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Table of Contents

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Estimating Determinants of Transportation and Warehousing Establishment Locations Using U.S. Administrative Data

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Abstract. Interactions between transportation and warehousing and other industry clusters are not widely explored and the determinants of logistics locational determinants is limited in the U.S. context. These gaps in the literature, along with the U.S. transportation and warehousing sector's decentralization from urban areas and concentration in regions, highlight the importance of understanding the effects of place-based factors and inter-industry clusters on the locations and employment of transportation and warehousing industries. The analysis uses restricted-access U.S. Census Bureau data aggregated to the county level, along with secondary data sources, to estimate the locational determinants of transportation and warehousing (TW) industries based on transportation infrastructure as well as sociodemographic and institutional variables. The analysis takes a cross-sectional (non-causal) approach to focus on time-invariant location factors while testing and implementing zero-inflated count data distributions to model the data generation processes more accurately. Results indicate that subsectors are affected differently by infrastructure, sociodemographic, and institutional variables. Additionally, different factors are associated with industry presence versus size. Finally, we show that data using aggregated industries obscures locational factors' importance for individual sub-sectors and, further, that industrial aggregation obscures TW sectors' relationships to other clusters.

1 Introduction

Transportation and warehousing (TW) industries provide or support the transport of passengers and storage of cargo via roads, rails, water, air, and pipelines. Given these modes of transportation, and in addition to local labor force composition, certain locations may offer comparative advantages to local industries based on their economic and place-based assets, leading to clusters of transportation and warehousing establishments (Kang 2020, Ng, Gujar 2009)[1]. Porter (2000, 2001) popularized the idea that inter-related industries harness regional competitive advantage to strengthen innovation, productivity, and other economic outcomes. Transportation infrastructure is often an institutional factor used to predict or describe economic outcomes.

[1]This article necessarily uses many abbreviations and acronyms. In addition to in-text first-use definitions, we provide a list of acronyms in appendix Table A.1 for reference.

Synergistic effects between transportation and warehousing and other industry clusters are not widely explored, and in general, the literature on logistics locational determinants is fairly limited in the U.S. context (Rivera et al. 2014, 2016). These gaps in the literature, along with the U.S. transportation and warehousing sector's decentralization from urban areas and concentration in some U.S. regions (Cidell 2010), highlights the importance of understanding the effects of place-based factors and inter-industry clusters on the locations and employment of transportation and warehousing industries.

While transportation topics have been more explored in the European context, less attention has been given to the potentially different U.S. transportation context, likely due to prior data limitations. Fewer inter-regional differences in transportation policy exist between U.S. states than European countries (Rodrigue, Notteboom 2010), which may have provided richer research opportunities regarding both transportation and its relationship to economic competitiveness. Additionally, state ownership of some transportation networks (Clausen, Voll 2013) is more common in Europe, which may prompt published studies of both industries and infrastructure. Regardless, understanding the relationships between TW location decisions and local economic, demographic, and infrastructure measures is pertinent to both geographies as infrastructure spending has waned in recent years in both the US and Europe, but may be increasing in the near future. Using confidential U.S. administrative data aggregated to the county level, the focus of this article is to illustrate how more refined data and unique data generation processes may be utilized to explore the influence of local industry, socioeconomic, and place-based factors on the size of local transportation and logistics (including warehousing) industries. This illustration includes accounting for clustering by examining the association of various other industries on TW location. The analysis takes a cross-sectional (associative and non-causal) approach to focus on time-invariant location factors while testing and implementing zero-inflated count data distributions to most accurately model the data generation processes of TW industries.

The following section reviews the literature on TW locational determinants and transportation's effects on economic competitiveness. The novel data and methods underlying our approach are then presented, followed by study results for selected transportation sectors. The conclusion discusses general observations about TW cluster predictors and the propensity of TW sectors to support other clusters, opening the door to future U.S. TW locational choice research.

2 Literature Review

Economic studies of transportation and warehousing (TW) tend to focus on the costs and barriers of moving either goods or people. Analyses of the benefits and costs (including external costs) of infrastructure often account for both people and freight in traffic volume (Behiri et al. 2018, Li, Madanu 2009, Mayeres et al. 1996). Researchers accept that the people and freight require different treatment, but common models are readily adapted to address either passenger or freight concerns based on quantities of goods to be transported between specific locations, distribution flows between those locations, modal splits, and assignment to transportation networks (de Jong et al. 2004). In essence, these models orient networks and transportation infrastructure to minimize transportation distances and costs.

Despite its importance in moving goods as well as labor and consumers, transportation emerged as a topic within economic geography relatively recently (Hesse, Rodrigue 2004), and the literature on TW firm location decisions, in particular, remains relatively sparse (Holl, Mariotti 2018). A comprehensive review of the extensive firm location literature is beyond the scope of this article; however, this section discusses key advances in the literature since McFadden's (1973) discrete choice work.

Much of the literature pertaining to transportation in an economic development context is focused on transportation infrastructure and its role in supporting development (Chen et al. 2016, Maparu, Mazumder 2017, Melecky et al. 2019). Demand increasingly influences supply chains and TW logistics, particularly with the rising importance of e-commerce and its associated distribution (Bowen 2008, Hesse, Rodrigue 2004, Hughes, Jackson 2015,

Rodrigue 2020). Beyond road densities, transportation hubs, flows, and networks are becoming increasingly important (Crang 2002). Inland hubs and intermodal facilities are becoming more important, and warehouses are moving to places with strong multi-modal networks, especially as technology promotes larger warehouses and distribution centers, which are increasingly independent firms rather than divisions of manufacturing or retail firms (Bowen 2008).

Cidell (2010) expands on this work, using Economic Census and County Business Patterns Data to measure the concentration of warehousing and distribution establishments across the U.S. by calculating Gini coefficients for each county, although they note that employment and payroll data are not reliably available from those sources for the warehousing sector, thus limiting her choice of dependent variable. Independent variables represent demand attributes, such as population and income, and physical infrastructure attributes such as interstate and railroad miles, enplanements, and distance. Infrastructure such as highways, rail, and inland waterways were not always significant predictors of freight establishments within a metropolitan area (Cidell 2010), although other researchers have continued to find these factors critical (Guerin et al. 2021, Holl, Mariotti 2018). Overall, warehouses and distribution centers decentralized and moved toward suburbs over time. Cities with strong warehousing sectors, as measured by the Gini coefficient, tended to have more concreated establishments near the city center. Concentration early in the study period was also associated with greater decentralization within the metropolitan area over time, although many cities added the largest number of freight establishments within the central county with the densest transportation infrastructure. Other researchers have found similar results related to suburbanization (Allen et al. 2012, Cidell 2010, Dablanc et al. 2014, Holl, Mariotti 2018) and inland hub development (Bowen 2008, Holl, Mariotti 2018, Monios, Wilmsmeier 2013, Rodrigue 2020).

While cost minimization drives TW location decisions, lower transportation costs often arise from agglomeration economies (Cidell 2010, Hesse, Rodrigue 2004). Further, the prevalence of railroad and highway miles, interstate highway and airport presence, and related transportation costs are often predictors of regional economic competitiveness, both for the TW sector itself (Cidell 2010, Guerin et al. 2021, Holl, Mariotti 2018) and for other sectors dependent upon the logistics (Belleflamme et al. 2000, Dudensing 2008). The range of variables included in recent logistics firm location models, such as gross domestic product (GDP) (Guerin et al. 2021), population density and accessibility to residential population and manufacturing (Sakai et al. 2020) and urban structure (Holl, Mariotti 2018), suggests that researchers are beginning to think beyond infrastructure density to broader factors that affect regional TW competitiveness. In the U.S. context, rural areas can be more attractive to certain types of firms because wages, property taxes, and land costs are all lower than in most metro areas (Parajuli, Haynes 2017, Wilkerson 2001).

