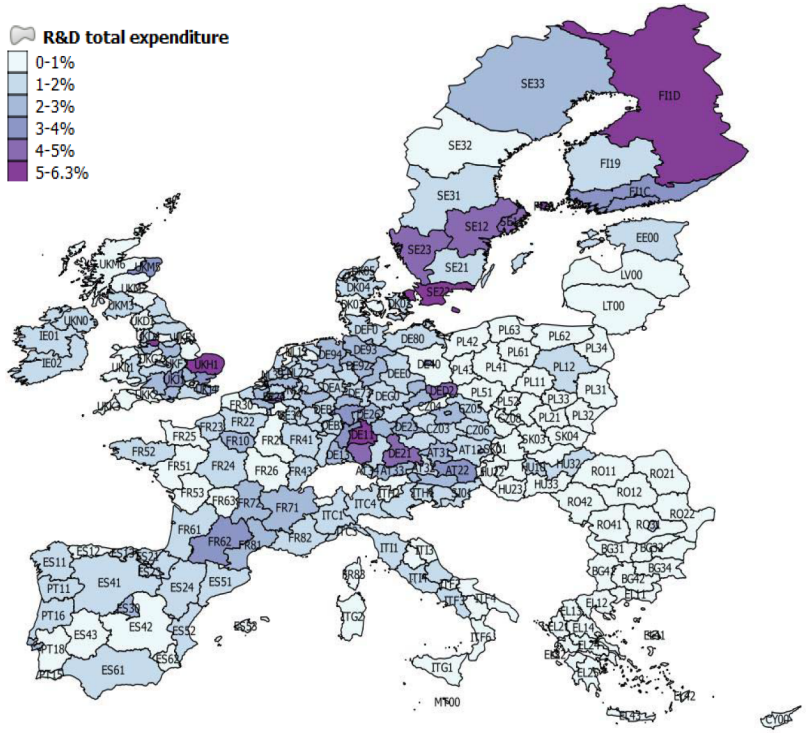


Figure 3: R&D total expenditure (as % of GDP) – 2008

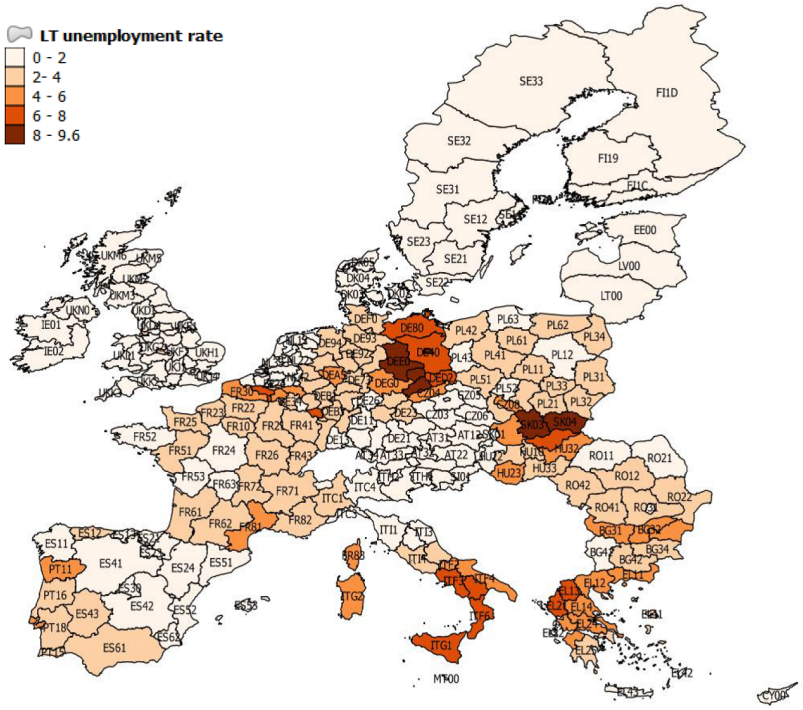
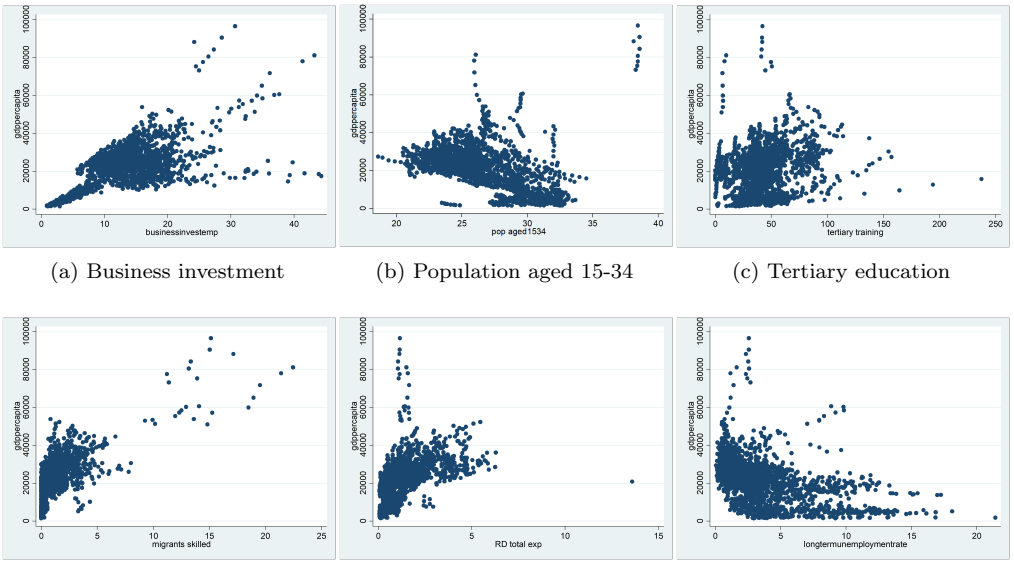


Figure 4: Long-term uneployment – 2008



(a) Business investment (b) Population aged 15-34 (c) Tertiary education

(d) Skilled migrants (e) R%D public exp. (% of GDP) (f) Long-term unemployment

Figure 5: Correlations between GDP per capita (vertical axis) and selected factors (2001-2008)

of an association between income per capita level and investment expenditures. Some high investment levels are also noticeable in Greece as well as in Spain, which may be related to the sharp increase in construction investment prior to the financial crisis in 2008. Figure 3 shows a similar picture for R&D expenditure. Although the high-income regions in the center of Europe generally show high levels of R&D expenditure ratios, specific regions in the periphery registered the highest ratios, including Finland, the south of Sweden, the regions of Cambridge and Toulouse, all known for either large innovation centers, universities or highly innovative industries. Finally, Figure 4 shows the geographical distribution of long-term unemployment. The highest levels of long-term unemployment are concentrated in a few areas, including Eastern Germany, Slovakia, some regions in Hungary, Greece, southern Italy and northern France. By contrast, the high-income regions generally have very low levels of long-term unemployed people.

Figure 5 provides a correlation analysis between GDP per capita and six different variables commonly associated with income or development level. As seen before, the positive correlation between GDP per capita and investment expenditures is confirmed. Similarly, we find a positive correlation between GDP per capita and innovation (R&D expenditure). Some positive association is also found between GDP per capita and education or percentage of labor considered high-skilled (higher education, tertiary training, skilled migrants). Again, there seems to be a negative correlation between high income and high long-term unemployment rates, which may possibly indicate that high long-term unemployment reflects structural issues that weigh on economic development. This will be further investigated in our empirical analysis.

3 Empirical specification and econometric approach

3.1 Theoretical background

The theoretical background of our research relates to the growth theory literature and the specification chosen can be seen as a Solow (1956) model augmented with human capital and technology level (Mankiw et al. 1992). At the same time, the empirical specification of the model is general enough to also be consistent with the endogenous growth models (Arnold et al. 2007). The augmented Solow model is based on a production function specification whereby output is a function of physical and human capital, labour and

technology. As shown by Boulhol et al. (2008), the long-run relationship derived from the augmented Solow model can be estimated either directly in levels or using a specification in growth terms. The estimation of the long-run relationship in levels has been used in the literature (see Mankiw et al. 1992, Hall, Jones 1999, Bernanke, Gürkaynak 2001) to analyse income level differentials and can then be applied to cross country or regional differences in economic performance, measured by GDP per capita in levels. Estimating the model in levels is also consistent with the assessment of steady-state relationships , which is a good benchmark to measure cross-regional structural differences.

The Mankiw et al. (1992) model can be written as:

$$Y_t = K_t^{\alpha} H_t^{\beta} \left(A_t L_t\right)^{1-\alpha-\beta} \tag{1}$$

where Y_t, L_t, K_t and H_t are output, labour, physical and human capital, respectively and A_t is the level of technology. L_t and A_t are assumed to grow at the exogenous rates n and g, respectively. The dynamics of the economy is determined by:

$$\dot{k}_t = \lambda_k \frac{Y_t}{A_t L_t} - (n + g + \delta) \frac{K_t}{A_t L_t} \tag{2}$$

$$\dot{h}_t = \lambda_h \frac{Y_t}{A_t L_t} - (n + g + \delta) \frac{H_t}{A_t L_t} \tag{3}$$

where λ_k and λ_h are the investment rates in physical and human capital and δ is the depreciation rate (assumed to be the same for the two types of capital).

Assuming decreasing returns to physical and human capital ($\alpha + \beta < 1$), Eq. (2) and (3) imply that the economy converges to a steady state (denoted by $*$) defined by:

$$k^* = \left(\frac{\lambda_k^{1-\beta} \lambda_h^{\beta}}{n + g + \delta} \right)^{1/(1-\alpha-\beta)} \tag{4}$$

$$h^* = \left(\frac{\lambda_k^{\alpha} \lambda_h^{1-\alpha}}{n + g + \delta} \right)^{1/(1-\alpha-\beta)} \tag{5}$$

Substituting the two steady-state forms above into (1) and taking logs gives the equation for output per capita, which gives the theoretical basis of our empirical specification:

$$\begin{aligned} \ln\left(\frac{Y_t}{L_t}\right) \quad = \quad & \ln A_0 + gt - \frac{\alpha}{1-\alpha} \ln(n + g + \delta) \\ & + \frac{\alpha}{1-\alpha} \ln(\lambda_k) + \frac{\beta}{1-\alpha} \ln(h^*) \end{aligned} \tag{6}$$

Equation (6) shows that output per capita depends on initial technology level (A_0), technological progress (g), demographic changes (n), investment in physical capital (λ_k) and the level of human capital (h^*). These variables will be included in our empirical specification, where alternative measures of these various factors will be used in the estimation.

3.2 Econometric approach

In regional science, spatial autocorrelation (or spatial dependence) refers to the situation where similar values of a random variable tend to cluster in some locations (Anselin, Bera 1998). The concept of spatial dependence is rather intuitive and has its origins in Tobler's first law of geography (Tobler 1970): "Everything is related to everything else, but near things are more related than distant things."

Applied to the economic growth literature, the inclusion of spatial effects implies that economic growth in a given country or region does not only depend on determinants in the country's own economy (e.g. savings ratio, initial GDP, population growth, technological change etc.), but also on the characteristics of the neighbouring economies (Ertur, Koch 2007).

The spatial econometric literature suggests a range of model specifications to cope with the data generating process behind spatially correlated data. Different spatial model specifications suggest different theoretical and statistical justifications. Alternative spatial regression structures arise when the spatial autoregressive process enters into combination with dependent variables (spatial autoregressive model), explanatory variables (spatial cross-regressive model) or disturbances (spatial error model). In this paper, we use a Spatial Durbin Model (SDM), which makes it possible to include simultaneously two types of spatial dependence: (i) through the dependent and (ii) through the explanatory variables. We find this approach more suitable for our research question, because while investigating the economic development of a given region, the influence of the economic performance and other economic features of neighboring regions could be determinant.

More precisely, we include business investment and human capital development of neighboring regions in our model specification. In this way, we explicitly capture the impact of industrial clusters as well as commuting and inter-regional migration patterns for economic development. In addition, the SDM provides us with larger parameter flexibility. Unlike the traditional spatial autoregressive models, the SDM allows the direct and indirect effects to have opposite signs and a varying ratio for each variable (see Section 4.3)[2].

3.2.1 Model specification

In recent years, the increasing availability of datasets tracking spatial units over time led to a growing interest in the specification and estimation of economic relationships based on spatial panels. Indeed, panel data specifications represent a large number of advantages compared to cross sectional studies. First of all, panel data are more informative and tend to contain more variation and less collinearity among observations (Elhorst 2014). Second, panel data specifications tend to increase efficiency in the estimation because of a greater degree of freedom. Panel specifications also allow addressing more complicated behavioural hypothesis, including effects that cannot be addressed using solely cross-sectional data (Baltagi 2013, Hsiao 2007).

Spatial variables are likely to differ in their background variables that may affect the dependent variable in a given spatial unit. Nevertheless, these space-specific variables tend to be difficult to measure or hard to obtain. For instance, being located close to the border or seaside, in an urban or rural area, or at the center/periphery may be a determinant to explain a socio-economic phenomenon. Overlooking these space-specific peculiarities may again lead to biased parameter estimates. A solution to this is to introduce an intercept ξ_i into the specification that captures the effect of the space-specific omitted variables. In the same way, the inclusion of the time-period specific effects controls for spatial-invariant time effects such as a specific year marked by an overall economic recession, the business cycle, introduction of new industrial policies in a given year, change in legislation, etc.

The space-time econometric model for a panel of N observations over T periods of time can be written as a SDM[3], specified as follows:

$$Y_t = \rho \mathbf{W} Y_t + \alpha \iota_N + X_t \beta + \mathbf{W} X_t \theta + \mu + \xi_t \iota_N + u_t \tag{7}$$

where Y_t is a $N \times 1$ vector of dependent variables, ι_N is an $N \times 1$ vector of ones associated with the constant term parameter α and ρ is the spatial autoregressive parameter. $\mathbf{W}$ is a non-negative $N \times N$ spatial weights matrix describing the arrangement of the units in space relative to their neighbours (with zero diagonal elements by assumption) and $\mathbf{W}Y_t$ is a spatial vector representing a linear combination of the values of the dependent variable vector from the neighbouring regions. X_t is the matrix of own characteristics and $\mathbf{W}X_t$ is the spatial lag matrix of the linear combination of the values of the explanatory variables from neighbouring observations. ρ and θ capture the strength of spatial interactions working through the dependent and explanatory variables, respectively. u_t is the stochastic

[2] For further information on the SDM specification, see LeSage, Pace (2009).

[3] The SDM is a global spillovers specification, which also involves higher-order neighbours (i.e. neighbours to the neighbours, neighbours to the neighbours of the neighbours, and so on), while the local spillovers specification involves only direct neighbours.

error term which – for the sake of simplicity – is assumed to be i.i.d. $N\left(0,\sigma^2\right)$. While μ is the time specific fixed effect, $\xi_t\iota_N$ is the spatial fixed effect.

In spatial panel models, spatial and time-period fixed effects may be treated as fixed or random effects in the same way as in traditional panel specifications[4]. The random effects model specification appears more suitable to our sample (with a relatively large N dimension), due to a smaller loss of degrees of freedom compared to the fixed effect model[5]. More importantly, the random effect specification makes it possible to estimate the coefficients of the time-invariant variables and variables that only vary a little.

In other words, the fixed-effect model would not be perfectly suitable for the analysis of economic development, which traditionally includes the level of initial GDP as an explanatory variable, as well as country dummies and possibly other structural variables that vary only marginally in time. However, as a robustness check, we also estimate the specifications reported in Tables 1 and 2 (without the initial GDP level variable and country dummies) with fixed effects. The results (available upon request) do not show qualitative differences regarding the significance level and associated signs of the parameter estimates. However, the associated coefficients, including the spatially lagged variables, are of greater magnitude in fixed effects estimations. This is probably related to omitted variables (initial GDP and country dummies) whose impact is captured by other variables. Not surprisingly, the fixed effect estimations have smaller R-squared values, suggesting a better fit of the random effect model.

In the SDM, the inclusion of the spatially lagged dependent variable into the right-hand side creates endogeneity, as the spatially lagged dependent variable $\mathbf{W}Y$ is correlated with the error term u. As a consequence, the estimation of the SDM with the OLS estimator may generate biased and inconsistent parameters and statistical inferences. Thus, in this study we use the maximum likelihood estimator proposed by Anselin (1988).

Parameters generated by spatial models which include simultaneously spatial interactions with the dependent variable, exogenous variables and the error term may be hard to interpret in a meaningful way because of the difficulty of distinguishing these interactions from each other. Therefore, in the SDM specification above we chose to only consider spatial endogenous and exogenous interactions and disregard possible spatial autocorrelation in the error term. LeSage, Pace (2009, pp. 155-158) point out that ignoring spatial autocorrelation in the error term would only cause loss of efficiency (through the inferences). On the other hand, ignoring spatial autocorrelation in the dependent or exogenous variables would require omitting relevant explanatory variables from the regression equation and may generate biased and inconsistent estimates of model parameters.

3.2.2 Partial derivatives

In traditional linear regression analyses, it is assumed that observations are independent from other. Therefore, the parameter estimates can be straightforwardly interpreted as the partial derivative of the dependent variable with respect to the explanatory variable. However, in models with spatially lagged variables, the parameter estimates also include information from the neighbours, which complicates the interpretation of the estimated parameters.

Thus, models that contain spatially lagged dependent variables exhibit a complicated derivative structure, where the standard regression coefficient interpretation of coefficient estimates as partial derivatives no longer holds:

$$\frac{\partial E\left(y_i\right)}{\partial X_{ir}} = S_r\left(W\right)_{ij}$$

Following LeSage, Pace (2009), the total impact arising from a change in explanatory

[4]While in the fixed effect model a dummy variable is introduced for $N-1$ spatial unit or $T-1$ time periods (to avoid perfect multicollinearity), in random effects model, μ_i and ξ_T are assumed to be i.i.d. random variables, independent from each other, with zero mean and variance σ_μ^2 and σ_ξ^2.

[5]Spatial fixed effects model can only be estimated consistently when N is relatively small and T is sufficiently large, since the number of observations available for the estimation of each μ is T (Elhorst 2014, pp. 41-42).

variable X_r is reflected by all elements of the matrix $S_r(W)$. The matrix expression of the own and cross partial derivatives can be expressed as follows:

$$S_r(W) = V(W)(I_n\alpha_1 + W\alpha_2) \quad (8)$$

$$V(W) = (I_n - \rho W)^{-1} = I_n + \rho W + \rho^2 W^2 + \rho^3 W^3 + \ldots \quad (9)$$

This can be broken down into direct, indirect (spatial spillovers impacts) and total impacts arising from a change in the variable X_r on average across all observations. While the diagonal elements of the $N \times N$ matrix $S_r(W)$ correspond to direct impacts, the off-diagonal elements represent indirect impacts. The direct effects can be used to test the hypothesis whether an explanatory variable has a significant effect on the dependent variable in its own economy and the indirect effects test the hypothesis whether spatial spillovers from this variable exist.

The partial derivative structure of spatial models present a reporting challenge as a dataset with N spatial units and K explanatory variables would generate K times $N \times N$ matrices of direct and indirect effects. LeSage, Pace (2009) propose to report one summary indicator for direct effects which is the average of the main diagonal elements (i.e. own partial derivatives), and one summary indicator for indirect effects, which is the average of the column (or row) sums of the off-diagonal elements of the matrix[6].

4 Empirical evidence

4.1 Distance matrix

The modelling of spatial effects requires an appropriate representation of spatial arrangement of observations. Distance-based matrices are widely used in the literature because of their exogenous nature to economic phenomenon (otherwise endogenous distance matrices would induce high non-linearity into the model). There are several types of distance-based spatial weights matrices based on contiguity (border sharing), inverse distance or a fixed number of the nearest neighbours.

In the case of our dataset, a distance matrix based on border sharing criteria contiguity would not be adequate as all countries in regional Europe do not necessarily belong to the EU. As a result, we have some empty polygons in our map (e.g. Norway, Switzerland). Therefore, we define the spatial structure as a distance decay function considering that the strength of spatial interactions declines with distance. In addition, we assume that beyond a certain critical bilateral geographic distance, interactions between provinces become negligible. To test the robustness of our results, we specify two alternative inverse distance matrices with 50km and 100km, as respective cut-off distances[7].

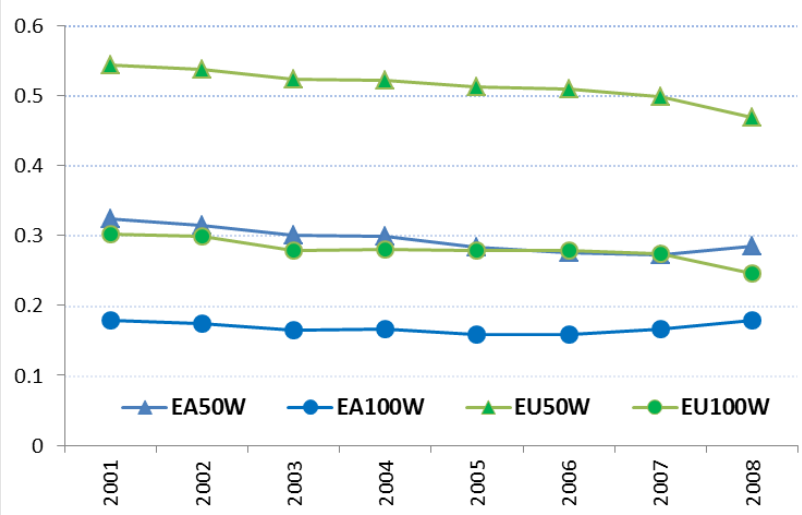
$$\mathbf{W} \begin{cases} w_{ij} = 1/d_{ij}, & \text{if} \quad d_{ij} \leq x\text{km} \\ w_{ij} = 0, & \text{if} \quad d_{ij} > x\text{km} \end{cases}$$

$\mathbf{W}$ consists of individual spatial weights w_{ij} that typically reflect the "spatial influence" of unit j on unit i. d_{ij} is the great-circle distance (calculated from the Haversine formula) between observation i and j[8] $\mathbf{W}$ is row-standardised by dividing each weight of an observation by the corresponding row sum $w_{ij}/\sum_j w_{ij}$. Whereas the original inverse-distance spatial weighting matrix is symmetric, the row-standardised one is not. This implies that, region i could have a larger influence on the random variable of interest in region j and vice-versa. By convention, the distance matrix has zeros on the main diagonal, thus no observation predicts itself.

[6] The numerical magnitude of the calculation of the indirect effects based on average row or column sums are the same. The average column effect can be interpreted as the impact of changing a particular element of an exogenous variable on the dependent variable of all other regions. The alternative interpretation based on average row sums corresponds to the impact on a particular element of the dependent variable as a result of a unit change in all elements of an exogenous variable (Elhorst 2014).

[7] In our dataset, 50km was the minimum cut-off distance which allowed all regions to have at least one neighbour.

[8] The distance between two regions is calculated using the longitudinal and latitudinal coordinates



Notes: All reported Moran's I coefficients are statistically significant at the 1% level (based on z-scores), GDP per capita in natural logarithm.

Figure 6: Moran's I coefficients for GDP per capita for the European Union and Euro Area cross-sections (2001-2008)

4.2 Spatial autocorrelation measure

Moran's I statistic (Moran 1950) is the most widely used measure to detect spatial autocorrelation. In other words, it evaluates whether the distribution pattern of a variable is clustered, dispersed, or random.

$$I = \frac{N}{S_0} \frac{\sum_{i=1}^{N} \sum_{j=1}^{N} w_{ij} \left(y_i - \widehat{y}\right) \left(y_j - \widehat{y}\right)}{\sum_{i=1}^{N} \left(y_i - \widehat{y}\right)}$$

where w_{ij} is the element of the matrix $\mathbf{W}$ corresponding to the observation pair i and j. S_0 is the sum of all w_{ij}'s and $\widehat{y}$ is the mean value of the variable of interest and N is the number of locations.

Moran's I statistic could be interpreted as the statistic measure of the covariance of the observations in nearby provinces relative to the variance of the observations across regions. The Moran's I test is based on the null hypothesis of absence of the clustering in some geographical areas. In a given year t, an index value close to 1 indicates clustering while an index value close to -1 indicates dispersion.

Moran's I statistics for GDP per capita reported below are based on two alternative distance matrix specifications with different cut-off points[9]. The positive Moran's I statistics in Figure 6 show that over the entire period of study, GDP per capita in the EU and euro area was spatially autocorrelated. In other words, GDP per capita was not randomly distributed across the EU regions and high- (low-) income values tended to cluster geographically. In addition, higher Moran's I statistics for the EU reveal stronger clustering in GDP per capita compared to the euro area. As expected, the magnitude of spatial interactions decays with distance. For both the EU and the euro area, the Moran's I coefficients are smaller for the matrix using 100km as cut-off distance. The results also show that in the EU, the level difference in Moran's I statistics generated by the two matrices are larger, probably reflecting the spread of countries across a larger geographic area.

of their respective centroids. x is the distance beyond which spatial interactions between regions are assumed to be non-existent.

[9]For the EU (euro area), EU50W corresponds to the row-standardised inverse distance spatial weights matrix with 50km as the cut-off distance while the cut-off distance is 100km in EU100W (EA100W).

Table 1: Key variables and expected signs of the parameters

Variable	Sign	Interpretation
Dependent variable		
GDP per capita		Measure of economic performance
Initial technogical level		
Initial GDP per capita	+	Knowledge available and distance to technological frontier
Innovation		
R&D public expenditure	+	Indicator of science and technology policies
Demographic/labour		
Pop. aged 15-34	+	Young population
Skilled migrants	+	Demographic changes from migration of skilled workers
Long-term unemployment	–	Degree of labour market rigidity and skill mismatch
Physical capital		
Business investment	+	Accumulation of physical capital
Human capital		
Tertiary education	+	Socio-economic conditions in educational achievements

4.3 Variables used as determinants of GDP per capita

The theoretical background presented above has determined the empirical specification used in this paper. Equation (6) includes the initial technology level, technological progress, demographic changes or labour market conditions, investment in physical capital and the level of human capital as the determinants of GDP per capita. Table 1 presents the variables used in the empirical exercise, the expected signs, and interpretation of the associated coefficients. After having tested alternative specifications including other variables available in the database we only report the most parsimonious ones with good statistical properties.

Given that the empirical modelling approach includes spillover effects from neighbouring regions through the spatially lagged dependent and explanatory variables, the drivers of economic performance will also include such external factors. We expect generally positive spillovers, confirming the economic benefits coming from knowledge and/or investment intensive neighbours. However, we cannot exclude possible crowding out effects in terms of investment (e.g. the attraction of investors in a region may reduce their investment in neighbouring regions) or human capital.

The SDM specification allows negative spillovers (indirect effects) from the neighbours although the direct effects (i.e. the impact of the explanatory variable on its own region) are positive. These potentially complex relationships could not be modelled with the use of, e.g., a spatial autoregressive model (SAR)[10], because in a SAR model the direct (the impact of a change in investment on its own economic performance) and the indirect effects (the impact of the same change on the economic performance of the neighbours and coming back to the region) have, by construction, the same sign. Furthermore, the ratio, indirect to direct effect, is identical in a SAR model for every explanatory variable (LeSage, Pace 2009, Elhorst 2012, Pace, Zhu 2012).

4.4 Empirical results

We conduct our empirical analysis based on the specification determined by Eq. (6) and using the variables included in Table 1. We run regressions both for the entire EU

[10]The SAR model includes spatial interactions only through the spatially lagged dependent variable.

Table 2: Empirical Results – Random effect – EU sample

Dep. var.: ln(GDP per capita) W = row-standardised inverse distance matrix, cut-off: 50km	[1]	[2]	[3]	[4]
$\rho\,(\mathbf{W}Y)$	0.85***	0.86***	0.71***	0.70***
$\Phi_1\,(\mathbf{W}*$bus.inv.)	0.003***	0.006***	0.006***	0.002***
$\Phi_2\,(\mathbf{W}*$tert.educ.)	-	-	0.002***	0.002***
Number of obs.	2024	2024	2024	2024
R^2	0.82	0.81	0.88	0.89
Log-likelihood	1991	1999	2217	2213
DIRECT				
GDP per capita (initial)	0.94***	0.92***	0.71***	0.70***
Business investment	0.007***	0.008***	0.005***	0.005***
R&D expenditure (% of GDP)	0.12***	0.13***	-	-
Pop aged 15-34	-	0.01***	0.01***	-
Skilled migrants	-	-	-	0.01***
Long-term unemployment	-	-	-0.02***	-0.02***
Tertiary education	-	-	0.003***	0.004***
INDIRECT				
GDP per capita (initial)	4.53***	4.80***	1.62***	1.47***
Business investment	0.05***	0.07***	0.03***	0.02***
R&D expenditure (% of GDP)	0.60***	0.67***	-	-
Pop aged 15-34	-	0.07***	0.03***	-
Skilled migrants	-	-	-	0.03***
Long-term unemployment	-	-	-0.04***	-0.04***
Tertiary education	-	-	0.02***	0.02***
TOTAL				
GDP per capita (initial)	5.48***	5.72***	2.34***	2.17***
Business investment	0.06***	0.08***	0.03***	0.02***
R&D expenditure (% of GDP)	0.73***	0.79***	-	-
Pop aged 15-34	-	0.08***	0.05***	-
Skilled migrants	-	-	-	0.04***
Long-term unemployment	-	-	-0.06***	-0.06***
Tertiary education	-	-	0.02***	0.02***

sample and for a sample restricted to euro area regions, using in all cases random-effect specifications as explained above. To account for country-specific effects, we include country dummies in our regressions. These dummies capture country-specific effects, such as economic policies taken at the national level (taxation, industrial policies and regulations in product and labour markets, ...). Concerning the distance matrix, we present here results based on the matrix with 50km as cut-off distance[11].

Tables 2 and 3 present the results for the whole EU sample and a euro area subsample respectively. After having tested a number of alternative specifications, we only report those yielding significant coefficients. The four specifications reported include the initial level of GDP per capita and business investment, but differ according to the measures of innovation, human capital or demographic/labour market indicators. Starting with the spatially lagged variables, the first interesting result concerns the large and significant spatial autoregressive coefficient $\rho\,(\mathbf{W}Y)$ confirming that being surrounded by low(high) income regions is a significant determinant of economic performance for a given region. In addition, the large spatial autoregressive coefficients in all specifications confirm the presence of significant spatial feedback effects where strong indirect effects reinforce direct effects. We also find that the investment going to the neighbouring regions,

[11] Results based on the matrix with 100km are as cut-off distance are very similar to those presented here and are available upon request.

Table 3: Empirical Results – Random effect – Euro area sample

Dep. var.: ln(GDP per capita)	[1]	[2]	[3]	[4]
W= row-standardised inverse distance matrix, cut-off: 50km				
$\rho\,(\mathbf{W}Y)$	0.70***	0.71***	0.66***	0.63***
$\Phi_1\,(\mathbf{W}*$bus.inv.)	0.010***	0.011***	0.008***	0.007***
$\Phi_2\,(\mathbf{W}*$tert.educ.)	-	-	0.003***	0.003***
Number of obs.	1264	1264	1264	1264
R^2	0.86	0.85	0.87	0.89
Log-likelihood	1599	1600	1670	1681
DIRECT				
GDP per capita (initial)	0.97***	0.97***	0.83***	0.76***
Business investment	0.006***	0.007***	0.006***	0.005***
R&D expenditure (% of GDP)	0.09***	0.09***	-	-
Pop aged 15-34	-	0.003***	0.008***	-
Skilled migrants	-	-	-	0.02***
Long-term unemployment	-	-	-0.01***	-0.01***
Tertiary education	-	-	0.003***	0.003***
INDIRECT				
GDP per capita (initial)	2.05***	2.13***	1.44***	1.16***
Business investment	0.04***	0.05***	0.03***	0.02***
R&D expenditure (% of GDP)	0.20***	0.21***	-	-
Pop aged 15-34	-	0.007***	0.01***	-
Skilled migrants	-	-	-	0.03***
Long-term unemployment	-	-	-0.02***	-0.02***
Tertiary education	-	-	0.01***	0.01***
TOTAL				
GDP per capita (initial)	3.02***	3.10***	2.27***	1.92***
Business investment	0.05***	0.05***	0.04***	0.03***
R&D expenditure (% of GDP)	0.29***	0.30***	-	-
Pop aged 15-34	-	0.01***	0.02***	-
Skilled migrants	-	-	-	0.05***
Long-term unemployment	-	-	-0.03***	-0.03***
Tertiary education	-	-	0.02***	0.01***

$\Phi_1\,(\mathbf{W}*$bus.inv.), has a positive effect on economic development of a given region, ruling out a possible crowding out effect on investment. This confirms our intuition that industrial clusters (i.e. highly invested regions) are important drivers of economic development. In the same way, the availability of well-educated human capital, $\Phi_2\,(\mathbf{W}*$tert.educ.) , in the neighbouring regions is found to have a positive impact on own economic development, most probably through commuting and inter-regional migration of the skilled workforce.

Moving to the other explanatory variables, traditional variables used in the literature are found significant. We find in all specifications a positive impact of initial GDP per capita, which proxies the initial technology level (i.e. the closer to the technological frontier, the higher the performance). The accumulation of both physical capital (business investment) and human capital (tertiary education) appear to significantly determine regional income. Demographic factors have also a positive and significant impact on income level, such as the share of young population (population aged 15-34) or demographic changes from migration of skilled workers. Concerning innovation, only public R&D expenditure is found to be statistically significant, which may point to the role of European governments in financing innovation, either to complement market failures or to provide financing at seed and initial stage. Finally, the negative coefficient of long-term unemployment is likely to signal that labour market rigidities and/or skill mismatch create inefficiencies hindering economic performance.

The results show the presence of significant indirect effects. We interpret the indirect

effect of initial GDP per capita (which is a time invariant variable) as follows: a high level of technology also helps the development of surrounding regions, leading to positive spillovers reinforcing the initial direct effects. The economic interpretation of the other indirect effects is rather straightforward; overall they amplify the direct impact of the explanatory variable through spatial feedbacks (i.e. the spatial multiplier effect).