Economic clustering – geographic concentrations of industries related through shared knowledge, skills, inputs, demand and/or other linkages – is a popular way of building economic competitiveness (Delgado et al. 2016). These geographic concentrations build upon regional competitive advantages (Porter 1990) and agglomeration factors (Marshall 1920). In Porter's (1990) framework, competitive advantage is influenced by four elements: firm strategy, structure, and rivalry; demand conditions; factor conditions; and related and supporting industries. Firm strategy, structure, and rivalry describes the size, number, ownership, and goals of firms. Demand conditions reflect needs of domestic (local) buyers, which can include the number of potential buyers, their purchasing needs, and their ability to pay. Factor conditions include the availability of factors of production, including land, labor, capital, and infrastructure. Related and supporting industries are those who require the goods or services of a given target industry, provide inputs, or use similar labor or technology. Each element is part of a system supporting the development of clusters that foster economic competitiveness within industries, and through those industries, of national and regional economies.

Clusters have been incorporated into a handful of TW location studies. Sakai et al. (2020) and Durmuş, Turk (2014) find the presence of industrial clusters has a positive effect on logistic establishment location decisions. Van den Heuvel et al. (2013) observes

within-sector clustering as Belgian TW establishments tend to develop in proximity to existing logistics establishments, and they call for additional research into drivers and benefits of clustering within the TW sector.

3 Conceptual Framework

The focus on cost-distance minimization models in the transportation literature, gravity models in transportation and trade/regional economics literatures, and economic clusters within the regional economic literature seem to converge where the rubber meets the road. That is, for an entrepreneur or economic developer looking for opportunities to start or grow a transportation-based business, establishment and employment agglomeration (clustering) signal locations with existing advantages. Locations with similar demographic, transportation, and economic characteristics should be similarly suited to transportation business success. Durmuş, Turk (2014), Sakai et al. (2020), and Van den Heuvel et al. (2013) all incorporate clustering into their location choice models but fall short of placing their work within the broader clustering framework. They incorporate agglomerations of TW or other industry establishments with other elements of traditional cost-minimization location modeling. However, economic competitiveness signaled by clusters is a function of cost factors, including infrastructure, population density, and labor availability and quality. In fact, these factors are represented within the four elements of competitiveness in the Porter (1990) model. Thus, we embrace the broader framework of economic competitiveness and treat factor conditions (infrastructure, labor), demand conditions, industry structure, and related industries as part of the competitive locational choice decision. The competitiveness model also facilitates the exploration of how TW and other industry clusters interact. While interesting clusters themselves, the TW sectors in this study serve numerous other clusters and in fact may be considered parts of those clusters. In addition, subsectors within the broader TW sector often reinforce and strengthen each other. Figure A.1 represents our adaptation of the Porter framework, emphasizing the interactive relationship between firm structure and related industries, as well as government's direct influence on factor condition through infrastructure investment.

4 Transportation and Warehousing Data

We use restricted-access 2014 data from the Longitudinal Business Database (LBD) and Integrated Longitudinal Business Database (ILBD) for the continental U.S. along with 2014 secondary data sources to econometrically estimate the location decisions of five TW industries. In Europe, Eurostat offers a program similar to the U.S. Federal Statistical Research Data Center program (Eurostat 2020). As noted above, researchers often measure industry size in a location with public establishment counts, which is a non-negative integer count and includes numerous zeros that increase with more geographically refined units of observation. This measure is limited both because of disclosure issues and because an establishment count is a poor measure of regional industry size. Employment may serve as a better measure of industry size, while still using count data methods. We thus examine both non-employer establishments (i.e., establishments without any paid employees), employer establishments, and total employment as measures of industry size.

The Census Bureau's County Business Patterns (CBP) is among the most utilized county-level public data sources for establishment and employment counts for industries within the North American Industry Classification System (NAICS), including TW industries. Other federal data programs publish information about the economic activity in TW, including the Quarterly Census of Employment and Wages (QCEW), the Quarterly Workforce Indicators (QWI), and Non-employer Statistics (NS). Although public versions of these data are available, the exact counts of a particular NAICS code are also often suppressed. These limitations are particularly prevalent in some TW industries due to the small number of employers within some counties, especially rural counties. Given the extensiveness of the disclosure limitations, exact counts yield more precise estimates; specifically, Carpenter et al. (2021) show that the measurement error in public U.S. regional economic data implies substantially biased estimates. A Federal Statistical Research Data

Center (FSRDC) is thus a natural place to make improvements to existing research using the LBD and ILBD, which we aggregate to the county-level to develop unsuppressed non-employer establishment counts, employer establishment counts, and total county employment (as in Carpenter et al. 2021, Van Sandt et al. 2021), all within specific TW industries. The zero-inflation methods described below capitalize on this refined data by being able to accurately discern the zero-generating regime for unsuppressed counties with no TW industries.

The LBD is an annual series produced by the U.S. Census Bureau based on establishment records from the Business Register (Jarmin, Miranda 2002). The Business Register (BR) acts as the source of information for both the public CBP as well as the restricted LBD; however, the LBD undergoes more edits for longitudinal consistency and does not contain suppressed or noise infused values. Consequently, the LBD is a fundamental dataset for studying the determinants of firm strategy, structure, and rivalry, including entry, growth, and exit at the establishment, firm, industry, and economy-wide level (Carpenter, Loveridge 2018, 2019, 2020, Davis et al. 2006, Foster et al. 2006, Haltiwanger et al. 2013). Comprehensive longitudinal establishment-level data are similarly available in other countries, with economists often using them to examine firm establishment location decisions, though TW locational analysis remains understudied (Arauzo-Carod, Viladecans-Marsal 2009, Chen, Moore 2010, Devereux et al. 2007, Figueiredo et al. 2002, Holl 2004). Location quotients (LQs) of groups of non–TW industries explore the effects of related industries and the potential for inter-industry clustering.

Despite the LBD and the ILBD being at the establishment level, the Census Bureau requires us to conduct our analysis at an aggregated county level due to the sensitivity of the data. However, this unit of analysis is useful for the inclusion of important secondary data sources that capture the potential influence of factor conditions, including local internet access, travel infrastructure, water coverage, urban influence, and human capital, as well as demand conditions including other demographic and locational variables.

Further, county-level aggregation facilitates the implementation of the previously discussed count data methods. Table 1 provides descriptive statistics for the publicly available county-level data[2]. Variables are grouped by Porter Element with demographic variables representing either demand or factor conditions; infrastructure and institution variables reflect factor conditions. A handful of variables may cross elements, but each variable is listed only once. The TW establishment and employment data, of course, reflect firm strategy. The detailed nature of the data allows us to model the location and employment attributes for a range of TW industries, which fall within Transportation and Warehousing (NAICS 48-49) and Professional, Scientific, and Technical Services (NAICS 54). Specifically, we examine General Warehousing & Storage (NAICS 493110); Process, Physical Distribution, & Logistics Consulting (NAICS 541614); Pipeline Transportation (NAICS 486); Support Activities for Road Transportation (NAICS 488490); General Freight Trucking (NAICS 4841). Other sectors and industries are feasible and interesting, but we limit the presentation to example sectors here to cover a breadth of TW sectors, for which locational determinants have been shown to vary in international contexts (Holl, Mariotti 2018, Kang 2020, Rivera et al. 2014), while maintaining relative brevity[3]. Figure 1 shows a map of the distribution of Pipeline Transportation (NAICS 486) employment and data suppression issues. Maps of the other industries examined herein are available in the appendix (Figures A.2-A.5).

Motivation for the included determinants of transportation location draw on both past literature and virtual focus groups. Following a method established by Loveridge et al. (2013) the authors conducted virtual focus groups with U.S. economic development practitioners, small business support professionals, and entrepreneurs. Commonly found location determinants in published studies include local land and labor costs, taxes, infrastructure, market size, and agglomeration economies (Blair, Premus 1987). Proxy variables often include per capita income or wage rate, high school and bachelor degree

[2]Table A.1 in the appendix provides additional descriptive statistics.