The majority of country dummies are found to be significant, showing the relevance of country-specific effects in explaining economic performance. Therefore, the inclusion of these dummies improves the performance of the model estimations, while not qualitatively changing the outcomes of the estimations (see Appendix Tables A.3 and A.4 for estimates excluding country dummies for the EU and the euro area samples respectively).

Finally, the results for the euro area subsample are fairly similar to those of the whole EU, showing that our specification is robust to different country samples. A few differences are however worth pointing out. First, the spatial autoregressive coefficient $\rho(\mathbf{W}Y)$ is higher for the EU sample, which leads to significantly larger feedback effects complementing the direct effects. Moreover, the coefficient of initial GDP per capita is higher for the euro area as regards the indirect effects, meaning that the initial level of technology is more important to explain economic performance in the euro area than in the EU regions. Given the larger presence of mature economies in the euro area sample this result appears rather intuitive: an economy initially close to the technological frontier is expected to remain among the best performers over time. Indeed, technology diffusion is a slow process requiring long periods to significantly enhance economic performance. However, due to data limitations, the initial GDP in 2000 is too close to the end period of 2008 to allow for the diffusion process to fully take place. Concerning total effects, the EU sample has nevertheless stronger coefficients associated with initial GDP per capita, driven by stronger indirect effects.

4.5 Comparison with previous studies

The variables used as determinants of regional growth are similar to Rodriguez-Pose, Crescenzi (2008), and, like them, we find significant contributions to innovation and innovative spillovers across regions. However, while they ignored a few key determinants of economic performance, like business investment or skilled migrants, our results show their important contribution to regional economic performance. Moreover, unlike Rodriguez-Pose, Crescenzi (2008), who do not find any significant role for long-term unemployment, this determinant appears as a key negative factor for economic performance in our empirical evidence. Finally, our results show stronger regional spillovers, which could be explained by important differences in the modelling approach. While Rodriguez-Pose, Crescenzi (2008) obtain their empirical evidence by estimating heteroskedasticity-consistent OLS regressions, we chose to use SDM specifications to model explicitly cross-regional spillovers. Like Wagner, Zeileis (2017), initial GDP and the share of highly educated in the working age population also significantly explains economic development. However, while they find that the investment share in physical capital is only significant for coastal regions in the EU peripheral countries, our results clearly point to a key role given to business investment in explaining heterogeneity in economic performance. This difference may be explained by the fact that Wagner, Zeileis (2017) use data that mix private and public capital. Such a limitation seems to lead to a critical underestimation of the role of business investment (in a given region but also in its neighbours) in the growth process. Their study also ignores the role of innovation and skilled migrants as determinants of economic performance and does not take into account long-term unemployment as a structural barrier to growth. These variables also appear as key determinants in our results.

Overall, thanks to the use of the original data included in the European Cluster Observatory dataset, our results appear closer to the theoretical prediction given by the human-capital-augmented Solow-type growth equation à la Mankiw et al. (1992). Moreover, our modelling approach based on the SDM enables us to explicitly capture spatial effects from neighbouring regions. Finally, studying within the EU sample the subset of regions belonging to the euro area, brings additional insights concerning the role of the initial level of technology to explain economic performance in more advanced economies.

5 Concluding remarks

Our results show that social-economic environment and traditional determinants of economic performance (distance from innovation frontier, physical and human capital and innovation) are significant. They also confirm the relevance of spatial spillovers, whereby strong indirect effects reinforce direct effects. In particular, we find that business investment and human capital of the neighbouring regions have a positive impact – both direct and indirect – on economic performance of a given region. At the same time, structural inefficiencies related to labour market rigidities and/or skill mismatch are found to hinder economic performance. These results encourage the pursuit of structural reforms in stressed European countries and, if possible, at the regional level to boost growth and competitiveness.

Overall, our results confirm the existence of high-income clusters (mostly located in the center of Western Europe) and their positive effects on the development of the neighbouring regions. From a policy perspective, this implies that the creation of growth poles specialised in innovative and high growth potential activities could be a strategy for Europe to catch up with the US in terms of technology and trend output. Our methodological approach focuses on the summary measures of the average spatial effects. Further research is warranted in identifying and quantifying the spillovers coming from specific clusters in a regional or European context. Furthermore, with better data availability exploring the sectoral dimension of the clusters would be insightful.

References

Abreu M, DeGroot H, Florax L, J R (2005) Space and growth: A survey of empirical evidence and methods. *Région et Développement* 21: 13–44

Aghion P, Howitt. P (1992) A model of growth through creative destruction. *Econometrica* 60[2]: 323–351. CrossRef.

Anselin L (1988) *Spatial Econometrics: Methods and Models*. Kluwer Academic, Dordrecht. CrossRef.

Anselin L, Bera A (1998) Spatial dependence in linear regression models with an introduction to spatial econometrics. In: Ullah A, E. D, Giles A (eds), *Handbook of Applied Economic Statistics*. Marcel Dekker, New York, 237–289

Anselin L, Le Gallo J, Jayet H (2008) Spatial panel econometrics. In: Matyas L, Sevestre P (eds), *The Econometrics of Panel Data, Fundamentals and Recent Developments in Theory and Practice* (3rd ed.). Springer-Verlag, Berlin, 627–662. CrossRef.

Arnold J, Bassanini A, Scarpetta S (2007) Solow or Lucas?: Testing growth models using panel data from OECD countries. OECD Working Paper No 592

Baltagi B (2013) *Econometric analysis of panel data* (5th ed.). Wiley, Chichester

Bernanke BS, Gürkaynak RS (2001) Is growth exogenous? Taking Mankiw, Romer and Weil seriously. NBER Macroeconomics Annual

Boulhol H, de Serres A, Molnar M (2008) The contribution of geography to GDP per capita. *OECD Journal: Economic Studies*. CrossRef.

Bush V (1945) Science: The endless frontier. U.S. Office of Scientific Research and Development, Report to the President on a Program for Postwar Scientific Research, Government Printing Office, Washington, D.C.

Crescenzi R (2005) Innovation and regional growth in the enlarged Europe: The role of local innovative capabilities, peripherality, and education. *Growth and Change* 36: 471–507. CrossRef.

Crescenzi R, Rodriguez-Pose A (2012) Infrastructure and regional growth in the European Union. *Papers in Regional Science* 91[3]: 487–615. CrossRef.

Crescenzi R, Rodríguez-Pose A, Storper. M (2007) The territorial dynamics of innovation: A Europe-United States comparative analysis. *Journal of Economic Geography* 7[6]: 673–709. CrossRef.

Elhorst JP (2012) Dynamic spatial panels: Models, methods and inferences. *Journal of Geographical Systems* 14: 5–28. CrossRef.

Elhorst JP (2013) Spatial panel models. In: Fischer MM, Nijkamp P (eds), *Handbook of Regional Science*. Springer, Berlin, Chapter 82. CrossRef.

Elhorst JP (2014) *Spatial econometrics: From cross-sectional data to spatial panels*. Springer, Berlin New York Dordrecht London. CrossRef.

Ertur C, Koch W (2007) Growth, technological interdependence and spatial externalities: Theory and evidence. *Journal of Applied Econometrics* 22: 1033–1062. CrossRef.

European Commission (2010a) Europe 2020: A strategy for smart sustainable and inclusive growth. COM (2010) 2020

European Commission (2010b) Regional policy contributing to smart growth in Europe 2020. Communication from the Comission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions. COM(2010) 553

Evangelista R, Meliciani V, Vezzani A (2018) Specialisation in key enabling technologies and regional growth in Europe. *Economics of Innovation and New Technology* 27[3]

Grossman GM, Helpman E (1991) *Innovation and Growth in the Global Economy*. MIT Press, Cambridge, MA

Hall R, Jones C (1999) Why do some countries produce so much more output per worker than others? *Quarterly Journal of Economics* 114[1]: 83–116. CrossRef.

Hasan I, Koetter M, Wedow M (2009) Regional growth and finance in Europe: Is there a quality effect of bank efficiency? *Journal of Banking and Finance* 33[8]: 1446–1453. CrossRef.

Hsiao C (2007) Panel data analysis – Advantages and challenges. *TEST: An Official Journal of the Spanish Society of Statistics and Operations Research* 16[1]: 1–22

Jaffe A, Trajtenberg M, Henderson R (1993) Geographic localization of knowledge spillovers as evidenced by patent citations. *Quarterly Journal of Economics* 108[3]: 577–98. CrossRef.

Ketels C, Protsiv S (2014) Methodology and finding report for a cluster mapping of related sectors. European Cluster Observatory Report. European Commission

LeSage J, Pace R (2009) *Introduction to Spatial Econometrics*. CRC Press, Boca Raton, FL. CrossRef.

LeSage JP (2014) What regional scientists need to know about spatial econometrics. *The Review of Regional Studies* 44[1]: 13–32

Maclaurin W (1953) The sequence from invention to innovation and its relation to economic growth. *Quarterly Journal of Economics* 67[1]: 97–111. CrossRef.

Mankiw GN, Romer D, Weil D (1992) A contribution to the empirics of economic growth. *Quarterly Journal of Economics* 107[2]: 407–437. CrossRef.

Moran PAP (1950) A test for the serial dependence of residuals. *Biometrika* 37: 178–181. CrossRef.

Pace RK, Zhu S (2012) Separable spatial modeling of spillovers and disturbances. *Journal of Geographical Systems* 14[1]: 75–90. CrossRef.

Porter M (1990) *The Competitive Advantage of Nations.* The Free Press, New York. CrossRef.

Rodriguez-Pose A (2014) Innovation and regional growth in Mexico: 2000-2010. CEPR Discussion Paper No. 10153

Rodriguez-Pose A, Crescenzi R (2008) R&d, spillovers, innovation systems and the genesis of regional growth in Europe. *Regional Studies* 42[1]: 51–67

Solow R (1956) A contribution to the theory of economic growth. *Quarterly Journal of Economics* 70[1]: 65–94

Tobler W (1970) A computer movie simulating urban growth in the Detroit region. *Economic Geography* 46: 234–40. CrossRef.

Usai S (2011) The geography of inventive activities in OECD regions. *Regional Studies* 45[6]: 711–731. CrossRef.

Wagner M, Zeileis A (2017) Heterogeneity and spatial dependence of regional growth in the EU: A recursive partitioning approach. German economic review, forthcoming

A Appendix A

Table A.1: Empirical Results - Random effect - EU sample country dummy coefficients (total effect)

Dep. var.: ln(GDP per capita) W= row-standardised inv. dist. matrix, cut-off=50km	[1]	[2]	[3]	[4]
Germany (benchmark)	-	-	-	-
Austria	1.73***	1.85***	0.51*	0.51**
Belgium	-0.22	-0.39	-0.23	-0.20
Bulgaria	7.59***	7.42***	1.76***	1.68***
Cyprus	3.89***	3.44***	1.20*	1.37**
Czech Rep.	4.63***	4.34***	0.98***	1.10***
Denmark	-0.56	-0.57	-0.66**	-0.57**
Estonia	4.75***	4.61***	0.58	0.57
Spain	2.03***	1.64***	0.16	0.37*
Finland	2.91***	3.21***	0.31	0.33
France	2.51***	2.55***	0.95***	0.95***
Greece	3.85***	3.89***	1.24***	1.36***
Hungary	6.41***	6.20***	1.41***	1.42***
Ireland	0.44	0.02	-0.17	0.13
Italy	0.90***	0.86***	-0.12	-0.01
Lithuania	5.09***	4.92***	0.65	0.75
Luxembourg	0.73	0.69	0.95	0.29
Latvia	4.67***	4.31***	0.29	0.38
Malta	1.31	0.95	-0.28	-0.08
Netherland	-0.22	-0.36	-0.48**	-0.37*
Poland	4.40***	3.96***	0.45	0.66**
Portugal	1.63***	1.33*	-0.24	-0.07
Romania	9.00***	8.86***	2.09***	2.11***
Sweden	0.26	0.25	-0.71**	-0.64**
Slovenia	2.42*	2.00	0.22	0.40
Slovakia	5.52***	5.10***	1.35***	1.56***
United Kingdom	-0.56*	-0.65*	-0.50***	-0.45*

Table A.2: Empirical Results - Random effect - EA sample country dummy coefficients (total effect)

Dep. var.: ln(GDP per capita)	[1]	[2]	[3]	[4]
W = row-standardised inverse distance matrix, cut-off: 50km				
Germany (benchmark)	-	-	-	-
Austria	-0.76***	-0.73***	-0.37***	-0.37***
Belgium	-1.17***	-1.17***	-0.57***	-0.60***
Cyprus	0.78	-0.12	0.30	0.22
Spain	-1.11***	-1.09***	-0.46***	-0.47***
Estonia	1.62***	1.67***	0.66**	0.32
Finland	0.60***	0.71***	0.25	0.21
France	-0.68***	-0.65***	-0.21**	-0.21**
Greece	0.05	0.05	0.27**	0.21*
Ireland	-0.82**	-0.87**	-0.65**	-0.48*
Italy	- 0.72	- 0.72	- 0.45***	-0.41***
Lithuania	1.37***	1.56***	0.48***	0.25
Luxembourg	-0.54	-0.62	0.31	-0.39
Latvia	1.45***	1.54***	0.44	0.19
Malta	-0.31	-0.29	-0.33	-0.37
Netherland	- 1.02***	- 1.02***	-0.63***	-0.56***
Portugal	-0.11	-0.10	-0.25*	-0.28*
Slovenia	-0.53	-0.56*	-0.48*	-0.43*
Slovakia	0.62***	0.62***	0.20	0.12

Table A.3: Empirical Results – Random effect – EU sample without country dummies

Dep. var.: ln(GDP per capita) W= row-standardised inv. dist. matrix, cut-off=50km	[1]	[2]	[3]	[4]
$\rho\,(\mathbf{W}Y)$	0.83***	0.85***	0.70***	0.68***
$\Phi_1\,(\mathbf{W} * \text{bus.inv.})$	0.005***	0.008***	0.008***	0.005***
$\Phi_2\,(\mathbf{W} * \text{tert.educ.})$	-	-	0.002***	0.002***
Number of obs.	2024	2024	2024	2024
R^2	0.69	0.68	0.79	0.80
Log-likelihood	1924	1935	2158	2152
DIRECT				
GDP per capita (initial)	0.48***	0.50***	0.52***	0.49***
Business investment	0.008***	0.008***	0.006***	0.005***
R&D expenditure (% of GDP)	0.12***	0.12***	-	-
Pop aged 15-34	-	0.02***	0.01***	-
Skilled migrants	-	-	-	0.01***
Long-term unemployment	-	-	-0.02***	-0.02***
Tertiary education	-	-	0.004***	0.004***
INDIRECT				
GDP per capita (initial)	2.11***	2.38***	1.11***	0.94***
Business investment	0.06***	0.09***	0.04***	0.02***
R&D expenditure (% of GDP)	0.53***	0.58***	-	-
Pop aged 15-34	-	0.08***	0.03***	-
Skilled migrants	-	-	-	0.03***
Long-term unemployment	-	-	-0.04***	-0.04***
Tertiary education	-	-	0.01***	0.01***
TOTAL				
GDP per capita (initial)	2.59***	2.88***	1.64***	1.43***
Business investment	0.07***	0.09***	0.04***	0.03***
R&D expenditure (% of GDP)	0.65***	0.71***	-	-
Pop aged 15-34	-	0.09***	0.05***	-
Skilled migrants	-	-	-	0.04***
Long-term unemployment	-	-	-0.05***	-0.06***
Tertiary education	-	-	0.02***	0.02***

Table A.4: Empirical Results – Random effect – Euro area sample without country dummies

Dep. var.: ln(GDP per capita) W= row-standardised inv. dist. matrix, cut-off=50km	[1]	[2]	[3]	[4]
$\rho\,(\mathbf{W}Y)$	0.69***	0.70***	0.63***	0.58***
$\Phi_1\,(\mathbf{W}*$bus.inv.)	0.011***	0.012***	0.009***	0.009***
$\Phi_2\,(\mathbf{W}*$tert.educ.)	-	-	0.004***	0.003***
Number of obs.	1264	1264	1264	1264
R^2	0.71	0.68	0.82	0.84
Log-likelihood	1529	1530	1632	1644
DIRECT				
GDP per capita (initial)	0.68***	0.69***	0.69***	0.63***
Business investment	0.007***	0.007***	0.006***	0.005***
R&D expenditure (% of GDP)	0.08***	0.08***	-	-
Pop aged 15-34	-	0.005***	0.010***	-
Skilled migrants	-	-	-	0.02***
Long-term unemployment	-	-	-0.01***	-0.01***
Tertiary education	-	-	0.003***	0.003***
INDIRECT				
GDP per capita (initial)	1.33***	1.42***	1.02***	0.77***
Business investment	0.05***	0.05***	0.03***	0.03***
R&D expenditure (% of GDP)	0.15***	0.16***	-	-
Pop aged 15-34	-	0.01***	0.01***	-
Skilled migrants	-	-	-	0.02***
Long-term unemployment	-	-	-0.02***	-0.02***
Tertiary education	-	-	0.01***	0.01***
TOTAL				
GDP per capita (initial)	2.01***	2.11***	1.71***	1.40***
Business investment	0.05***	0.06***	0.04***	0.03***
R&D expenditure (% of GDP)	0.23***	0.24***	-	-
Pop aged 15-34	-	0.01***	0.02***	-
Skilled migrants	-	-	-	0.04***
Long-term unemployment	-	-	-0.03***	-0.03***
Tertiary education	-	-	0.02***	0.01***

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Market Access and the Concentration of Economic Activity in a System of Declining Cities

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Abstract. While the positive effect of market access (MA) on population and economic growth has shown to be robust, the results in the literature were obtained in a context of population growth. This article examines the impact that MA has on a system of cities that has suffered a negative population shock. An extended version of the Brezis, Krugman (1997) model of life cycle of cities predicts that a system of cities experiencing population loss will see a relative reorganization of its population from small to larger cities, increasing population concentration. Accordingly, cities with higher MA will lose relatively more. We confirm these predictions using multiple definitions of MA with a comprehensive sample of cities in Eastern Europe and Central Asia, a region with declining population growth since 1990.

Key words: Market access, urban decline, demographic transition, Eastern Europe and Central Asia

1 Introduction: Market Access in a Declining System of Cities

Agglomeration economies quantify the impact on firms and worker's incomes of being located in larger and denser local markets (Combes, Gobillon 2015). Since firms trade with distant markets, these agglomeration economies can have spillovers. The trade literature has documented that the strength of these spillovers between countries can be determined positively by the size of the economies and negatively by its trading costs, usually measured with distance (Head, Mayer 2004), following gravity models (Anderson 1979).

The spillovers of agglomeration economies can be measured by market access (MA), a measure that is similar to market potential, but that leaves the focus economy size out to capture the partial effect of proximity to other markets. Empirical work often follows Harris (1954) and defines trade costs as being proportional to the inverse of distance. Using a notation similar to Henderson, Wang (2007), we define city MA:

$$MA_i(t) = \sum_{k \in j | j \neq i}^{N_{jt}-1} \frac{n_k(t)}{d_{ik}} \tag{1}$$

where n is a measure of market size[1], d_{ik} is the distance between city i and k, and N_{jt} is the total number of cities at time t[2].

Higher MA is expected to benefit the city's economy through higher average effective demand and average lower transportation costs for its exports to other cities. This increased demand applies to tradeable goods, but in equilibrium can affect local labor and non-tradeables. The positive effect of MA on economic output and population growth has been predominant in empirical results. Head, Mayer (2006), Bosker et al. (2010), and Combes et al. (2010) find that MA significantly increases local regional wages in different European regions. Fallah et al. (2010) find similar results for the US. These patterns have been less studied for developing economies but there are some robust results, such as Au, Henderson (2006) for China, Amiti, Cameron (2007) for Indonesia, and Quintero, Roberts (2018) for Latin America. To our knowledge, only one study has previously found a negative effect of MA (Duranton 2016).

The previous results focus on the impact of MA on productivity measured through wages. This is closely related to our analysis, but we focus instead on the effect on population growth, which is affected by differences in productivity too (Harris, Todaro 1970). Henderson, Wang (2007) and Redding, Sturm (2008) test the effect of MA precisely on population growth and find again a positive effect. Combes, Gobillon (2015) summarize estimates of MA impact and conclude that the positive effect of the economic size of distant locations and the spatial decay of this effect are rarely rejected empirically. These results have been obtained in a context of population growth. To test what would happen in the context of population decline, we perform our analysis in Eastern Europe and Central Asia, a region that has suffered a dramatic population decline in the last decades.

In contrast to most literature, we find a negative effect of MA. In a system of declining (population) cities, having a higher MA is found to be detrimental to population growth relative to the national trend. This result is robust to MA measures that use population. Alternative measures that use NLs are tested, and the results are weaker. These findings are in line with the theoretical predictions in Quintero, Restrepo (2017), which use the model found in Brezis, Krugman (1997) to simulate city population growth under the effects of a negative population shock and predict a relative reorganization of the urban population from small to larger cities. These findings highlight the importance of the insight in Glaeser, Gyourko (2005), which suggests population decline should be studied specifically and not assumed as a mirror image of positive growth.

A possible explanation for the negative impacts of MA in a declining system of cities is the effect it has on relative real income in the short run. The main prediction in Quintero, Restrepo (2017) is that a decline in population will have two main effects. First, differences in nominal wages across cities will be slow to adjust because productivity depends on historical cumulative production. Second, local costs, especially housing, will adjust downwards, creating a wedge between productivity and costs that were formerly balanced by the spatial equilibrium. This creates incentives for labor to reallocate from smaller to larger (formerly more productive) cities. In this context, MA can act as a push factor (an incentive to move out to get better pay elsewhere), as opposed to the traditional interpretation as a pull factor (an incentive to produce in a place that has access to larger markets to sell its local products).

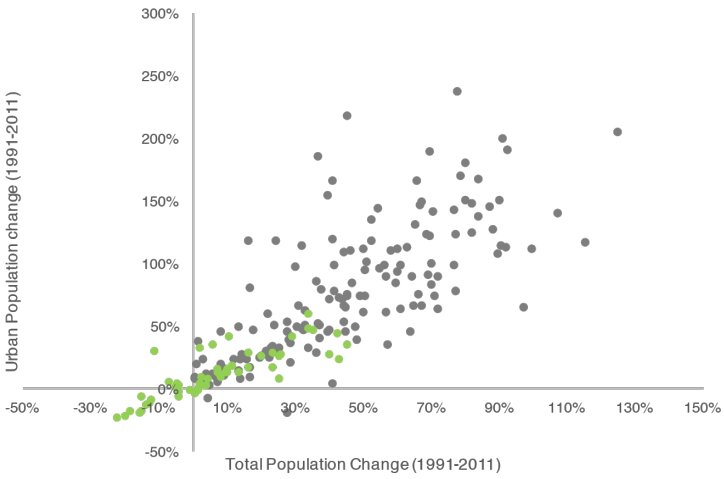
2 Eastern Europe and Central Asia: A system of cities with declining population and increasing concentration

Eastern Europe and Central Asia (ECA)[3] has gone through a drastic population decline. 65% of the cities lost population between 1989 and 2010, with an average loss of 21%

[1] These markets are sometimes measured by local GDP. We use population to measure market size, and night lights (NLs) as a proxy in a robustness test.

[2] Fujita et al. (1999) emphasize that under imperfect competition, Harris' specification would need to include local prices. We lack this data and thus use the specification in equation (1), which is common. This is a differenced and linearized version of Au, Henderson (2006).

[3] ECA is Easter Europe and Central Asia as classified by the World Bank. The countries included are: Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Georgia, Kazakhstan, Kosovo, Kyrgyz Republic, Macedonia, Moldova, Montenegro, Romania, Russian Federation, Serbia, Tajikistan, Turkey, Turkmenistan, Ukraine, and Uzbekistan.



Source: UN World Population Prospects

Figure 1: Urban and total population growth, ECA (green) countries versus rest

for declining cities[4]. Table 1 gives an overview of the urban systems we use in our analysis. 11 out of 15 countries present negative population growth in at least one of the decades analyzed, while the others present low positive population growth. All present a decline in growth trends observed before 1989 (see footnote 5). Decline happens all across the city size distribution, as can be seen by comparing declining cities in different size subsamples. Furthermore, the decline is happening in cities that hold an important share of the national population. Figure 1 illustrates the extent of urban population decline of countries in the ECA region compared to others in the world. In particular, this is partially explained by declining fertility rates (Table 2) that have not been offset by immigration (Figure 2).

This structural change in the population trends began at a crucial moment in the history of the region, between 1989 and 1990, when the countries in the region that had command and control economies transitioned into market economies either because of the separation of the USSR or as part of independent reform movements (the earliest transition is observed in December 1989 and the latest in March 1992). It is not surprising that many ECA cities would lose population as they transition to a market economy. Many were probably artificially large given the influences of a command economy on industry and population location prior to the transition. More freedom of movement after this transition implied actual population movement, as people left unproductive and sectoral concentrated cities, and focused on more diverse ones (Andrienko, Guriev 2004, Commander et al. 2011, Kofanov, Mikhailova 2015). Similar patterns have been studied for the rust belt in the US (Yoon 2017) and Germany (Redding, Sturm 2008).

We take this population decline as an exogenous departure point or shock in our empirical work[5]. Thus, we do not attempt to further explain this shock but measure how MA affected cities heterogenous reaction to this shock.

[4]In contrast, the counties covered by Glaeser, Gyourko (2005), which studies population decline in metropolitan areas in the US, only show 6.72% of the counties considered losing population, with an average loss of 9%.

[5]We expect this structural population shock to occur precisely around 1989 because of the large economic and political regional changes discussed above. To confirm, we regress time on country dummies and population levels for the period 1960-2017, allowing for a structural break in one year in slope and constant. Iteratively, all years are tested as transition periods. As expected, 1990 is confirmed to be the year in which all countries present a statistically significant structural change. One year before (1989) and one and two years after (1991, 1992) also reject this hypothesis for some countries, but not for all. We also calculate the tests for structural break found in Gendron-Carrier et al. (2017) and confirm 1990 as the year with a structural break.

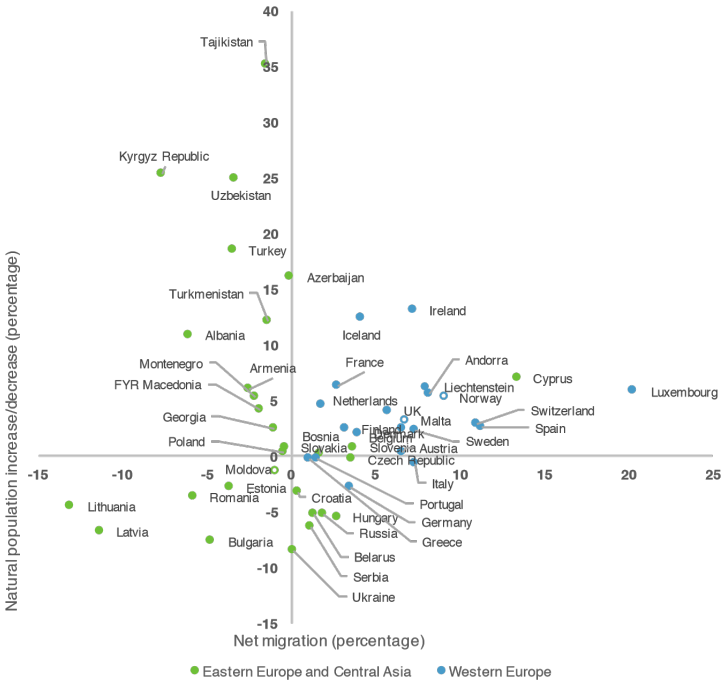
Table 1: Summary statistics

Country	Period	Total population change (annual)	Urban population change (annual)	% of population living in shrinking cities	% of cities losing population		
					all	>30k	>100k
Albania	1989-2001	-0.2	1.08	14.12	27.42	10	0
	2001-2011	-0.55	1.65	47.25	82.26	60	0
Belarus	1989-2001	-0.16	0.47	-	-	-	-
	2001-2014	-0.39	0.22	26.87	70.8	43.33	21.43
Bulgaria	1989-2001	-0.87	-0.47	-	-	-	-
	2001-2013	-0.81	-0.42	67.66	94.7	91.11	55.56
Georgia	1989-2002	-0.67	-1.06	96.45	94.44	87.5	100
	2002-2014	0.2	0.35	6.92	31.48	0	0
Kazakhstan	1989-1999	-0.62	-0.68	59.8	69.86	67.92	68.18
	1999-2015	0.85	0.54	5.8	21.92	13.21	0
Kyrgyz Rep.	1989-1999	1.25	0.52	25.76	75.61	68	75
	1999-2013	1.21	1.2	12.49	42.86	33.33	0
Moldova	1989-2000	-0.04	-0.17	74.97	55.77	80	100
	2000-2015	-0.16	-0.31	40.88	81.13	80	0
Poland	1989-2003	0.06	0.13	-	-	-	-
	2003-2011	-0.04	-0.21	64.06	52.94	68.21	82.05
Romania	1992-2002	-0.51	-0.71	95.52	93.57	95.45	100
	2002-2011	-0.93	-0.73	90.41	90.86	92.54	90
Russia	1989-2000	-0.01	0.004	50.15	65.19	54.51	50.92
	2000-2010	-0.27	-0.23	42.15	73.61	63.04	48.17
Serbia	1991-2002	-0.09	0.43	50.9	46.37	55	60
	2002-2011	-0.36	-0.03	50.94	71.91	51.28	11.11
Tajikistan	1989-2000	1.75	0.02	-	-	-	-
	2000-2014	2.05	2.03	2.38	5.26	7.69	0
Turkey	1989-2000	1.61	2.73	-	-	-	-
	2000-2012	1.31	2.19	7.77	59.23	12.77	4.17
Ukraine	1989-2001	-0.43	-0.34	83.29	80	79.41	73.33
	2001-2013	-0.59	-0.35	75.48	82.06	81.02	75.56
Uzbekistan	1990-2000	1.87	1.15	11.88	10.17	9.84	22.22
	2000-2014	1.56	1.33	5.85	11.86	8.2	11.11

Table 2: Fertility Rates

sub-region	1960-1989	1989-2000	2000-2014
Belarus, Moldova, Ukraine, Russia	2.25	1.61	1.36
Central Europe, Baltic Countries	2.16	1.54	1.39
Central Asia	5.12	3.41	2.74
Eastern Europe, Central Asia	2.40	1.72	1.65
World	4.26	2.95	2.54

Source: World Development Indicators



Source: UN World Population Prospects

Figure 2: Net migration and natural and total population growth, ECA (green) countries versus rest

3 Estimation of the Role of Market Access

Under this context declining population, we estimate the role of MA. We use the following estimating equation:

$$\Delta p_i = \beta_1 n_i + \beta_2 MA_i + \text{controls}_{i,c} \tag{2}$$

where Δp_i is the annual percentage population change between years 2 and 3 (specified in Table 1), n_i is the initial local market size, MA_i is the MA defined in (1), variables are introduced in logarithms. We build controls for migration, fertility, and natural population growth rates, which vary by country c. We also control for secondary cities and groups of cities in agglomerations and include six location fundamental controls: (i) distance to border, (ii) distance to coast, (iii) forest coverage, (iv) annual precipitation, (v) average temperature in January and (vi) land usability.

Finally, to assuage any concern that the interpretation of our results which assumes a market economy for this region might be flawed, the population growth we use is calculated around 11 years after the transition, where population decline is still happening but the region's economic systems have probably fully transitioned. Figures B.1 and B.2 shows economic indices constructed to measure, to the extent that this is possible, integration to a market economy system. The indices indicate that, at the time of our analysis, the economic systems of the countries are at least as market oriented as those of other developing regions.

3.1 Identification

We are interested in the effect of MA in the relative loss of population of cities. MA can be endogenous to population change. For instance, natural features can provide advantages that affect population growth, and at the same time affect the probability of more towns locating closer together in nearby areas, increasing MA. The endogeneity is also suggested by Hausman tests. We use instrumental variables that affect population change only through their effect on MA: a measure of city centrality calculated as the

Table 3: Specifications of market access

transportation costs, market size	population	NL
geodetic distance	MA(g,pop)	MA(g,nl)
driving distance	MA(d,pop)	MA(d,nl)

distance of each city to the center of the country; and a measurement of ranking of the city's size within its country. These instruments perform well in a first stage, and pass Sargan's test of overidentifying restrictions.

Our results stem from cross sectional variation: we analyze the impact of MA in the population growth of different cities exposed to the negative population shock, controlling for country effects and clustering errors at the country level. As such, unless we expect cities within the same country to adapt to a market economy at different speeds, we expect our results to be robust even in the context of different transition speeds between countries.

To further control for different cities being disproportionately affected by unobserved factors, like sectoral composition, in their transition to a market economy, we construct a dummy variable to identify places officially classified as a monotown (list obtained from Kuzmenko, Soldak 2010) in Soviet times for Russia (data only available for this country). We do not find a significant effect of this variable (these results available upon request).

3.2 Constructing Market Access Measures

We construct MA following equation (1) and restricting inclusion to cities in the same country. Table 3 shows the four versions of MA constructed: First, market size, $n_k(t)$, is measured using city population. Population is measured by each administrative unit (generally municipalities) obtained from official sources, for municipalities as small as 1,000. Despite having a shorter time frame than comparable datasets, our larger scope allows for conclusions to be applicable to the whole urban system population distribution[6].

Alternatively, we use NLs as a proxy of economic activity to capture market size. Henderson et al. (2011) discuss the benefits of using this data and present evidence of its validity as a proxy. NLs data provide a globally consistent data set that is comparable, across countries. Also, it is sampled uniformly (Henderson et al. 2012), and its measurement error is not related to development levels. Finally, NLs provide information about economic activity at levels of geographical disaggregation for which economic data is generally absent, which is the case of cities in ECA. We perform tests similar to those in Henderson et al. (2012) using subnational Gross Regional Domestic Product (GRDP) and find robust positive correlations that support the use of NLs (Table C.1).