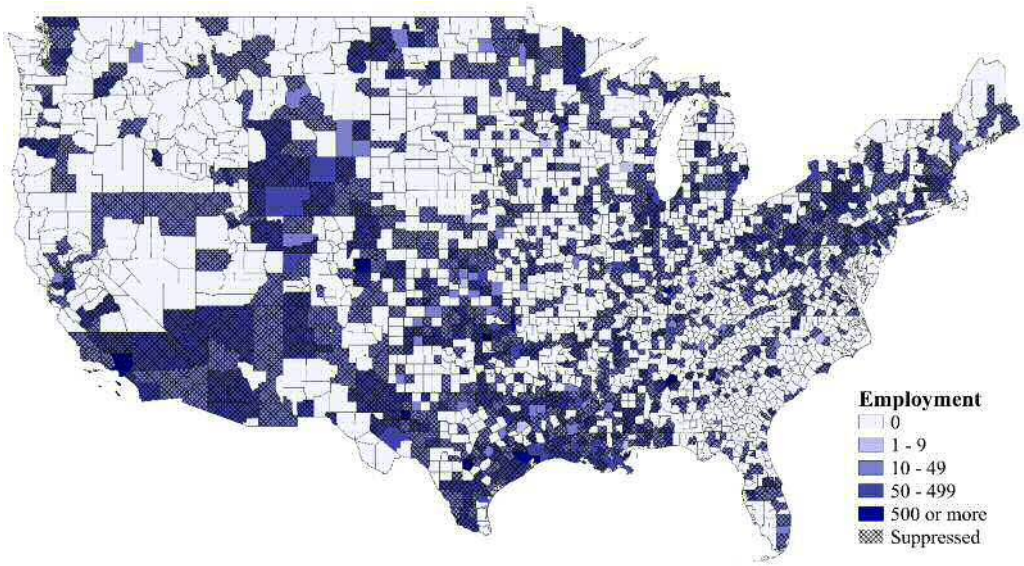
[3]The authors acknowledge that the choice of sectors could be criticized as ad hoc, rather than covering a breadth of industries. Nonetheless, these sectors are common to transportation and warehousing research, and as the results indicate, this breadth of sectors allows for interesting cross-sector comparisons of locational determinants and future researchers are encouraged to examine additional sectors.

Table 1: Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Source
Demographics – Demand Conditions				
Population	3,107	101,931.30	327,468.00	ACS
Population Density	3,107	0.27	1.80	ACS
Median Age	3,107	40.85	5.18	ACS
Per Capita Income (thousands $)	3,107	39.59	11.64	BEA
Percent of Residents in Poverty	3,107	16.84	6.55	ACS
Demographics – Factor Conditions				
Unemployment Rate (5yr avg.)	3,107	7.89	2.68	BLS
Social Capital Index	3,107	0.01	1.26	NERCRD
Opiates Prescribed / 100 People	2,944	85.72	49.37	CDC
Percent Work in Another County[1]	3,107	30.10	17.69	ACS
Percent Black	3,107	0.09	0.15	ACS
Percent Hispanic	3,107	0.09	0.14	ACS
Percent – Bachelors or Above	3,107	13.24	5.48	ACS
Infrastructure and Institutions – Factor Conditions				
Median Home Value ($1,000's)	3,107	135.77	79.20	ACS
Avg. Combined Sales Tax Rate[2]	3,107	7.01	1.68	Tax Foundation
Avg. Effective Property Tax Rate	3,107	1.06	0.51	SmartAsset.com
Internet Service Providers (ISPs)	3,106	5.19	1.12	FCC
Metro - Urban Influence Code	3,107	0.37	0.48	ERS, USDA
Micropolitan Metro Adjacent - UIC	3,107	0.33	0.47	ERS, USDA
Micropolitan Non-metro Adjacent - UIC	3,107	0.30	0.46	ERS, USDA
Interstate Density[3]	3,107	1.79	3.07	Census Shapefiles
Highway Density[3]	3,107	0.37	0.24	Census Shapefiles
Percent Covered by Water	3,107	4.50	11.15	ERS, USDA
Community Colleges	3,107	0.33	0.84	NCES
Universities or Colleges	3,107	0.72	2.40	NCES
Military Bases	3,107	0.04	0.22	US Census Bureau
Census Region Fixed Effects	3,107	N/A	N/A	US Census Bureau
TW Industry Establishments and Employment – Firm Strategy, Structure, and Rivalry				
General Warehousing & Storage (493110) Estab.	3,106	3.32	13.22	WholeData
General Warehousing & Storage (493110) Emp	3,106	209.12	881.42	WholeData
Warehousing and Storage (4631) Non-emp	1,681	5.21	24.31	NS
Management Consulting Services (54161) Estab.	3,106	41.78	198.01	WholeData
Management Consulting Services (54161) Emp.	3,106	293.25	1,705.54	WholeData
Management, Scientific, and Technical Consulting Services (5416) Non-emp.	3,072	228.31	924.11	NS
Pipeline Transportation (486) Estab.	3,106	1.33	3.93	WholeData
Pipeline Transportation (486) Emp.	3,106	16.89	187.20	WholeData
Pipeline Transportation (486) Non-emp.	511	1.23	5.91	NS
Support for Road Transportation (488490) Estab.	3,106	0.81	3.31	WholeData
Support for Road Transportation (488490) Emp.	3,106	10.89	59.73	WholeData
Support for Transportation (488) Non-emp.	2,924	44.28	229.92	NS
General Freight Trucking (4841) Estab.	3,106	22.18	85.38	WholeData
General Freight Trucking (4841) Emp.	3,106	293.68	1,014.61	WholeData
General Freight Trucking (4841) Non-emp.	3,100	160.87	781.12	NS

Notes: Due to disclosure prevention limitations, these descriptive statistics are based on public data sources, while the main regression results are based on the limit-access Longitudinal Business Database and Integrated Longitudinal Business Database. All data are based on 2014; 2014 is chosen for practical reasons related to the availability of many of the secondary data sources. The internal and unsuppressed data used in regressions differ slightly in addition to the inclusion of unsuppressed cells. The more refined 541614 NAICS was not publicly available. Industry size measure abbreviations: non-employer establishments (Non-Emp.); employer establishments (Est.); total employment (Emp.). [1] Percent of all residents age 16 and older. [2] State-level variable. [3] Miles of road per hundred square miles.

Abbreviations: ACS: American Community Survey, BLS: Bureau of Labor Statistics, BEA: Bureau of Economic Analysis, CDC: Center for Disease Control and Prevention, FCC: Federal Communications Commission, ERS: Economic Research Service, NS: Non-employer Statistics, NCES: National Center for Education Statistics, NERCRD: Northeast Regional Center for Rural Development, USDA: US Department of Agriculture



Notes: Map shows employment ranges in every county in the continental U.S. "Suppressed" indicates that the exact value of the data is suppressed to prevent improper disclosure of identifiable information and placed into bins (e.g., "20-99 employees"). For the sake of these maps, we replace these ranges with their midpoint.

Figure 1: Employment Distribution of Pipeline Transportation (NAICS 486)

shares, unemployment rate, highway and interstate coverage, property taxes, rurality spectrum codes, population density, climate, racial composition, and location quotients (Coughlin, Segev 2000, Guimarães et al. 2000, 2004). The virtual focus groups supported many of these previously found factors but added insights into the potential importance in the rural U.S. of broadband access and issues related to workforce turnover and opioid misuse, particularly in rural areas and particularly related to TW industries (Joudrey et al. 2019, Rigg et al. 2018). This article uses the opioid prescription rate as a proxy for opioid misuse; though imperfect, given regional variation in prescription rates and negative outcomes associated with opioid misuse (Quast 2018), we continue to include this variable given the relevance of the opioid epidemic in the U.S. noted in our qualitative focus groups and in past research (Rigg et al. 2018).