There are two issues that affect the NL based measurements. First, the captured NL footprint, cannot be separated between municipalities whose NL emissions touch in space, forming agglomerations. We follow Roberts et al. (2015) to determine footprints and agglomerations[7] and use agglomerations as our observation level when dealing with municipalities in them. Since agglomerations are groupings of cities who work as a single functional entity, we expect any type of agglomeration benefits and spillovers to be shared as well. Second, the algorithm has a lower performance when identifying dimmer NLs in smaller places. As a consequence, some smaller cities included in the total sample are left out in the sample that has NLs available data (NLs sample). The average size of the city in the NLs sample is 100,670, compared to an average population of 64,470 in the total sample. The NLs sample is nearly half the size of the total sample.

Second, we use different measures of distance as a proxy of transportation costs for exports to other cities. Most literature uses geodetic distance calculated as distance

[6] As a contrast, Henderson, Wang (2007) build a data set on all metro areas over 100,000 from 1960 to 2000; the UN Statistics Division has a dataset since 1950, for cities only with more than 300,000 inhabitants.

[7] We identify a total of 352 agglomerations composed of a total of 2,358 cities.

between points on an oblate spheroid (Vincenty 1975), an approximation of the earth, ignoring any actual road system[8]. A more realistic measure, as suggested by Lall et al. (2004) and Combes, Gobillon (2015), is actual driving distances, which we construct using Open Source Routing Machine (OSRM) and OpenStreetMap[9].

4 Results and discussion

Table 4 shows the results of regressions of the model specified in equation 2. In the main specification that constructs MA using population, the estimated impact of MA is negative. A possible explanation for this effect is real income differences that result after a negative population shock and the effect these have in the influence of MA on population flows. The two main effects of a negative population shock discussed in Quintero, Restrepo (2017) are: First, frictions in the dynamics of productivity tend to maintain differences in nominal wages between large and small cities shortly after the shock, because productivity depends on the historical accumulation of production and knowledge. At the same time, housing prices decline in both cities due to the reduction in demand and the short run durable housing stock (Brueckner 2000). This changes the real incomes and creates incentives for labor to reallocate from smaller to larger cities (originally more productive but more expensive). The induced movement of population will be particularly strong for cities with larger MA because they have those larger, more productive, labor markets nearby for the fleeing population. Because of these income differences, and because smaller cities will have a relative higher MA[10] in a fixed system of cities, this result would also predict concentration of population in fewer larger cities after a negative population shock, which is consistent with the evidence[11].

The effect after instrumentation is only significant for the MA measures that use population, not our robustness test that uses NLs. One possible explanation comes from the interpretation of the channel through which MA impacts population growth. Our results suggest that the population flow is determined by being near populated places more than being near places with large economic activity. It could be the case that it is the access to large labor markets that matters the most, as opposed to just economic activity, which could be determined more by capital in cities focused on capital intensive or extractive industries.

Another possible interpretation of the difference in the results could come from the changes in the sample of cities used (see discussion in Section 3.2). The NLs sample of cities is smaller and concentrated in larger cities. If the negative effect of MA is mainly led by smaller cities, then our measurement of MA with NLs would not be appropriate, and we should rely on the population-based measurements. This result is in agreement with Greenstone et al. (2010), which discusses that the effect of MA is larger for smaller cities because they rely more on outside markets. Yet, results are robust to using either geodetic distance or driving distance, which makes the former preferable for this application given its much lower cost to calculate.

The role of local market size changes significantly when using measures with NLs and population. In specifications 1-4 a larger local market is associated with lower population loss, as predicted in the Brezis, Krugman (1997) model. The effect is not significant for the MA measure that uses NLs. As before, it could be the case that either local agglomeration economies are led by population size and not the magnitude of the economy, or that the effects are different because of sample selection implied by the nature of NL measurement. Finally, the effect of belonging to a formerly communist country is also different in the different specifications. Cities in former communist countries lost, on

[8] High altitudes imply errors in this approach. In the cities in our dataset, this does not seem to be an issue. Only Tajikistan and Kyrgyztan have few small towns with altitudes higher than 3.2 km, but their populations are lower than 5,000 (hence, very low weight in any MA calculation).

[9] Google maps data undergoes more strict validation but could not be used for the whole sample because of query volume restrictions. Calculation code is available from authors. Subsamples were tested in Google maps and no significant changes were found.

[10] In a system of N cities, the largest city j will only have access to smaller markets $-j$, while the other cities will have access to the large market j.

[11] See appendix section A

Table 4: The market access (MA) definitions follow notation in Table 3. The dependent variable is the annual population growth between year 2 and 3

	MA(G,pop)		MA(D,pop)		MA(G,nl)		MA(D,nl)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Market								
local mkt	0.034*	0.036*	0.034*	0.038*	0.002	-0.000	0.003	0.007
	(13.41)	(12.97)	(13.40)	(12.42)	(0.63)	(-0.12)	(1.14)	(1.10)
mkt access	-0.002	-0.072*	-0.001	-0.071*	-0.013*	0.006	-0.011*	-0.022
	(-0.62)	(-2.66)	(-0.37)	(-2.64)	(-2.57)	(0.31)	(-3.94)	(-1.17)
Population Fundamentals								
nat. pop Δ	0.007*	0.005*	0.007*	0.005*	0.009*	0.010*	0.010*	0.009*
	(16.60)	(6.68)	(16.64)	(6.13)	(12.72)	(11.28)	(13.08)	(11.92)
net migration	0.020*	0.023*	0.020*	0.025*	0.007*	0.005	0.010*	0.015+
	(17.72)	(13.94)	(17.54)	(11.68)	(3.16)	(1.43)	(4.17)	(1.76)
Former	0.142*	0.097*	0.143*	0.101*	-0.055*	-0.045*	-0.063*	-0.075*
communist	(16.34)	(4.95)	(16.57)	(5.50)	(-3.20)	(-2.39)	(-3.66)	(-2.54)
Constant	-0.461	0.018	-0.485	-1.015	0.117	0.097+	-0.050	-0.200
	(-10.26)	(0.09)	(-10.74)	(-4.90)	(2.25)	(1.72)	(-0.78)	(-0.76)
Observations	5392	5381	5388	5377	2376	2368	2373	2365
R^2	0.136	0.070	0.136	0.060	0.177	0.170	0.180	0.174
Adjusted R^2	0.135	0.068	0.135	0.059	0.174	0.167	0.177	0.170

Notes: t statistics in parentheses; +: $p < 0.10$, *: $p < 0.05$

average, more population when considering the NLs sample, which could be again driven by sample selection. Other variables included have the expected values.

In conclusion, we present evidence suggesting that having higher MA – when operating in an environment of population decline – is detrimental to city population growth. The impact is negative for the MA measure that uses population as a proxy for market size, our preferred specification. We use a comprehensive sample of cities in Eastern Europe and Central Asia, which allows us to capture the effect on cities in all ranges of the city size distribution. Even in countries where all cities are losing population, this result suggests that cities with higher MA would lose relatively more. Our results contrast with the positive effects of MA found in the literature, which are estimated in a context of population growth. In times of population decline, nearby large markets could instead act as a push factor, as the remaining population see them as possible labor markets.

Future work should analyze the heterogeneity of the effects in cities of different sizes. Evaluating the causal impact of local market sizes in a context of decline is another interesting area to elaborate on the results of this letter.

References

Amiti M, Cameron L (2007) Economic geography and wages. *The Review of Economics and Statistics* 89[1]: 15–29. CrossRef.

Anderson JE (1979) A theoretical foundation for the gravity equation. *The American Economic Review* 69[1]: 106–116

Andrienko Y, Guriev S (2004) Determinants of interregional mobility in Russia. *Economics of transition* 12[1]: 1–27. CrossRef.

Au CC, Henderson JV (2006) Are Chinese cities too small? *The Review of Economic Studies* 73[3]: 549–576. CrossRef.

Bosker M, Brakman S, Garretsen H, Schramm M (2010) Adding geography to the new economic geography: Bridging the gap between theory and empirics. *Journal of Economic Geography* 10[6]: 793–823. CrossRef.

Brezis ES, Krugman PR (1997) Technology and the life cycle of cities. *Journal of Economic Growth* 2[4]: 369–383. CrossRef.

Brueckner JK (2000) Urban growth models with durable housing: An overview. In: Huriot JM, Thisse J (eds), *Economics of Cities: Theoretical Perspectives*. Cambridge University Press, Cambridge, 263–289

Combes PP, Duranton G, Gobillon L, Roux S (2010) Estimating agglomeration economies with history, geology, and worker effects. In: Glaeser E (ed), *Agglomeration economics*. University of Chicago Press, Chicago IL. CrossRef.

Combes PP, Gobillon L (2015) The empirics of agglomeration economies. In: Duranton G, Henderson V, Strange W (eds), *Handbook of Regional and Urban Economics*, Volume 5. Elsevier, Oxford

Commander SJ, Nikoloski Z, Plekhanov A (2011) Employment concentration and resource allocation: One-company towns in Russia. European Bank for Reconstruction and Development

Duranton G (2016) Agglomeration effects in Colombia. *Journal of Regional Science* 56[2]: 210–238. CrossRef.

Fallah BN, Partridge MD, Olfert MR (2010) New economic geography and US metropolitan wage inequality. *Journal of Economic Geography* 11[5]: 865–895. CrossRef.

Fujita M, Krugman PR, Venables AJ (1999) *The spatial economy: Cities, regions and international trade*. The MIT Press, Cambridge, MA. CrossRef.

Gendron-Carrier N, Gonzalez-Navarro M, Polloni S, Turner MA (2017) Subways and urban air pollution. NBER working paper series, working paper 24183. CrossRef.

Glaeser EL, Gyourko J (2005) Urban decline and durable housing. *Journal of Political Economy* 113[2]: 345–375. CrossRef.

Greenstone M, Hornbeck R, Moretti E (2010) Identifying agglomeration spillovers: Evidence from winners and losers of large plant openings. *Journal of Political Economy* 118[3]: 536–598. CrossRef.

Harris CD (1954) The market as a factor in the localization of industry in the United States. *Annals of the association of American geographers* 44[4]: 315–348. CrossRef.

Harris JR, Todaro MP (1970) Migration, unemployment and development: A two-sector analysis. *The American Economic Review* 60[1]: 126–142

Head K, Mayer T (2004) The empirics of agglomeration and trade. In: Henderson J, Thisse JF (eds), *Handbook of Regional and Urban Economics*, Volume 4. North Holland, Amsterdam, 2609–2669

Head K, Mayer T (2006) Regional wage and employment responses to market potential in the EU. *Regional Science and Urban Economics* 36[5]: 573–594. CrossRef.

Henderson JV, Wang HG (2007) Urbanization and city growth: The role of institutions. *Regional Science and Urban Economics* 37[3]: 283–313. CrossRef.

Henderson V, Storeygard A, Weil D (2011) A bright idea for measuring economic growth. *The American Economic Review: Papers and Proceedings* 101[3]: 194–199. CrossRef.

Henderson V, Storeygard A, Weil D (2012) Measuring economic growth from outer spaces. *The American Economic Review* 102[2]: 994–1028. CrossRef.

Kofanov D, Mikhailova T (2015) Geographical concentration of Soviet industries: A comparative analysis. *Journal of the New Economic Association* 28[4]: 112–141

Kuzmenko L, Soldak M (2010) Monofunctional cities: Problems, support provision and development. *Економічний вісник Донбасу* 4: 83–88

Lall SV, Shalizi Z, Deichmann U (2004) Agglomeration economies and productivity in Indian industry. *Journal of Development Economics* 73[2]: 643–673. CrossRef.

Quintero L, Restrepo P (2017) City decline in an urbanizing world. Available from the authors upon request

Quintero L, Roberts M (2018) Explaining spatial variations in productivity: Evidence from Latin America and the Caribbean. The world bank. CrossRef.

Redding SJ, Sturm DM (2008) The costs of remoteness: Evidence from German division and reunification. *The American Economic Review* 98[5]: 1766–1797. CrossRef.

Roberts M, Stewart B, Prakash M, McWilliams K (2015) Global night time lights urban extents and growth patterns product. Alpha Version World Bank

The Heritage Foundation (2018) Index of economic freedom. Technical report

The World Bank (2018) Ease of doing business index. Technical report. CrossRef.

Vincenty T (1975) Direct and inverse solutions of geodesics on the ellipsoid with application of nested equations. *Survey review* 23[176]: 88–93. CrossRef.

Yoon C (2017) Estimating a dynamic spatial equilibrium model to evaluate the welfare implications of regional adjustment processes: The decline of the rust belt. *International Economic Review* 58[2]: 473–497. CrossRef.

A Concentration

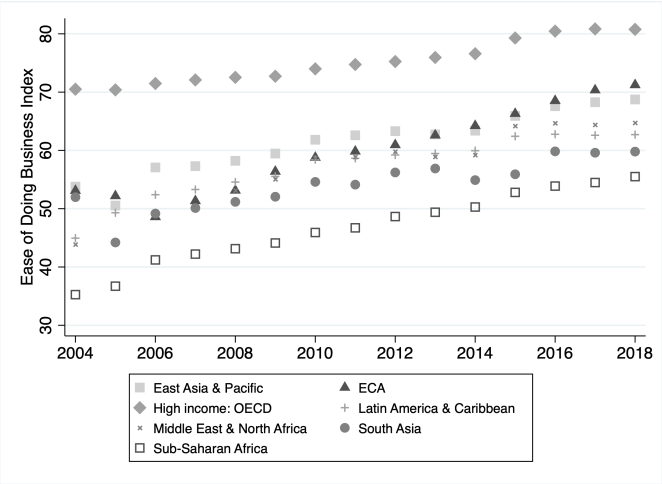
Besides population decline, the region has presented concentration of population in fewer larger cities, which is precisely the prediction of Brezis, Krugman (1997) as a response to such a negative population shock. GINI coefficients for most ECA countries in table 5, for both population and night lights (NLs), support this. Only two countries show decreases in the population concentration, and the average growth in concentration is 0.51% per year overall.

Table A.1: Concentration of Population and Economic Activity

	Population GINI			Change		NLs GINI			Change	
	year 1	year 2	year 3			year 1	year2	year 3		
Serbia	0.507	0.507	0.7	+	1.81%	0.564	0.558	0.785	+	1.87%
Kazakhstan	0.508	0.542	0.651	+	1.34%	0.64	0.725	0.739	+	0.74%
Russia	0.608	0.629	0.758	+	1.17%	0.756	0.795	0.834	+	0.49%
Bulgaria		0.628	0.68	+	0.83%	0.768	0.776	0.782	+	0.09%
Belarus		0.668	0.713	+	0.67%	0.831	0.837	0.804	–	-0.15%
Albania	0.696	0.718	0.756	+	0.41%	0.77	0.783	0.814	+	0.27%
Poland		0.712	0.735	+	0.32%	0.854	0.856	0.799	–	-0.31%
Tajikistan		0.61	0.629	+	0.31%	0.671	0.706	0.796	+	0.89%
Moldova	0.656	0.708	0.688	+	0.23%	0.775	0.768	0.787	+	0.07%
Kyrgyz Rep.	0.644	0.676	0.671	+	0.20%	0.799	0.797	0.811	+	0.07%
Romania	0.622	0.63	0.641	+	0.15%	0.679	0.695	0.685	+	0.04%
Ukraine	0.737	0.735	0.744	+	0.05%	0.834	0.891	0.814	–	-0.11%
Uzbekistan	0.674	0.652	0.65	–	-0.17%	0.826	0.817	0.82	–	-0.03%
Georgia	0.674	0.672	0.64	–	-0.24%	0.709	0.763	0.774	+	0.44%

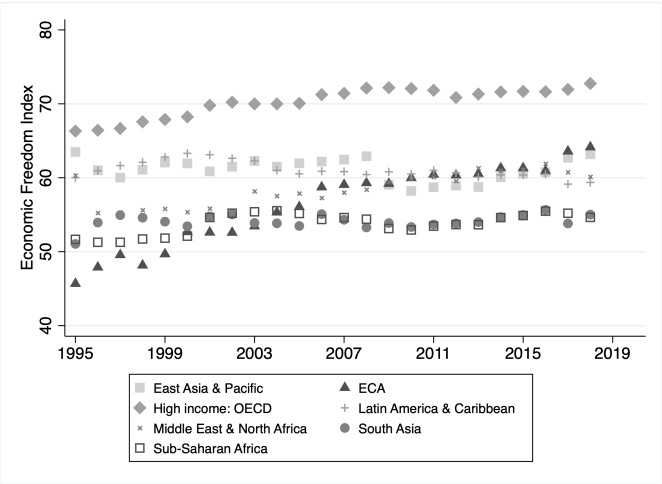
Notes: Estimated for the sample of cities which have both NLs and population data. Year 1, 2 and 3 refer to 1989, 1999, and 2010 (or the latest year available). In some countries one of these years might be different for one or two years. Table 1 shows specific years for the data available for each country. Change refers to the average annual change.

B Transition to Market Economies



Notes: The Economic Freedom Index measures how economically free societies are, where freedom is understood as no government obstruction to the free movement of labor, capital, and goods (The Heritage Foundation 2018)

Figure B.1: Economics Freedom Index



Notes: The Ease of Doing Business Index measures how fair and friendly economies are to medium and small private firms (The World Bank 2018)

Figure B.2: Ease of Doing Business Index

C Using NLs as a proxy of economic activity

Table C.1: NLs as proxy of economic activity

Country	Log NLs	Constant	Observations	R^2
Albania	1.24**	-0.48	12	0.80
Belarus	1.25**	-6.43	6	0.84
Bulgaria	1.17***	-6.04***	140	0.72
Georgia	0.88*	-1.19	7	0.6
Germany	0.72***	0.95***	1,980	0.41
Kazakhstan*	0.50**	21.20***	28	0.13
Kyrgyz Republic	0.92***	0.21	7	0.66
Poland	0.61***	0.87***	325	0.94
Romania	1.07***	-4.92***	210	0.67
Russia	0.33***	6.82***	456	0.98
Serbia*	1.26***	-1.87	25	0.83
Tajikistan*	0.92***	13.17***	8	0.99
Turkey	1.40***	0.21	52	0.74
UK	0.56***	2.56***	840	0.28
Ukraine*	0.85***	-0.69	135	0.5
Uzbekistan	1.01***	1.94	39	0.95

Notes: Column 2 shows the coefficient of a regression of log region GDP on log region aggregate NLs. Test is performed for for 16 of the 17 ECA countries analyzed (Moldova does not produce subnational GDP data). Robust standard error in parentheses. ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$. Countries with asterisks use raw nighttime lights; remaining countries used radiance calibrated nighttime lights.

Resources

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Social Progress for Resilient Regions

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Abstract. This paper is the base text for the speech of the then EIB Vice President[1] Mr. Pim van Ballekom at the ERSA Congress in Groningen, on August 2017. This text represents his and the Bank's views on the topic "Social Progress for Resilient Regions". Although in his speech he deviated from the prepared speech to react on topics raised by the other speakers, this text and its contents remain valid.

Ladies and gentlemen,

I am delighted having the opportunity to address you today at the Policy Day of the ERSA Congress in Groningen.

You might be wondering what the EIB is doing here, as we are a bank and therefore not necessarily known to produce science. We do however support not only scientific projects, but also urban and regional development, by means of financing, advisory services and technical assistance. And as much as we would like for the world to be different, not a lot of things can get done without money, so banks like us will still be needed in the future.

It is good to bear in mind that the EIB is public bank, owned by the 28 member states. We are operating on the basis of policies, guidelines and recommendations of the European Union (Council, Commission and Parliament), indeed we are one of the EU institutions. And since cohesion, urban and regional development are topics high on the EU agenda, it is per definition a core activity of the EIB. In fact, achieving a balanced development of the European Union is the oldest operational priority of the EIB.

The challenges for Regions and Cities

The White Paper on the Future of Europe (European Commission 2017) makes a powerful statement about the current state of the European integration and its uncertain future. Regions and cities have to deal with the continuing consequences of the financial, the economic, and the migration crisis. They have to master the concrete economic, social, demographic and environmental demands of globalisation, technological change and digital transformation at local level. By doing so they make significant contributions to a wide range of EU objectives and priorities, ranging from the promotion of jobs and growth, integration of migrants and support for climate action.

The Paris Climate Agreement (see, for example, European Commission 2015) and the Sustainable Development Goals – to name but two – provide an impetus for regions and cities to move towards sustainable development. Effects on regional development from

[1] Mr. van Ballekom's term as Vice President of the EIB ended January 2018.

natural causes are equally important as those of economic and financial causes and can, in the worst case, reinforce each other.

Regional and urban sustainability are critically linked to how communities recover when they are affected by disasters. Investment in capacity to prevent, prepare, manage and reduce climate and other various types of risks, is therefore essential for building resilient regions and cities. Also essential is strengthening the capacities of governments to plan and implement the recovery processes to deliver an effective response. The EIB is eager to support urban investment programmes in various ways.

Linking regional and urban lending to cohesion policy

A major part of the EIB activities supporting regions and cities falls under the Bank's policy objective of "cohesion". As said, the support of the European Cohesion policy has been at the heart of EIB operations since its foundation in 1958. It remains central to the task of the EIB that the Bank should continue to facilitate the financing of projects in less-developed regions.

The EIB's strong and continued commitment to support cohesion policies is well documented by our past lending. In the last 10 years (2007-2016) more than 200 billion euros of loans have been provided under the cohesion objective. In my opinion this will remain an objective in the foreseeable future. The more so because of budgetary constraints, national and European. In all policy domains you can identify a shift from grants and subsidies to loans and guarantees. In the new financial framework for the years 2020 and beyond, it is my safe guess that this trend will continue. In fact, the current aim of the European Fund for Strategic Investments (EFSI) is to find alternative ways of financing public needs

Framework Loans

The EIB has continuously helped European regions and cities to finance their integrated regional and urban development strategies through what we call 'framework loans'. This is a flexible instrument, which allows supporting hundreds or even thousands of smaller projects that the Bank would be unable to finance if they were stand-alone projects. Indeed, though we are a "big" bank in terms of our balance sheet, we only have about 3.000 employees. I know that sounds like a lot, but if you serve 28 EU member states and many projects outside the EU, it is quite modest.

Framework loans fill the gap by covering – under one credit line for a region, province or city – smaller projects across a whole spectrum of sectors: Research and development, transport, broadband, regional and urban mobility, water and wastewater treatment, energy efficiency, healthcare, education, cultural heritage among others. On this basis, the EIB agrees with the region or city a set of upfront project criteria. These are the basis for approving projects in a 3-5 year investment period on an ongoing basis. This approach gives regions and cities the flexibility to handle necessary adaptations in their investment programmes if needed.

Regions and cities that benefit from European Structural and Investment Funds (ESIF) use EIB Framework Loans in particular to pre-finance their national co-financing obligations. These dedicated Framework Loans, called Structural Programme Loans, are important enablers for ESIF based investment across the EU.

In order to give you a better understanding of how regions and cities benefit from the framework loan product, let me give you a few practical examples:

- In Greece, the Bank provided several Structural Programme Loans, which co-financed the European Structural Funds. The loans supported over 120.000 small projects across the country, including schools, archaeological museums, tourism, vocational training, research, environmental programmes and water and waste projects. They also supported small and medium-sized companies, the backbone of the Greek economy. All these being part of the Integrated Territorial Development Plans.

- In Italy, we are helping to set up a dedicated Framework Loan to support post-disaster reconstruction and rehabilitation investments in 16 Regions, which have been affected by a series of extreme weather events over the last five years. The investments contribute to the sustainable restoration of livelihoods in the affected areas. It is important to mention that reconstruction will respect new urban planning rules and risk prevention measures to ensure resilience against repetitive events.
- Following the floods in Madeira (2010) and the earthquakes in Murcia, Tuscany and Emilia-Romagna, the Bank supported the sustainable and resilient reconstruction of infrastructure, livelihoods and the economy by dedicated comprehensive multi-sector post-disaster Framework Loans.

But although the EIB is a bank, there are other ways in which we are able to assist projects in cohesion regions. Our advisory services, for example, help local authorities prepare projects better, in order to have an increased change of attracting EU and other funding. Especially under the EFSI, the European Fund for Strategic Investments, central pillar of the so-called Juncker Plan, our possibilities in this area have much increased. For more information on this, contact the "EIAH", the European Investment Advisory Hub, at http://eiah.eib.org/.

Financing the Urban Agenda

The Pact of Amsterdam sets out the key challenges for urban areas in the EU. The pact calls specifically on the EIB to support its implementation through our lending, co-financing and advising activity. Talking to European cities – many of which are also EIB borrowers – about their financing needs leads us to at least 3 broad conclusions.

1. There are many new demands facing cities and most of them – like providing housing to refugees, tackling climate change and enhancing disaster resilience – are typically not revenue generating, thus they depend directly on the national or city budget, or grant funds, for financing.
2. Many cities in Europe are debt-constrained, and need to make more effective use of their debt capacity. Ways to do this include financial instruments or using private sector vehicles to achieve public goals, but this often puts the challenge on the banks and other lenders because of the higher levels of risk.
3. Cities need access to knowledge and information about financing possibilities, but they do not necessarily need new instruments or facilities. What they need is a more concerted way to help them navigate the vast array of existing facilities and instruments and find out which can best support them.

This is where the EU's one stop shop for cities provides value and that is where we are working with the Commission on the financing component. Examples of urban projects that the EIB has financed include the redevelopment of city centres, the creation of smart districts and eco-quartiers and the modernisation of transport and municipal infrastructure in cities across Europe.

Conclusions

Regions and cities have to cope with numerous challenges, which require an integrated response in the shape of Integrated territorial development. It is short term as well as long term demands. Economic resilience and resilience against natural disasters, as well as against the effects of climate change are two sides of the same coin. Cohesion policy is the EU's main instrument for responding to uneven development across the Union. The EIB has a good track record in this respect and will continue to assist cities and regions alike, wherever possible, in order to fulfil common European goals. Please remember that the European Investment Bank belongs directly to all member states, therefore it is also YOUR bank.

I thank you for your attention.

References

European Commission (2015) Energy Union Package. Communication from the commission to the European parliament and the council. The Paris Protocol – A blueprint for tackling global climate change beyond 2020

European Commission (2017) White Paper on the future of Europe. Reflections and scenarios for the EU27 by 2025

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The US Census Longitudinal Employer-Household Dynamics Datasets

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Abstract. Over the last several years, the Longitudinal Employer-Household Dynamics program at the US Census Bureau has partnered with state labor market information offices to produce a collection of extremely rich datasets based on linked employer-employee records. These datasets, available free for download from the program website, offer exceptionally detailed information on a number of topics of interest to regional scientists, including migration, local labor market dynamics, and the spatial distribution of employment. This article describes the different publicly available datasets, the process by which these data are generated, and examples of research in regional science that is already using these data.

1 Introduction

Regional science is becoming an increasingly data-intensive field. More and more, scholars require highly detailed and comprehensive information about regional economies in order to accurately characterize them. This change requires moving beyond the traditional data sources that regional scientists have used, and incorporating new datasets, often compiled from administrative records.

One new data source of interest to regional scientists studying the United States (US) is the data produced by the Longitudinal Employer-Household Dynamics (LEHD) program at the US Census Bureau. Based on a unique collaboration between the Census Bureau and labor market information offices in all 50 states, the LEHD provides scholars and the public with free access to highly detailed information produced from linked employer-employee insurance records at an unprecedented spatial resolution.

2 The LEHD Infrastructure Files and main data products

At the core of the LEHD data project are the LEHD Infrastructure Files. These confidential files are constructed by linking state unemployment insurance records with the Quarterly Census of Employment and Wages, the Decennial Census, and other administrative and survey datasets. The result is a set of longitudinal files that track individuals who are covered by unemployment insurance over time. The Infrastructure Files themselves are confidential, but available at Federal Statistical Research Data Centers to scholars with proposals accepted by the Census Bureau. The Infrastructure Files have been used extensively in scholarly papers within labor economics and to study topics of interest to regional scientists such as the spatial mismatch hypothesis (Andersson et al. 2018) as well as trends in migration (Hyatt et al. 2016).

While the Infrastructure Files offer an extremely powerful tool for studying labor market dynamics at all spatial scales, they may be impractical to access for many researchers, particularly those based in Europe. To provide easier access to much of the information collected through the LEHD program, the program offers three publicly available datasets downloadable from its website. These are the Quarterly Workforce Indicators (QWI), the LEHD Origin-Destination Employment Statistics (LODES), and the Job-to-Job Flows dataset (J2J).

2.1 Quarterly Workforce Indicators

The QWI is the flagship data product produced by the LEHD program. The QWI provides quarterly (i.e. four times per year) employment and earnings information at the county level. The power of the QWI data comes from the ability to cross tabulate these statistics by a variety of industry, firm, and employee characteristics. The data are disaggregated into 4-digit NAICS Industry Groups, a detailed classification with categories such as "Communications Equipment Manufacturing" and "Vegetable and Melon Farming." The data can be further disaggregated by firm characteristics, such as firm age and firm size, and by employee demographic characteristics, including education level, gender, and race. With the QWI data, it is possible to answer question such as "are women and men working in Silicon Valley web startups paid similar amounts?" or "is the manufacturing decline in Cleveland affecting workers of all races similarly?" More comprehensively, one could ask, "which counties have the largest gender gaps in tech?" or "where are manufacturing startups located?"

The total time span covered by the QWI data varies based on when each state joined the program. Data for all states is available from Q1 2010 to Q2 2016. For many states, including California, Oregon, Washington, Illinois, North Carolina, and Maryland, data extends back until the early 1990s. The available date ranges for each state are posted at https://qwiexplorer.ces.census.gov/loading_status.html.

2.2 LEHD Origin-Destination Employment Statistics

The LODES data compliment the QWI. Whereas the QWI data provide extremely detailed job characteristics at a relatively large level of geography, the LODES data provide limited job characteristics at very fine geographic resolution. Data are provided by census block, the smallest nationally-defined spatial unit, which correspond to city blocks in size. The LODES data are provided state by state in three files. The Workplace Area Characteristics (WAC) file provides information on the jobs located in each block. In addition to the total count of jobs located in that block, the WAC file gives the count of jobs in each of the 20 2-digit NAICS sectors, in each of three income categories, and by employee race, ethnicity, age, sex, and education level. This dataset is perhaps the most comprehensive and detailed publicly available data on the spatial location of employment throughout the US.

The Residential Area Characteristics (RAC) file mirrors the WAC file, but provides characteristics for the workers who live in each block rather than those who work there. The RAC file can be used to determine the rough industry or education breakdown of the residents living in a particular census block.

Finally, the Origin-Destination (OD) file provides information on commuting patterns. For each pair of census blocks, the OD file gives the total count of workers who commute between them, i.e. a person that lives in census block A and works in census block B. The OD file also provides limited information on the characteristics of both the workers and their jobs, including three industry categories, three income categories, and three worker age categories. The OD file is similar in purpose to the data in the Census Transportation Planning Package (CTPP), and can be analyzed similarly. The main difference is that the LODES OD file contains less demographic information but a much higher sample size and much finer spatial resolution. Compared to the CTPP, the LODES data show longer commutes and a smaller fraction of within-county commutes, likely in part because of differences in the sampling frame and in part because of the difficulties in assigning

workers in some multi-establishment employers to particular establishments described below (Graham et al. 2014, Green et al. 2017).

Each of these files is provided for all states and all available years. Note that certain state-year combinations are not available, though data for all 50 states are available for the years 2011-2013. Separate versions of the three files are available for all jobs, private sector jobs only, and federal government jobs only. "Primary job" versions of the files are also available that include only one job per worker, the job from which they earned the most money during the second quarter of each year. The baseline specification for most analyses will be all primary jobs.

In addition to downloading the raw data files, scholars and analysts can interactively extract data and conduct analysis on custom areas using the OnTheMap tool at https://onthemap.ces.census.gov.

2.3 Job-to-Job Flows

The third major dataset available from the LEHD program is the Job-to-Job Flows (J2J). This innovative dataset, still in its beta version, provides information on how people transition between jobs as well as between employment and nonemployment. A third to half of all hires in the United States involve movements between employers rather than from nonemployment (US Census Bureau 2017). These movements between employers are important for job-employee matching – on average, such movements involve an 8% increase in earnings – and are particularly sensitive to the economic climate (Fallick et al. 2012). The J2J data allow detailed study of job transitions, including topics of great interest to regional scientists such as the relationship between job change and migration.

The J2J data consist of two types of files. The main files provide tabulations of hires and separations to other jobs and to nonemployment by geography (state or Metropolitan Statistical Area), firm demographic characteristics (size and age), NAICS 2-digit sector, and worker demographic characteristics. These are provided as both raw counts and as rates, and in both raw and seasonally adjusted form (because hiring has strong seasonal patterns, many analyses will benefit from seasonal adjustment). The second set of files consist of origin-destination data, and report flows of workers moving between industry-geography combinations by firm and worker demographics. Further details about the J2J data and the data creation process are provided in the technical paper "Job-to-Job Flows: New Statistics on Worker Reallocation and Job Turnover" (Hyatt et al. 2017).

J2J data are available quarterly for most states from Q2 2000 until Q1 2018. The data can also be accessed interactively through the Job-to-Job Flows Explorer at https://j2jexplorer.ces.census.gov.

3 Creation of the LEHD files

The LEHD dataset is created through a partnership between the Census Bureau and state employment agencies. The core of the dataset is constructed by linking unemployment insurance records, which contain information on the job tenure and payment of employees, with firm-level data from the Quarterly Census of Employment and Wages. Details of the exact procedure are described in the academic papers about the creation of the datasets (Abowd et al. 2004, 2009a).

3.1 Coverage

The LEHD data includes all jobs covered by unemployment insurance and select federal government jobs. It excludes, most notably, self-employed individuals and federal employees working in defense-related agencies. While the exact proportion of private jobs covered by unemployment insurance is not known, the BLS estimated in 1997 that roughly 95% of private sector jobs are covered by unemployment insurance and thus included in the LEHD data (US Bureau of Labor Statistics 1997). The proportion covered by unemployment insurance may have declined with the rise of contract and contingent labor (Kalleberg 2000). Details on the exact jobs that are not covered by state unemployment are provided in (Stevens 2007). Details on the coverage of federal jobs are provided

at http://lehd.ces.census.gov/doc/help/onthemap/FederalEmploymentInOnTheMap.pdf and http://lehd.ces.census.gov/doc/help/onthemap/LODESDataNote-FedEmp2015.pdf.