Finally, researchers define the transportation and logistics clusters based on research interests and purposes, and definitions may affect study outcomes. For example, the Kumar et al. (2017) transportation and logistics cluster includes both freight and passenger transportation, suggesting that passenger transportation might affect the prevalence of the cluster in metropolitan areas. For clarity in the presentation of results, this article relies on Location Quotients (LQs) of groups of non–TW industries to examining the potential for inter-industry clustering in this article[4].

5 Methods

Given the nature of geography-based establishment and employment data, and the ability to allow for two zero-generating processes through an added logit link function, count data models are useful for empirical estimation. Resultantly, count data estimators have become common in locational and threshold models (Carpenter et al. 2021), though researchers often fail to appropriately apply and compare the various models, as we will demonstrate. For non–TW establishments, there are numerous applications of Poisson (Arauzo-Carod, Viladecans-Marsal 2009, Papke 1991), Negative Binomial (NB) (Conroy et al. 2016, Holl 2004, Smith, Florida 1994), Hurdle Poisson (HP) (Chakraborty 2012,

[4]This article uses the entire U.S. as the reference for the location quotient because, as Figure 1 highlights, that TW industries tend to cluster in areas above alternatives, such as at the states. Additionally, many states are quite small and have few TW industries, confusing the interpretation of the LQs. As noted later, regressions include regional fixed effects.

Henderson et al. 2000), Zero-Inflated Poisson (ZIP) (Chakraborty 2012, List 2001, Reum, Harris 2006). We also consider the Zero-Inflated Negative Binomial (ZINB) here within TW when using a large geographic scope without data suppression.

The Poisson model is useful as a starting point for comparison to other estimation procedures. However, the Poisson model's assumption that dependent variable's conditional variance is equal to the conditional mean is often violated in practice due to multiple sources of overdispersion, in which case the NB is more efficient. Overdispersion is likely to exist in TW industries due to large infrastructure endowments in some geographical units motivating the need for many TW establishments and levels of employment[5]. Zero-inflated and hurdle versions of the Poisson model are often used to account for excess zeros in the data when it is believed that the zeros arise from two separate regimes. In the current context, the two zero-generating regimes in zero-inflated models may be interpreted as structural and non-structural zeros, i.e., counties that have zero establishments due to a lack of a requisite resource like water and counties that have zero establishments due to chance or extant economic conditions. On the other hand, HP only assumes one type of zero and truncates the Poisson distribution after the logit zero-generating, which is less flexible[6].

Finally, researchers can fail to account for overdispersion that remains after the zero-inflation. This is particularly important when examining TW sectors because remaining overdispersion (from unobserved heterogeneity or excessive concentration of firms) increases in economies of scale and agglomeration, which are common in TW sectors. If authors are interested in modeling both an inflation stage and accounting for these multiple sources of overdispersion, ZINB is underutilized; indeed, we find it to be preferred for many TW industries.

We compare results and diagnostics from the Poisson, NB, and their zero-inflated complements to provide results across five TW subsectors. This flexible approach takes advantage of the count data, while using the potential for overdispersion caused by (1) numerous zeros, which depend on industrial sector specificity, spatial monopsony, and economies of scale, (2) long-tailed distributions, resulting from spatial concentration, which varies depending on spatial resource dependence and economies of agglomeration, and (3) unobserved heterogeneity (Carpenter et al. 2021).

To choose among the various count data models, many researchers incorrectly use Vuong's Statistic to compare these various count data estimators (Wilson 2015). To provide a consistent comparison, we use graphical distribution and information criteria comparisons as suggested in Greene (1994). All models make use of White's robust standard errors, and variance inflation factors did not indicate any potential concern over loss of efficiency from multicollinearity.

6 Results

While TW includes dozens of industries spanning many sectors of the economy and NAICS sector codes, we focus on investigating a subset of these industries. To summarize, the purpose of this section is not to present an exhaustive analysis of all TW industries' locations, but instead to provide examples of different data generation processes and the advantages of different industry size measures. Through these example models, we illustrate how more refined data and unique data generation processes may be utilized to explore how local industry, socioeconomic, and place-based factors influence the size of

[5]The NB approach allows unobserved heterogeneity between subjects and implies overdispersion, but where the amount of overdispersion increases with $E(y_i|x_i)$ (Wooldridge 2010). Although this may hold when modeling TW employment (e.g., due to large employers), this relationship is unlikely to hold when measuring establishments due to excess zeros driving much of the overdispersion while *decreasing* $E(y_i|x_i)$. Additionally, we note that, though less efficient, Poisson would still produce consistent estimates with fewer assumptions than NB.

[6]The log-likelihood of the Zero-Inflated Poisson model may be written, $\ln L = \sum_{i\in S} \ln\{F(\gamma' Z_i) + [1 - F(\gamma' Z_i)]\exp(-\lambda_i)\} + \sum_{i\notin S}\{\ln[1 - F(\gamma' Z_i)] - \lambda_i + y_i\beta' X_i - \ln(y_i!)\}$, where S is the set of observations taking on a zero value ($y_i = 0$), F is the logit link function that determines the odds of a zero belonging to regime one or two, Z is a vector of covariates that describe the participation decision, X is a vector of covariates that describe the amount decision, and γ and β are the participation and amount parameters of interest to be estimated, respectively.

Table 2: T&W sector distributions across industry size measures

Industry (NAICS code)	Non-Employer Establishments	Employer Establishments	Employment
General Warehousing & Storage (493110)		ZINB	ZINB
Process, Physical Distribution, & Logistics Consulting (541614)		ZINB	ZINB
Pipeline Transportation (486)	ZINB	ZINB	ZINB
Support Activities for Road Transportation (488490)	ZIP	ZINB	ZINB
General Freight Trucking (4841)	NB	NB	NB

Notes: This article does not examine non-employer establishments for NAICS 493110 and 541614 (and there are empty cells in this table) due to no or very few non-employer establishments.

local TW industries. We also note that these results are associative, so we avoid causal interpretations of the results.

To facilitate comparisons across different measures of industry size (e.g., non-employer establishments, employer establishments, and employment), the model covariates are the same between each industry. Each model includes regional fixed effects, population demographics, sectoral location quotients (base = U.S.), employment in three transportation industries, rurality, and other place-based variables of interest through policy or industry perspectives.

We identified the data generation process underlying each industry by first testing for overdispersion in the data to select between the Poisson and negative binomial distributions[7]. After checking for zero-inflation, the significance of the alpha parameter was checked again to determine if overdispersion was still present in the data after accounting for a dual zero-generating process leading to excess zeros. Table 2 summarizes the distributional findings of a selection of TW industries for each industry size measure. The resulting distribution is the product of several economic and administrative features. The NB distribution indicates these establishments can operate in most locations and likely serve smaller, more rural communities where fewer agglomeration economies arise or fewer specialized resources are needed. Industry aggregation (i.e., industries with fewer NAICS digits) also influences the observed data generation process. Aggregating industries leads to fewer counties with zero establishments in the data, meaning that research questions specific to an industry subset of an aggregated NAICS code suffer not only from estimated coefficients values being confounded by noise from other industries, but also from the inability to identify the industry's true data generation process. In this study, we consider four- to six-digit NAICS. Specific codes are provided in Table 2. The rarity of Poisson data generation processes across TW establishments and employment informs our understanding of TW industries and implies that establishments in these industries frequently cluster together, leading to positive skewness and overdispersion.

The marginal effects for five TW models are presented in Tables 3.1–3.3 to demonstrate the effect on model coefficients from (1) different levels of industry aggregation and (2) different measures of industry size. We number these tables 3.1–3.3 to emphasize that the marginal effect estimates are derived from the same regression for each respective industry. In all zero-inflated models, the logistic link function in the ZI equation predicts the odds of a county being in the certainly zero category (i.e., a structural zero opposed to a sampling zero). Thus, the negative coefficients in the inflation stage of Table 3.1 indicate that an increase in the variable is associated with a decrease in the likelihood of the county being a structural zero.