3.2 Anonymization

Procedures are used to protect the anonymity of people covered by the LEHD files. In the QWI, LODES WAC, and J2J files, a multiplicative "fuzz factor" is generated for each employer and each establishment. This factor distorts the true estimates by a minimum of c and a maximum of d percent, where c and d are kept confidential (Abowd et al. 2009a). The fuzz factor assigned to each establishment is permanent, with the same factor used across different years and iterations of the data (Abowd et al. 2012). Further information on the details of the multiplicative noise generation process as applied to each of the datasets are available in the technical papers describing each of the datasets (Abowd et al. 2012, Abowd, McKinney 2016, Abowd et al. 2009a, Hyatt et al. 2017).

A more extensive anonymization process is used for the LODES RAC and OD files. Here, a full set of "synthetic data" is produced that attempts to preserve the statistical properties of the true data without actually being based on that data. Details of the construction of this synthetic data are described in (Abowd et al. 2012). Computer scientists have attempted to de-anonymize this data, and have described the limitations of the anonymization procedures used (Golle, Partridge 2009, Machanavajjhala et al. 2008).

3.3 Caveats

There are certain limitations to the LEHD datasets. First, as described above, the LEHD datasets do not fully cover the entire workforce, specifically lacking employees in defense-related industries.

Second, the geocoding of jobs to blocks in the LODES data is imperfect. Attempts are made to assign jobs at the establishment level, such that the jobs at a particular branch of a multi-branch company are located in the block containing that branch. However, this is not always possible. This difficulty is most prominent in the case of local government agencies like school districts and public transportation agencies. The jobs at such agencies are often assigned to the block containing their headquarters. This results in some blocks in the dataset having unreasonably high employment levels. The block containing the Brooklyn Municipal Building and the New York City Board of Education, for example, is listed as having 173,449 jobs in 2014. Studies of employment counts or density, especially those that use metrics sensitive to outliers, should take care to either drop or top-code these observations. Additionally, in certain types of jobs, such as home health aides, construction workers, and bus drivers, much of the work is performed at a location physically separate from the office, so even if employees are correctly assigned to the block containing their offices, this may not accurately reflect where the work is being done.

Third, the LODES data are not directly comparable across years, particularly at high geographic resolution. Improvements are continuously being made to the geocoding and job assignment algorithms, and these improvements are not typically applied backwards to previous data releases. The continuous improvement process means that the assignment process used in one year is not usually the same as the process used in the next year. In some cases these changes result in the movement of large numbers of jobs among neighboring blocks from year to year. Because of the continuously evolving algorithms, using the LODES data for longitudinal analysis at high spatial resolutions is not advised.

4 Examples of LEHD data use

The LEHD data products have begun to be used in a number of applications. The first applications were in labor economics without a geographic or spatial focus. For instance, Abowd et al. used the LEHD infrastructure file to examine how the relationship between technology and demand for skills varied within and across firms (Abowd et al. 2007). A number of studies have examined job to job mobility and flows into and out of employment (Abowd et al. 2009b, Abowd, Vilhuber 2011, Fallick et al. 2012, Haltiwanger et al. 2018). Some studies have examined earnings inequality (Abowd et al. 2018). There has also

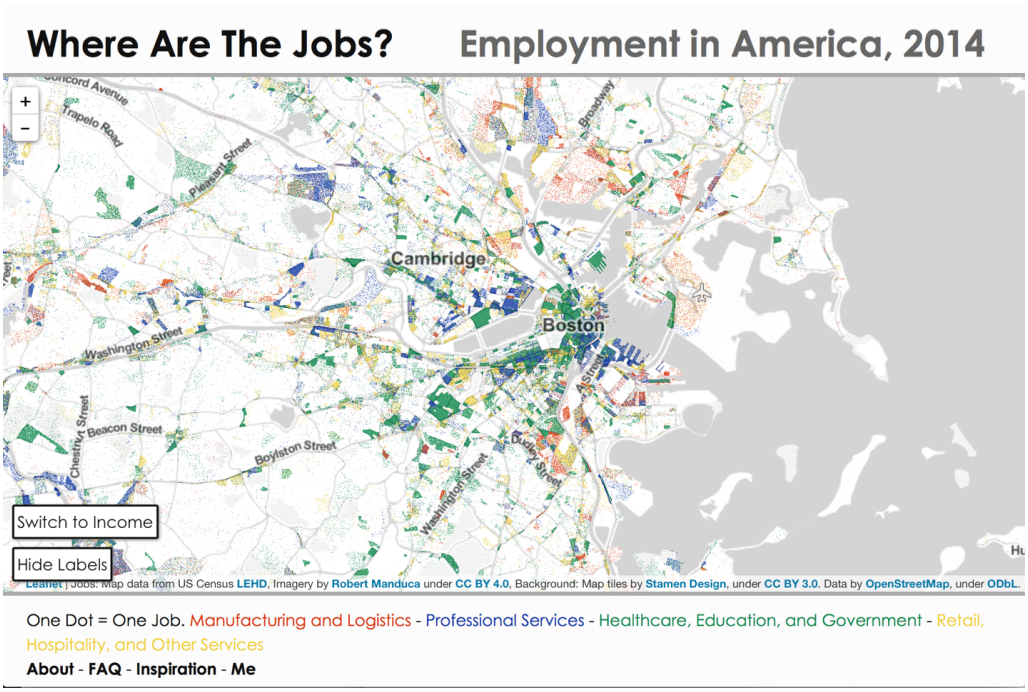

Figure 1: Screenshot from "Where Are the Jobs?", a web visualization of the LODES Workplace Area Characteristics data (http://www.robertmanduca.com/projects/jobs.html)

been increasing use of the LEHD data to study entrepreneurship (Goetz et al. 2015). Quarterly Workforce Indicators data have been used to study the effects of changes in the minimum wage (Dube et al. 2016).

Within regional science, the LODES origin-destination data have been used extensively to study commuting patterns and mobility (Horner, Schleith 2012, Horner et al. 2015, Kim 2014, Kneebone, Holmes 2015, Levinson, El-Geneidy 2009, Owen, Levinson 2015, Schleith, Horner 2014, Schleith et al. 2016). One aspect of this research includes studying vulnerability to emergencies (Kermanshah, Derrible 2016). The Workplace Area Characteristics files have been used to describe neighborhood character (Folch et al. 2017) and to identify business districts (Manduca 2018). The LODES data have also been used for web visualization, including the "Where Are The Jobs?" web maps (Manduca 2015).

The restricted use LEHD infrastructure files have been used to study spatial mismatch (Andersson et al. 2018), migration (Hyatt et al. 2016), and agglomeration (Freedman 2008). There is still a great deal of opportunity remaining for research using both the public and confidential data files.

5 Conclusion

The LEHD data products represent an impressive example of government agencies working across jurisdictions to create a truly new and rich source of information about regional economies. Although both the confidential and public versions of the data are being used more and more, there remains a huge amount of opportunity for future research. Regional scientists in the United States, Europe, and beyond should take advantage of this detailed and rich source of data.

References

Abowd J, Gittings RK, McKinney K, Stephens B, Vilhuber L, Woodcock S (2012) Dynamically consistent noise infusion and partially synthetic data as confidentiality protection measures for related time series. Presented at the FCSM. http://digitalcommons.ilr.cornell.edu/ldi/5

Abowd J, Haltiwanger J, Lane J (2004) Integrated longitudinal employer-employee data for the United States. *American Economic Review* 94[2]: 224–229. CrossRef.

Abowd J, Haltiwanger J, Lane J (2009b) Wage structure and labor mobility in the United States. In: Lazear EP, Shaw KL (eds), *The Structure of Wages: An International Comparison*. University of Chicago Press, Chicago IL, 81–100. CrossRef.

Abowd J, Haltiwanger J, Lane J, McKinney KL, Sandusky K (2007) Technology and the demand for skill: An analysis of within and between firm differences. National Bureau of Economic Research, Cambridge. CrossRef.

Abowd J, McKinney K (2016) Noise infusion as a confidentiality protection measure for graph-based statistics. *Statistical Journal of the IAOS* 32[1]: 127–135. CrossRef.

Abowd J, McKinney KL, Zhao NL (2018) Earnings inequality and mobility trends in the United States: Nationally representative estimates from longitudinally linked employer-employee data. *Journal of Labor Economics* 36[S1]: S183–S300. CrossRef.

Abowd J, Stephens BE, Vilhuber L, Andersson F, McKinney KL, Roemer M, Woodcock S (2009a) The LEHD infrastructure files and the creation of the Quarterly Workforce Indicators. In: T. Dunne, J. B. Jensen MJR (ed), *Producer Dynamics: New Evidence from Micro Data*. University of Chicago Press, Chicago, IL, 149–230. CrossRef.

Abowd J, Vilhuber L (2011) National estimates of gross employment and job flows from the quarterly workforce indicators with demographic and industry detail. *Journal of Econometrics* 161[1]: 82–99. CrossRef.

Andersson F, Haltiwanger JC, Kutzbach MJ, Pollakowski HO, Weinberg DH (2018) Job displacement and the duration of joblessness: The role of spatial mismatch. *Review of Economics and Statistics* 100[2]: 203–218. CrossRef.

Dube A, Lester TW, Reich M (2016) Minimum wage shocks, employment flows, and labor market frictions. *Journal of Labor Economics* 34[3]: 663–704. CrossRef.

Fallick B, Haltiwanger J, McEntarfer E (2012) Job-to-job flows and the consequences of job separations. Federal Reserve Board, Washington DC. https://www.federalreserve.gov/Pubs/feds/2012/201273/201273pap.pdf

Folch DC, Spielman SE, Manduca R (2017) Fast food data: Where user-generated content works and where it does not. *Geographical Analysis* 50[2]: 125–140. CrossRef.

Freedman ML (2008) Job hopping, earnings dynamics, and industrial agglomeration in the software publishing industry. *Journal of Urban Economics* 64[3]: 590–600. CrossRef.

Goetz C, Hyatt H, McEntarfer E, Sandusky K (2015) The promise and potential of linked employer-employee data for entrepreneurship research. National Bureau of Economic Research, Cambridge. CrossRef.

Golle P, Partridge K (2009) On the anonymity of home/work location pairs. In: Tokuda H, Beigl M, Friday A, Brush A, Tobe Y (eds), *Pervasive Computing. Pervasive 2009*, Volume 5538 of *Lecture Notes in Computer Science*. Springer, Berlin, Heidelberg. CrossRef.

Graham MR, Kutzbach MJ, McKenzie B (2014) Design comparison of LODES and ACS commuting data products. Working Paper No. 14-38, Center for Economic Studies, U.S. Census Bureau, Washington DC. https://ideas.repec.org/p/cen/wpaper/14-38.html

Green AS, Kutzbach MJ, Vilhuber L (2017) Two perspectives on commuting: A comparison of home to work flows across job-linked survey and administrative files. Working Paper No. 17-34, Center for Economic Studies, U.S. Census Bureau, Washington DC. https://ideas.repec.org/p/cen/wpaper/17-34.html

Haltiwanger J, Hyatt H, McEntarfer E (2018) Who moves up the job ladder? *Journal of Labor Economics* 36[S1]: S301–S336. CrossRef.

Horner MW, Schleith D (2012) Analyzing temporal changes in land-use-transportation relationships: A LEHD-based approach. *Applied Geography* 35[1-2]: 491–498. CrossRef.

Horner MW, Schleith DK, Widener MJ (2015) An analysis of the commuting and jobs-housing patterns of older adult workers. *The Professional Geographer* 67[4]: 575–585. CrossRef.

Hyatt H, McEntarfer E, Ueda K, Zhang A (2016) Interstate migration and employer-to-employer transitions in the US: New evidence from administrative records data. Working paper. https://papers.ssrn.com/sol3/papers.cfm?.abstract_id=2859095

Hyatt H, McKinney K, Vilhuber L, Hahn JK, McEntarfer E, Tibbets S, Walton D, Janicki H (2017) Job-to-job flows: New statistics on worker reallocation and job turnover. US Census Bureau, Washington DC. https://lehd.ces.census.gov/doc/-jobtojob_documentation_long.pdf

Kalleberg AL (2000) Nonstandard employment relations: Part-time, temporary and contract work. *Annual Review of Sociology* 26[1]: 341–365. CrossRef.

Kermanshah A, Derrible S (2016) A geographical and multi-criteria vulnerability assessment of transportation networks against extreme earthquakes. *Reliability Engineering & System Safety* 153: 39–49. CrossRef.

Kim JH (2014) Residential and job mobility: Interregional variation and their interplay in US metropolitan areas. *Urban Studies* 51[13]: 2863–2879. CrossRef.

Kneebone E, Holmes N (2015) The growing distance between people and jobs in metropolitan America. Brookings Institution, Washington DC. https://www.brookings.edu/-research/the-growing-distance-between-people-and-jobs-in-metropolitan-america/

Levinson D, El-Geneidy A (2009) The minimum circuity frontier and the journey to work. *Regional Science and Urban Economics* 39[6]: 732–738. CrossRef.

Machanavajjhala A, Kifer D, Abowd J, Gehrke J, Vilhuber L (2008) Privacy: Theory meets practice on the map. IEEE 24th international conference on data engineering, Cancun, Mexico. CrossRef.

Manduca R (2015) Where are the jobs? http://www.robertmanduca.com/projects/jobs.-html

Manduca R (2018) The spatial structure of US metropolitan employment: New insights from LODES data. SocArXiv. September 13. CrossRef.

Owen A, Levinson DM (2015) Modeling the commute mode share of transit using continuous accessibility to jobs. *Transportation Research Part A: Policy and Practice* 74: 110–122. CrossRef.

Schleith D, Horner M (2014) Commuting, job clusters, and travel burdens: Analysis of spatially and socioeconomically disaggregated longitudinal employer-household dynamics data. *Transportation Research Record: Journal of the Transportation Research Board* 2452: 19–27. CrossRef.

Schleith D, Widener M, Kim C (2016) An examination of the jobs-housing balance of different categories of workers across 26 metropolitan regions. *Journal of Transport Geography* 57: 145–160. CrossRef.

Stevens DW (2007) Employment that is not covered by state unemployment insurance laws. US Census Bureau, Suitland MD. https://www2.census.gov/ces/tp/tp-2007-04.pdf

US Bureau of Labor Statistics (1997) Employment and wages covered by unemployment insurance, ch. 5. BLS Handbook of Methods (pp. 42–47). US Department of Labor, Washington DC. http://www.bls.gov/opub/hom/homch5_b.htm

US Census Bureau (2017) Job-to-job flows: New statistics on worker flows across jobs. Washington DC. https://lehd.ces.census.gov/doc/J2J_quickstart_guide.pdf

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A Short Course on Spatial Econometrics and GIS

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Abstract. This resource gives a brief overview of a website and playlist of YouTube videos using open source software (R, GeoDa, and QGIS) designed to help get scholars up and running with analyzing their own data using Spatial Econometrics. Sample data, handouts, code, and map files are provided for ease of replication. The course covers the basics of integrating data into a spatial data set, contiguity and spatial correlation, doing basic spatial regressions in GeoDa, and doing more sophisticated specification tests and regressions in R.

JEL classification: R1, C21

Key words: spatial econometrics, instructional videos

1 Introduction

The internet has drastically improved the ability to provide quality distance-learning opportunities over the past decade. The explosion of MOOCs and high-quality educational videos hosted on YouTube have reduced the need for professionals to travel to a certain place in order to learn or refresh their skills in mathematics or data analysis. While there are still many opportunities for taking these courses at various conferences or universities, there are cheaper high quality substitutes becoming available. Specifically when it comes to Spatial Econometrics, there are many opportunities to travel for face-to-face instruction (Table 1), and the author of this article benefitted greatly from a short course offered by Luc Anselin at UI-UC in 2003. However, these courses can easily cost well over $5,000 when the tuition, travel, and lodging are factored in. In this paper we introduce one complete, yet continuing series of free resources that are available.

2 Overview of the course

The core of the course is comprised of 12 YouTube videos, between 15 and 41 minutes long. These videos use screen capture technology (Burkey 2015), rather than videos of a professor in front of a typical classroom. All of the videos and materials are free of charge, posted at http://spatial.burkeyacademy.com. The software used is also all freely available[1], making the course very accessible to faculty and students alike. Each

[1] One file is an Excel File, but is also works in some open source applications such as LibreOffice/Open Office.

Table 1: Examples of Short Courses related to Spatial Econometrics and Spatial Data Analysis

Location	Recent Offerings	Cost
Regional Research Institute, West Virginia University, USA	Summer, 1 Week, 2016-2019	$3,000 + lodging, travel (2018)
Spatial Econometrics Advanced Institute, Università Cattolica del Sacro Cuore of Rome	Summer, 4 weeks, 2018	€ 2,300-3,300 + lodging, travel (2018)
ICPSR, University of Michigan, USA	Summer, 1 Week	$1,700-3,200 + lodging, travel (2018)
NARSC Workshop, San Antonio, TX, USA	1 Day, before the start of the 2018 NARSC Conference	$95 in addition to the cost of attending NARSC Conference

video has an accompanying handout, dataset, Excel file, or text file containing code, as is appropriate.