Population and population density are most consistently associated with the probability of non-structural zeros in the inflation stage. Increasing home values and incomes are associated with reduced probability of structural zeros, indicating that economic forces are the dominant barriers to TW locating in areas with higher home values. However,

[7]In addition to the preferred models that use the LBD and ILBD shown in-text, the appendix provides results when using Poisson and the preferred models with publicly available data. This comparison is useful both to show the Poisson as a benchmark model and show the importance of using unsuppressed administrative data, especially in less-aggregated industries.

Table 3.1: Inflation Stage Marginal Effects for Locational Determinants of T&W Sectors

Industry (NAICS)	General Warehousing & Storage (493110)		Process, Physical Distribution, & Logistics Consulting (541614)		Pipeline Transportation (486)			Support Activities for Road Transportation (488490)		
Size Measure	Est.	Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.
Interstate Density	-0.005	-0.011***	-0.043***	-0.005	-0.010	-0.009	-0.004	-0.038	-0.039*	-0.002
Highway Density	-0.732	-12.120**	35.32**	1.667	25.04*	26.15***	23.77***	4.615	-5.244	4.249
Water coverage	-0.002	0.000	-0.025*	0.000	-0.027	0.004***	0.004***	0.004**	-0.002	0.000
Sales tax	0.007	0.004	-0.013	-0.006	0.005	-0.02**	-0.029***	-0.011	0.017	0.003
Property tax rate	0.005	-0.013	-0.001	0.011	-0.068	-0.009	-0.003	0.069	0.081	0.005
ISP count	0.029*	-0.012	-0.009	-0.003	-0.033	-0.002	0.015	0.020	-0.014	-0.013
Micro Metro-Adj.	-0.006	0.007	-0.046	0.006	-0.113**	0.043	0.05*	-0.422	-0.168**	0.039
Metropolitan	0.000	-0.006	-0.006	-0.005	-0.097	0.024	0.037	-0.172*	-74.140	0.015
ln(Population)	-0.074**	-0.212***	-0.052	-0.139***	-0.017	-0.129***	-0.159***	-0.035	-0.022	-0.140***
Population density	-4.485***	-0.068	-1.312**	-0.572	-0.050	-0.173*	-0.119**	-0.042	1.030	-0.059*
Per capita income	-0.006**	-0.003***	-0.001	-0.002*	0.002***	-0.007***	-0.009***	-0.009	-0.007**	-0.003**
Home Value	-0.001	0.000	-0.002**	-0.001***	-0.003***	0.001***	0.002***	0.000	0.000	0.000

Significance levels: *** p <1%, ** p <5%, * p <10%

Notes: Table presents the inflation stage for the regressions specified in Table 2 (either Zero-Inflated Poisson or Zero-Inflated Negative Binomial). Industry size measure abbreviations: non-employer establishments (Non-Emp.); employer establishments (Est.); total employment (Emp.). There is no inflation stage for the General Freight Trucking (4841) industry because it did not need to be zero-inflated (it is modeled as NB). Regressors in Table 3.1 are included in same respective regressions as Tables 3.2 and 3.3.

a county with a higher per-capita income has a greater chance of observing structural barriers preventing the location of pipeline non-employer establishments in the county. Similarly, higher home values are associated with more structural zeros for pipeline employer establishments and employment. Highway density is also associated with greater chance of structural zeros in the Process, Physical Distribution & Logistics Consulting and pipeline sectors, perhaps due to the opportunity costs imposed by the existing infrastructure already present.

The marginal effects of the locational factors in the amount stage (of the same ZIP and ZINB model) are presented in Table 3.2. Population, income, and housing factors also influence the amount stage for several transportation sectors. Logged population is universally associated with more establishments and income; it is logical that more businesses and employees are needed to serve a larger population. Population density also has a strong positive relationship with general warehousing establishments and employment – suggesting a particular need to serve denser populations by storing goods – and consulting establishments, which likely respond to urbanization economies and flourish where a large number of client firms exist. However, while denser populations are associated with both extensive and intensive expansion for the general warehousing and storage industry, they are only associated with extensive growth for consulting establishments. Income has a positive relationship with consulting and pipeline industry establishments as well as pipeline employment, while higher home values have a negative relationship with transportation sector establishment and job counts. As Calafati et al. (2021) note, housing, transportation, and utility costs have confounding effects with income, but it also makes sense that warehouses and trucking yards are constructed in areas with lower real estate costs. Racial and ethnic diversity also generally related to more TW employer and non-employer establishments and sometimes more employees. The share of the Hispanic population, in particular, was generally associated with more non-employer and employer establishments.

The density of transportation infrastructure including interstates and highways, as well as sales tax rates and commuting, are associated with general warehousing and storage and general freight trucking. While more interstate and highway miles support increased establishments and employees, the quadratic relationship of these determinants indicate both establishments and employment experience diminishing returns from higher densities. Nonetheless, the magnitude of these coefficients is quite large, emphasizing the importance of infrastructure. Sales tax usually has a negative relationship but bolsters the number of pipeline employer establishments. Interestingly, the share of out-commuters has a negative relationship with employer establishments but a positive relationship with employment levels within the warehousing industry, while indicating near-opposite relationships for non-employer establishments and employment within the general freight trucking industry. We posit that interactions with other industries affect the community relationships, which is addressed with locational determinants. Somewhat similar factors are associated with the number of pipeline employer establishments, which may reflect overlapping agricultural and oil- and gas-mining regions. Most variables are associated with general freight trucking, although interstate and highway density are only weakly significant factors.

Share of the population with a bachelor's degree is positively associated with general warehousing and storage and consulting establishments but negatively associated with all three measures of general freight trucking, which demonstrates how sociodemographic factors affect TW subsectors differently. Consulting is usually considered to include higher education levels, and warehousing is increasingly computerized and requires special skills. In contrast, general freight trucking continues to have relatively low education requirements and low barriers to entry. The effects of unemployment were felt most acutely in warehousing and general freight trucking while other sectors, such as pipeline transportation, were more insulated. Processes generating establishments and employment also differ, as evidenced by conflicting coefficient signs on the share of workers out-commuting for general warehousing and storage, as well as the opioid prescription rate in general freight trucking. This negative association is surprising, given the literature on the opioid epidemic and discussions in our focus groups, which

Table 3.2: Amount Stage Marginal Effects for Locational Determinants of T&W Sectors

Industry (NAICS)	General Warehousing & Storage (493110)		Process, Physical Distribution, & Logistics Consulting (541614)		Pipeline Transportation (486)			Support Activities for Road Transportation (488490)			General Freight Trucking (4841)		
Size Measure	Est.	Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.
Interstate Density	0.146***	15.85***	-0.021	-0.220	-0.014	0.044	1.699**	0.010	0.019*	-227.3	0.485	0.237*	10.49***
Interstate Density2	-0.005**	-0.662***	0.001	-0.019	0.000	-0.003	-0.119**	0.000	0.000	13.140	0.001	-0.003	-0.296***
Highway Density	228.5***	28680***	70.54*	765.1	10.83	-2.003	-1955*	-7.309	11.900	244500	3093*	298.2	8426
Highway Density2	-9867***	-1267000***	-3298**	-37070	-218.5	-2852	14900	-34.45	-293.5	-1371000	-1473*	-23680	-578900
Water coverage	-0.022***	-4.113***	-0.002	0.115	0.007	-0.003	-0.005	0.001	-0.004**	-41.37	-1.062***	-0.115***	-2.405***
Sales tax	-0.126**	-16.93**	-0.086***	-2.069*	-0.022	0.092***	0.563	-0.021	-0.015	-73.600	-2.261*	-0.397**	-3.209
Property tax rate	-0.042	-20.25	0.213*	-1.831	-0.110*	-0.025	-4.810*	0.082	0.001	-329.00	-15.67***	-1.545**	-49.300**
Military bases	-0.346	-26.76	-0.003	6.641	-0.029	-0.168	0.216	-0.079*	-0.101	820.00	-18.96**	-2.243**	-21.31
Community colleges	0.057	11.76	-0.008	-0.550	0.004	-0.036	2.040	-0.032**	-0.010	-161.2	0.139	-0.186	-0.977
Universities	-0.016	-4.585	-0.004	-0.231	-0.009	-0.024	-0.123	0.018***	0.013*	116.5	-3.969**	-0.150	2.815
ISP count	-0.022	-5.013	-0.124**	-0.951	-0.011	-0.139***	-0.284	-0.036	-0.007	-182.0	-0.230	0.569**	7.898
Social capital	-0.123	-29.32*	-0.092	4.871	0.015	0.133***	2.878*	-0.082	0.011	-517.1	0.695	0.932	21.65*
Micro Metro-Adj.	-0.465	-66.47	0.224	9.495	-0.033	-0.112	-0.469	-0.383*	-0.396**	-124.5	-10.25**	-3.383***	-41.47**
Metropolitan	-0.236	-98.35**	0.309	15.490*	-0.045	0.02	0.348	-0.501***	17.320*	126.9	-23.89***	-5.000***	-19.16
Out-commute %	-0.019***	1.676**	-0.003	-0.111	0.001	-0.009***	0.016	0.000	-0.002	11.16	0.365**	-0.029	-2.561***
Opioid RX rate	0.001	-0.410	0.003	-0.016	-0.001	0.001	0.031	-0.001	-0.001	2.197	-0.189***	-0.013*	0.438**
Poverty rate	-0.087***	-5.063*	-0.035	-1.342**	0.009	-0.016	0.143	-0.010	-0.008	-75.81	-0.728	-0.370***	-6.646***
Median age	-0.039	-3.415	0.044**	-0.430	0.005	-0.048***	-1.337***	0.000	-0.004	139.0	-0.394	-0.260***	-10.19***
Unemployment rate	0.014	-23.51***	-0.028	-0.927	-0.022	-0.048*	1.191	-0.017	-0.030	-60.38	-0.681	-0.733***	-16.18***
Bachelors degree %	0.066**	2.341	0.129***	0.698	-0.004	-0.038**	0.172	-0.005	-0.011	72.29	-5.455***	-0.429***	-6.615**
ln(Population)	3.593***	225.2***	2.521***	33.20***	0.503***	0.917***	15.32***	0.580***	0.767***	2542	164.0***	23.07**	362.3***
Population density	2.395***	12.22**	0.560***	7.782	0.019	0.313*	1.046	0.011	-0.263*	633.6	2.799	0.152	-3.847
Per capita income	-0.01	-1.163	0.009*	0.200	0.007***	0.029***	0.430***	-0.003	-0.001	51.02	1.120***	0.050	0.898
Hispanic %	0.029***	-0.381	0.034***	0.661***	0.004**	0.002	0.041	0.004*	0.006*	38.31	1.119***	0.093*	0.337
Black %	0.039***	2.181**	0.008	0.286	-0.003	0.008	-0.031	0.000	0.006**	61.07	0.158	0.008	1.782*
Home Value	-0.002	-0.427*	-0.001	-0.109***	-0.001	-0.008***	-0.091***	0.000	0.000	-5.060	-0.272***	-0.025***	-0.218

Significance levels: *** p <1%, ** p <5%, * p <10%

Notes: Table presents the inflation stage for the regressions specified in Table 2 (either Zero-Inflated Poisson or Zero-Inflated Negative Binomial). Industry size measure abbreviations: non-employer establishments (Non-Emp.); employer establishments (Est.); total employment (Emp.). There is no inflation stage for the General Freight Trucking (4841) industry because it did not need to be zero-inflated (it is modeled as NB). Regressors in Table 3.2 are included in same respective regressions as Tables 3.1 and 3.3.

emphasized the likely association of opioid misuse and rural TW. However, again, these relationships may reflect the need for freight trucking services by industries (e.g., meat processing, resource extraction) prevalent in areas with high levels of opioid use, or it may be an artifact of opioid prescription rates being an imperfect measure of opioid misuse and the regional variation thereof (Quast 2018). These differences between subsectors and between establishment and employment generation may pose challenges in building or strengthening local transportation clusters. Developers may need to tailor development strategies to specific TW subsectors.

To the authors' knowledge, this is among the first attempts to model non-employer establishments and employment using demand threshold modeling. In considering the associations of other industries on transportation, the TW location quotient (LQ) was generally associated with more establishments across transportation subsectors[8]. General warehousing and storage; process, physical distribution, and logistics consulting; and general freight trucking had negative associations with most LQs in other clusters. However, these clusters are often service-based and require less transportation services. More transportation-dependent sectors, such as agriculture and manufacturing, may have positive relationships with TW, but these sectors are very broad and include a large number of clusters, which are outside the scope of this analysis. Positive associations between pipeline transportation establishments and employment and the LQs for mining and gas and construction likely reflect pipeline transportation's role within oil and gas clusters, which also require various types of construction activities.

The different data generation processes found between non-employer and employer establishments and the differences in significance and magnitude across model covariates within each industry demonstrate that these establishment types behave very differently. This suggests that a given policy designed to support TW employer establishments may have insignificant or opposite effects on non-employers, some of whom may be entrepreneurs responsible for tomorrow's innovations in the TW sector.

7 Conclusions

The chief contributions of this manuscript lie in its use of a fully disclosed dataset and its elaboration of a methodology for modelling industry spatial distributions characterized by overdispersion (in this instance few US counties with many firms in an industry and many counties with none). Specifically, the data set and model allow researchers to carefully consider the presence of structural and non-structural zeros and understand the reasons a county has no establishments in a given industry. Different factors influence industry presence (inflation) and employment levels (amount) for TW sectors. From there, planners and policymakers can use the locational determinants to strategize ways to strengthen transportation and related sectors in regional economies. Population, population density, and sometimes highway density tended to influence sector formation in a county. Population, income, and housing factors consistently influenced amount-stage results, but the effects of other sociodemographic and institutional factors varied by TW sector. Results presented in Table 3.2 suggest that aggregating industries decreases or obscures locational factors' importance for individual sectors.

Similarly, aggregation obscures TW sectors' relationships to other clusters. Most TW sectors had a positive association with wholesale LQ. Warehousing and general freight trucking tended to be negatively associated with LQs in other industries included in the analysis. These results were consistent using both establishment and employment data.

Several studies consider the effects of transportation infrastructure on the economy in general and specific economic sectors. This study furthers that research by considering the impact of sociodemographic and institutional variables on transportation business establishments while also controlling for infrastructure. The study also shows that other industries influence transportation subsectors in different ways. For example, a larger professional and technological LQ is associated with few warehousing and general freight establishments and lower employment in those industries. Future research could use

[8]TW LQs are calculated on all NAICS 48, 49, and 541614, except for the respective NAICS under consideration.

Table 3.3: Amount Stage Marginal Effects for Locational Determinants of T&W Sectors