3 Brief outline of the course

Though additions to the series will continue to be made based on viewer feedback, the core 12 videos (plus an additional 9-minute brief "Welcome" video) form a complete, though basic introduction to Spatial Econometrics. It is assumed that the viewers are familiar with cross-sectional econometrics and basic matrix notation. Some basic familiarity with map files and R would be helpful, but not required.

3.1 Introduction to thinking spatially with some econometric models

The first video outlines some of the major Spatial Econometric Models and how to think about spatial interaction/spillover in basic terms. The video and handout also discuss some of the major researchers who developed the models, and give some references for books and journal articles where viewers can find more information. In this section we introduce the following models:

OLS Model

$$y = X\beta + \epsilon \tag{1}$$

The OLS model does not contain a spatial relationship, but is often used as a starting place. Anselin (1988) favored the Lagrange Multiplier approach to specification searches. Starting with OLS, Anselin derived 5 Lagrange Multiplier statistics that help determine if the (possibly misspecified) OLS model points toward the Spatial Lag, Spatial Error, or SARMA models, though he suggested that the SARMA model was probably never the correct specification.

Measuring "neighbors" with a Spatial Weights Matrix, W, allows us to mathematically specify how spatial relationships among regions might be structured. Regions might be related with their neighbors in three different ways:

1. The value of y in a region might impact (or be related to) the value of y in a neighboring region

2. The values of X's in a region might affect (or be related to) the value of y in a neighboring region

3. The residuals ϵ might affect (or be related to) the residuals in a neighboring region (spatial heteroskedasticity or spatial autocorrelation)

Manski Model

$$y = \rho W y + X\beta + WX\theta + u \qquad u = \lambda W u + \epsilon \tag{2}$$

The Manski Model builds in all three types of spatial relationship. If $\theta = 0$ then Manski becomes the Kelejian-Prucha Model:

Kelejian-Prucha, SARAR, Cliff-Ord, SAC model

$$y = \rho W y + X\beta + u \qquad u = \lambda W u + \epsilon \tag{3}$$

Or if $\lambda = 0$, we get the Spatial Durbin Model (SDM), which involves lagged y and spatially-related residuals. LeSage, Pace (2009) favor starting with this specification (or the Spatial Durbin Error Model, discussed in the last of the core videos), and then using Likelihood Ratio techniques to test to see if the model should be restricted to a simpler, nested model.

Spatial Durbin Model

$$y = \rho W y + X\beta + WX\theta + \epsilon \tag{4}$$

If $\rho = 0$, then this becomes the

Spatially Lagged X (SLX) Model

$$y = X\beta + WX\theta + \epsilon \tag{5}$$

If $\theta = 0$, then (4) degenerates into the Spatial Lag Model

Spatial Lag, Spatial Autoregressive (SAR)

$$y = \rho W y + X\beta + \epsilon \tag{6}$$

If $\theta = -\rho\beta$, then (4) simplifies into the spatial error model (because $\lambda = \rho$ in this case)[2].

$$\begin{aligned} y &= \rho W y + X\beta + WX[\theta = -\rho\beta] + \epsilon \\ y &= \rho W[X\beta + \epsilon] + X\beta + WX[-\rho\beta] + \epsilon \\ y &= \rho WX\beta + \rho W\epsilon + X\beta + WX[-\rho\beta] + \epsilon \end{aligned}$$

Spatial Error (SEM)

$$y = X\beta + u \qquad u = \lambda W u + \epsilon, \qquad \text{where} \quad \epsilon \sim i.i.d. \tag{7}$$

Of course, setting all of the spatial parameters (λ, ρ, and the vector of θ's) to zero will restrict the model back to OLS.

3.2 GIS basics

The next two videos give a brief introduction to using QGIS (QGIS Development Team 2018). The focus is on how to download a SHP file mapping a set of regions, open it in a GIS program, edit it by removing regions that may not be of interest, and add additional data for the regions to be analyzed. Users are provided with a ZIP file to download that contains the map files and extra data to import for practice with the video.

3.3 Understanding the idea of contiguity and spatial correlation

A video focusing on contiguity and spatial correlation (Moran's I) follows, along with a downloadable spreadsheet file. In this file the viewers help to complete small contiguity and weights matrices by hand, using a simple set of regions. The users are shown how simple row standardization can be done. This spreadsheet allows users to change data values in each region, and dynamically see how the value of the spatial correlation changes as the user creates different patterns in the data.

[2]The lines below – although not mathematically correct – provide intuition for why the SEM is nested with the SDM. For the correct (though possibly less intuitive) derivation, see LeSage, Pace (2009, pp. 51-52).

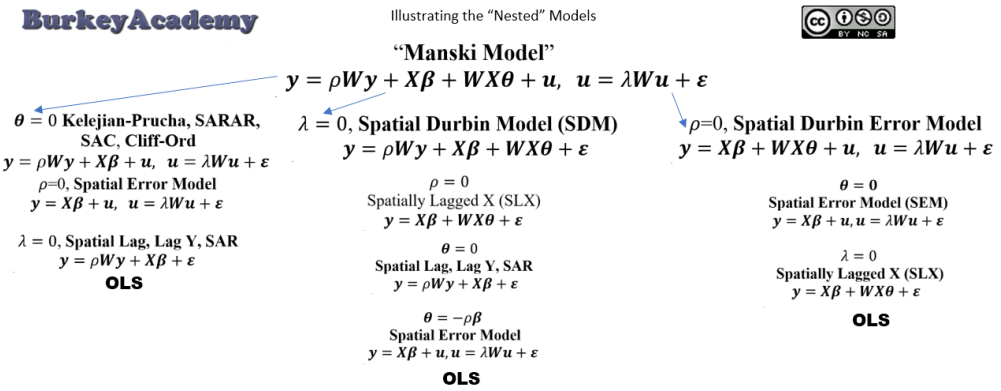

Figure 1: Part of the "Nested Models" Handout

3.4 ESDA, making and visualizing spatial weights for spatial data with GeoDa

The next four videos in the series use GeoDa's fantastic visualization tools (Anselin et al. 2006) to do basic Exploratory Spatial Data Analysis (ESDA), create and export spatial weights matrices, calculate spatial correlations, and do basic spatial regressions and specification tests. The strengths and weaknesses of GeoDa are discussed, and the user is encouraged to also learn R for spatial data analysis in the remaining videos.

3.5 R for spatial data analysis and regression

In the final four videos of the sequence, the user is introduced to R, and many of the common packages used for spatial data manipulation and analysis (especially spdep (Bivand, Piras 2015, Bivand et al. 2013). The first two videos focus on getting data into R and creating contiguity matrices. Viewers are shown how to read in spatial data, create weights matrices, import weights created in GeoDa, export weights, and plot contiguity relationships.

The final two videos in the core of the series explore ways to perform a spatial specification search and estimate many of the common spatial econometric models in R. The difference between Lagrange Multiplier (LM) tests and Likelihood Ratio (LR) tests are discussed. In summary, the LM tests begin with estimating a nonspatial OLS model and calculating the score, indicating the rate of improvement in the model fit as we relax the constraints making the model nonspatial. Anselin derived five LM tests: One for the SEM and SAR (with a robust version for these, attempting to filter out some propensity for a false positive between these two models), and a test for a SARMA Model[3].

The benefit to the LM approach is that only the OLS model needs to be estimated before calculating the LM statistics. However, this method of spatial specification search is very limiting, because only three types of models can be considered. Thus, many spatial econometricians favor the LR approach, because any model can be tested to see if a simpler, nested model may be more appropriate (See Figure 1). The LR statistic is also very easy to calculate after running the two models to be compared:

$$\text{LR}_{\text{stat}} = -2(\text{L}_{\text{restricted}} - \text{L}_{\text{unrestricted}}) \sim \chi^2(\#\text{ restrictions}) \tag{8}$$
$$\text{Ho: restricted model is true}$$

LeSage (2014) suggests running the SDM if a global specification is needed, and if a local structure is needed, first run the Spatial Durbin Error Model (SDEM):

$$y = X\beta + WX\theta + u, \qquad u = \lambda Wu + \epsilon \tag{9}$$

[3]A SARMA is similar to a Kelejian-Prucha model, with a more quickly-decaying spatial impact.

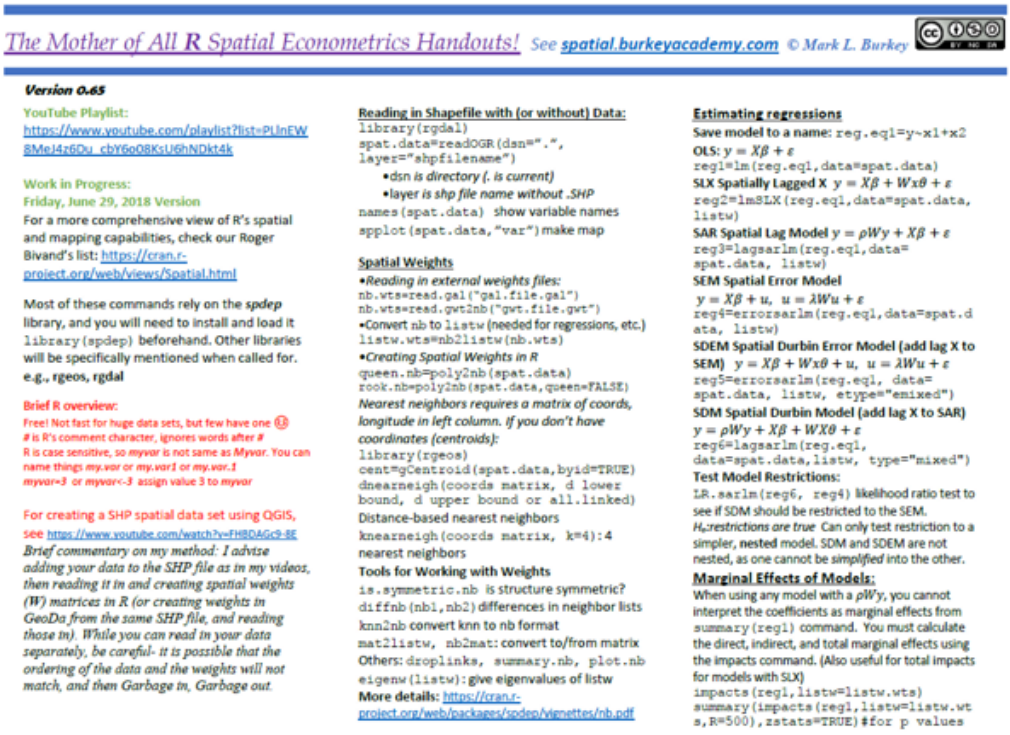

Figure 2: Snapshot of the Spatial Econometrics Cheat Sheet (Burkey 2018)

This model is "local" because it does not contain a lag y term; so while neighbors affect each other, this effect does not propagate throughout the entire space. Links to the data, commands, and handouts are included, along with a two-page spatial econometrics in R reference sheet with commands and tips (Figure 2).

4 Conclusion

While this web page and YouTube series are not a perfect substitute for a short course, it is hoped that it helps to introduce Spatial Econometrics to a wider audience, and serve as a resource for those who cannot afford to take a face to face course. The author welcomes any suggestions and corrections from the academic community. The author hopes to add some interviews with leading researchers in the field to this series of videos, as well as add additional topics of interest.

Acknowledgement

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References

Anselin L (1988) *Spatial Econometrics: Methods and Models*. Kluwer Academic Publishers, Dordrecht. CrossRef.

Anselin L, Syabri I, Kho Y (2006) Geoda: An introduction to spatial data analysis. *Geographical Analysis* 38[1]: 5–22. CrossRef.

Bivand RS, Hauke J, Kossowski T (2013) Computing the Jacobian in Gaussian spatial autoregressive models: An illustrated comparison of available methods. *Geographical Analysis* 45[2]: 150–179. CrossRef.

Bivand RS, Piras G (2015) Comparing implementations of estimation methods for spatial econometrics. *Journal of Statistical Software* 63[18]: 1–36. CrossRef.

Burkey ML (2015) Making educational and scholarly videos with screen capture software. *REGION* 2[2]: R2–10. CrossRef.

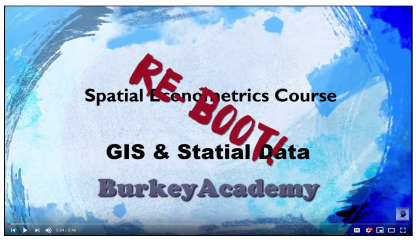
Burkey ML (2018) The mother of all R spatial econometrics handouts. Available from http://spatial.burkeyacademy.com

LeSage JP (2014) What regional scientists need to know about spatial econometrics. *The Review of Regional Studies* 44[1]: 13–32

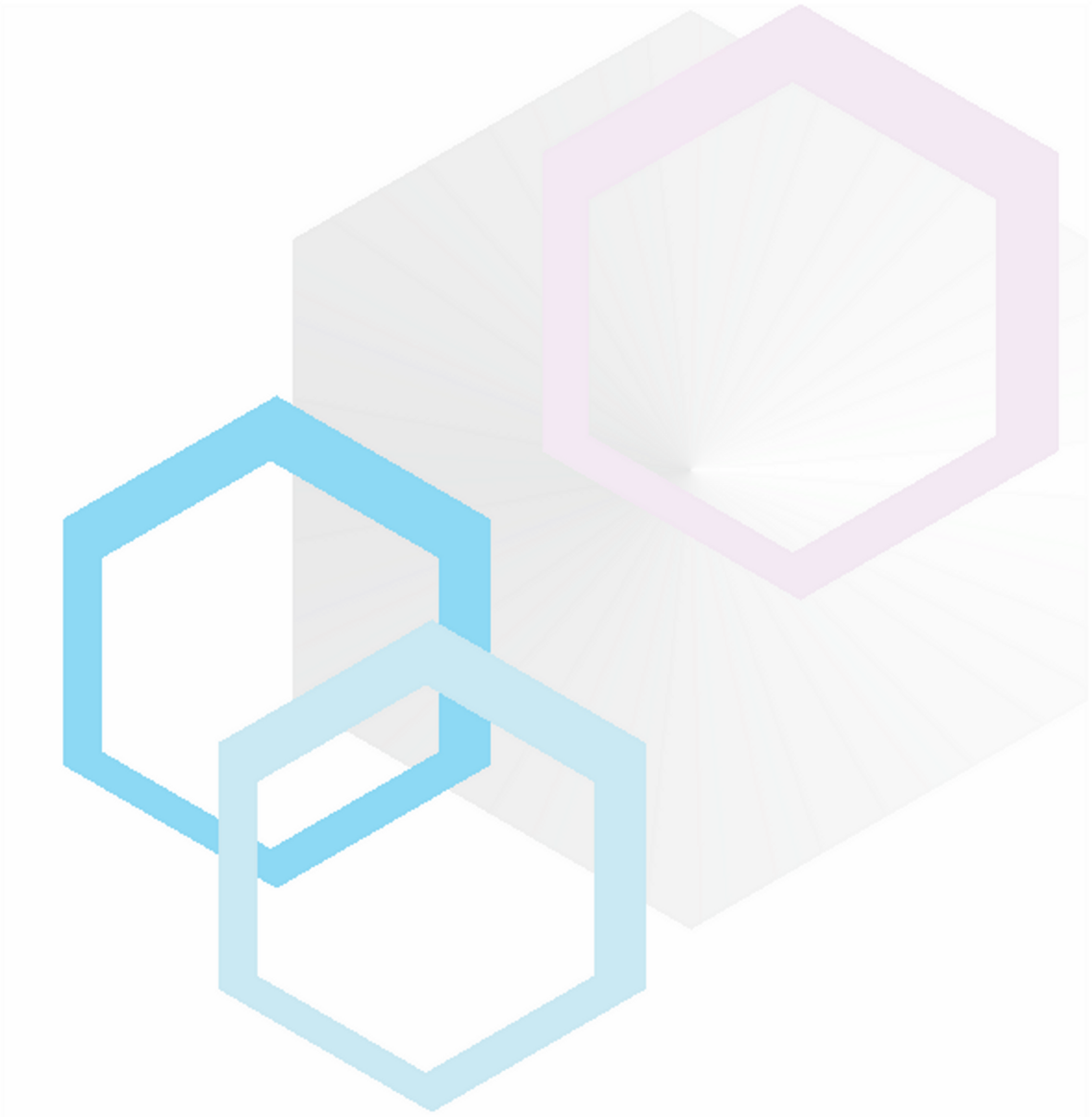
LeSage JP, Pace RK (2009) *Introduction to Spatial Econometrics*. CRC Press, Boca Raton, FL. CrossRef.

QGIS Development Team (2018) QGIS geographic information system. Open source geospatial foundation project. http://qgis.osgeo.org

A list of the videos with descriptions and links to the supplementary material can be found at http://spatial.burkeyacademy.com.



The playlist of videos is at https://www.youtube.com/playlist?list=PLlnEW8MeJ4z6Du_cb-Y6o08KsU6hNDkt4k



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