Industry (NAICS)	General Warehousing & Storage (493110)		Process, Physical Distribution, & Logistics Consulting (541614)		Pipeline Transportation (486)			Support Activities for Road Transportation (488490)			General Freight Trucking (4841)		
Size Measure	Est.	Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.
Location Quotients													
TW	0.290***	8.728	0.066***	0.507	0.026***	0.003	0.258	0.024***	0.043***	286.9	3.618***	0.767***	4.348*
Finance	-0.066**	-8.276	-0.006	-0.801	0.006	-0.032	-0.291	0.003	-0.006	13.43	-0.023	-0.178	-0.107
Real Estate	-0.258***	-29.36***	-0.011	-1.515	0.009	0.002	-0.424	0.039***	0.015	-268.2	-1.234	-0.109	-17.96***
Professional and tech	-0.274***	-23.58***	0.056	3.842**	-0.015	0.021	-0.665	-0.02*	-0.026*	-24.51	-4.500***	-1.307***	-24.84***
Education	-0.130***	-9.738**	-0.029	-3.868***	0.000	-0.019	-1.226***	-0.019*	-0.033***	12.23	-2.117***	-0.714***	-19.1***
Health services	-0.234***	-9.108	-0.186***	-3.732***	0.011	0.003	-0.197	-0.039**	-0.032*	-44.80	-4.844***	-0.968***	-39.18***
Art and recreation	-0.006	-0.347	0.020	0.458	0.001	-0.004	0.456	-0.018**	0.001	-41.75	-1.727***	-0.282***	-9.524***
Accommodation & Food	0.013	-13.64*	-0.067*	0.08	-0.002	-0.023	-0.878	0.004	0.013	194.7	-4.427***	-0.875***	-15.58***
Mining and gas	-0.014***	-1.559***	0.000	0.162*	0.002***	0.002***	0.108***	0.001	0.001*	10.26	-0.281***	-0.011*	-0.265**
Construction	-0.197***	-27.73***	-0.094***	-2.725***	0.020***	0.067***	0.457	-0.005	-0.008	-68.78	1.026	-0.174*	-7.705***
Retail	-0.182**	-5.665	-0.163***	-6.563***	-0.017	-0.059	-1.512*	-0.012	0.016	-7.510	1.817	0.206	-19.15***
Regional FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
n	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100

Significance levels: *** p <1%, ** p <5%, * p <10%

Notes: The exact observation count is suppressed by U.S. Census Bureau disclosure review process. We use all counties in the continental U.S. in 2014. Industry size measure abbreviations: non-employer establishments (Non-Emp.); employer establishments (Est.); total employment (Emp.). TW LQs are calculated on all of NAICS 48, 49, and 541614, except for the respective NAICS under consideration. No inflation stage for the General Freight Trucking (4841) industry. Regressors in Table 3.3 are included in same respective regressions as Tables 3.1 and 3.2. Regional fixed effects (FE) based on Census regions. Number of observations (counties) in the sample (n) rounded due to disclosure limitations.

spatial econometric techniques to measure effects of neighboring counties. The increasing availability of disclosed data through multiple U.S. agencies also presents opportunities to further explore differences in locational determinants of TW in the U.S. and European contexts. Finally, future research could expand the study of inter-cluster dependence, which could reduce hazards associated with cluster targeting in economic development (Barkley, Henry 2009) and improve overall competitiveness opportunities (Porter 2001). Such research could support efforts to capture inter-industry linkages and define industries within local clusters (Delgado et al. 2016).

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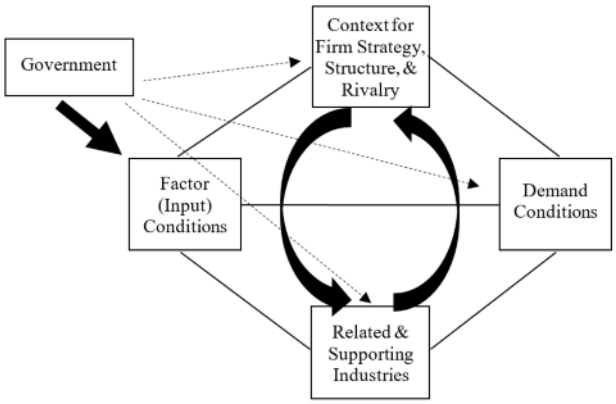
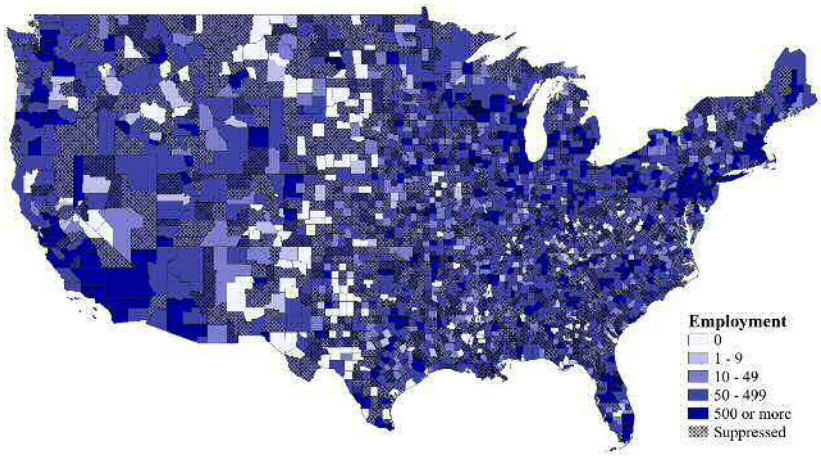
A Appendix:



Notes: This figure adapts the Porter Diamond model to reflect the specific interaction of TW sector firm structure and related industries. This interaction recognizes that TW is often considered a support sector to other clusters and that various subsectors of TW reinforce the broader TW sector. The adapted model also shows the substantial direct effect of government on factor conditions through infrastructure investment. The bold arrow indicates the substantial effect that government investment (typically) has on factor (input) conditions.

Figure A.1: Porter diamond model adapted for TW industry clustering



Notes: Map shows employment ranges in every county in the continental U.S. "Suppressed" indicates that the exact value of the data is suppressed to prevent improper disclosure of identifiable information and placed into bins (e.g., "20–99 employees"). For the sake of these maps, we replace these ranges with their midpoint.

Figure A.2: Employment Distribution of General Freight Trucking (NAICS 4841)

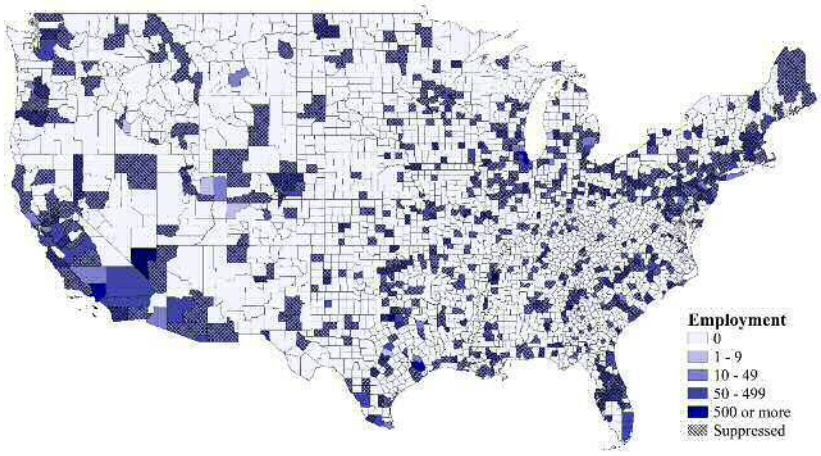


Figure A.3: Employment Distribution of Support Activities for Road Transportation (NAICS 488490)

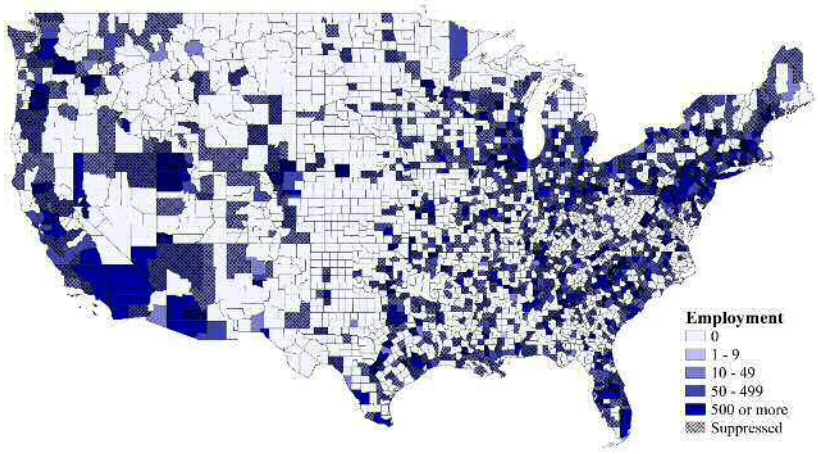


Figure A.4: Employment Distribution of General Warehousing & Storage (NAICS 493110)

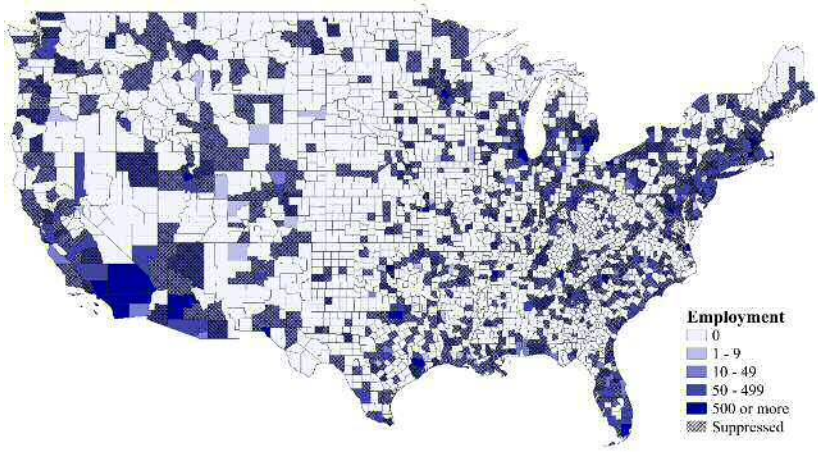


Figure A.5: Employment Distribution of Process, Distribution, & Logistics Consulting (NAICS 541614)

Table A.1: List of Abbreviations and Acronyms

ACS	American Community Survey
BEA	Bureau of Economic Analysis
BLS	Bureau of Labor Statistics
BR	Business Register
CBP	County Business Patterns
CDC	Center for Disease Control and Prevention
Emp.	Total employment
ERS	Economic Research Service
Est.	Employer establishments
FE	Fixed Effects
FCC	Federal Communications Commission
FSRDC	Federal Statistical Research Data Center
GDP	Gross Domestic Product
HP	Hurdle Poisson
ILBD	Integrated Longitudinal Business Database
ISP	Internet Service Provider
LBD	Longitudinal Business Database
LQ	Location Quotients
NAICS	North American Industry Classification System
NB	Negative Binomial
NCES	National Center for Education Statistics
Non-Emp.	Non-employer establishments
NERCRD	Northeast Regional Center for Rural Development
NS	Nonemployer Statistics
QCEW	Quarterly Census of Employment and Wages
QWI	Quarterly Workforce Indicators
TW	transportation and warehousing
USDA	United States Department of Agriculture
ZINB	Zero-Inflated Negative Binomial
ZIP	Zero-Inflated Poisson

Table A.2: Additional TW Industry Summary Statistics

Industry and size measure	Min.	Median	Mean	Max.	Source
General Warehousing & Storage (493110) Estab.	0	2	8	411	CBP
General Warehousing & Storage (493110) Emp	0	0	209	17,576	WholeData
Warehousing and Storage (4931) Non-emp	0	0	3	572	NS
Management Consulting Services (54161) Estab.	0	5	49	5,380	CBP
Management Consulting Services (54161) Emp.	0	6	293	37,724	WholeData
Management, Scientific, and Technical Consulting Services (5416) Non-emp.	0	25	226	23,562	NS
Pipeline Transportation (486) Estab.	0	2	3	155	CBP
Pipeline Transportation (486) Emp.	0	0	17	10,067	WholeData
Pipeline Transportation (486) Non-emp.	0	0	0.2	110	NS
Support for Road Transportation (488490) Estab.	0	1	3	110	CBP
Support for Road Transportation (488490) Emp.	0	0	11	1,282	WholeData
Support for Transportation (488) Non-emp.	0	9	42	6,786	NS
General Freight Trucking (4841) Estab.	0	9	23	3,929	CBP
General Freight Trucking (4841) Emp.	0	45	294	20,782	WholeData
General Freight Trucking (4841) Non-emp.	0	50	161	23,074	NS

Notes: Due to disclosure prevention limitations, these descriptive statistics are based on public data sources, while the main regression results are based on the limit-access Longitudinal Business Database and Integrated Longitudinal Business Database. All data are based on 2014; 2014 is chosen for practical reasons related to the availability of many of the secondary data sources. The internal and unsuppressed data used in regressions differ slightly in addition to the inclusion of unsuppressed cells. The more refined 541614 NAICS was not publicly available. For details on WholeData, see Bartik et al. (2018).
Abbreviations: Estab: employer establishments; Non-Emp: non-employer establishments; Emp: total employment; CBP: County Business Patterns; NS: Non-employer Statistics.

Table A.3: Poisson Marginal Effects for Locational Determinants of T&W Sectors

Industry (NAICS)	General Warehousing & Storage (493110)		Process, Physical Distribution, & Logistics Consulting (541614)		Pipeline Transportation (486)			Support Activities for Road Transportation (488490)			General Freight Trucking (4841)		
Size Measure	Est.	Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.
Interstate Density	0.076**	16.08***	-0.006	0.125	0.059***	2.324***	0.061***	0.262***	-1.396***	0.008	-2.273***	0.887***	0.070
Interstate Density2	0.002	-0.208***	0.0009	-0.039***	-0.014***	-0.145***	-0.003	0.004	0.074***	-0.000004	0.342***	0.839***	0.022***
Highway Density	3.332***	291.8***	1.320***	5.340***	-0.224*	8.134***	-0.075	-1.537	19.29***	0.094	46.41***	280.4***	7.885***
Highway Density2	-1.578***	-154.5***	-0.418***	2.447***	0.305***	-17.58***	-0.226	-0.952*	-11.25***	-0.100	-22.60***	-131.6***	-3.697***
Water coverage	-0.027***	-4.546***	-0.007***	0.054***	-0.001	-0.111***	-0.004*	-0.067***	-0.091***	-0.002	-0.590***	-2.298***	-0.037***
Sales tax	-0.058**	0.205	-0.038	-0.949***	-0.024	-0.708***	0.034*	-0.324***	0.036	0.0005	2.937***	-9.601***	-0.192***
Property tax rate	0.014	-19.64***	-0.141	-2.433***	0.004	-0.522**	-0.064	-2.973***	1.391***	-0.003	9.717***	-27.31***	2.530***
Military bases	-0.113*	-8.909***	0.044	2.803***	0.083***	0.519***	-0.156**	-2.770***	0.412***	-0.147***	-18.22***	-21.12***	-2.162***
Community colleges	0.122***	20.69***	-0.061***	-1.023***	0.016**	-1.835***	0.056***	-0.467***	-0.734***	-0.009	-0.117	10.27***	-0.200***
Universities	-0.066***	-8.727***	0.017**	0.110***	-0.003	1.136***	0.013	0.390***	0.266***	0.005	2.317***	-1.468***	0.508***
ISP count	0.049	2.117***	-0.153***	-0.485***	-0.005	-3.371***	-0.116***	-0.499***	0.143*	0.020	-0.009	1.454***	0.691***
Social capital	0.316***	23.97***	-0.115	0.928***	0.036*	2.302***	0.169***	-2.677***	0.585***	0.037	2.218***	21.96***	1.004***
Micro Metro-Adj.	0.191	4.955***	0.268	-3.723***	-0.089	-2.853***	-0.115	-1.896***	-2.750***	-0.151	-24.87***	-19.72***	-4.514***
Metropolitan	0.509**	-13.37***	0.631***	8.756***	-0.128**	-3.609***	-0.103	-8.930***	3.582***	0.063	-61.42***	36.12***	-6.539***
Out-commute %	-0.008***	0.263***	-0.006**	-0.074***	0.002*	-0.161***	-0.006***	0.223***	-0.064***	-0.003**	0.816***	-1.424***	-0.034***
Opioid RX rate	0.013***	0.269***	0.001	0.161***	0.001**	-0.017***	0.001	0.004	0.026***	0.009	-0.485***	0.793***	-0.022***
Poverty rate	-0.001***	-0.107***	-0.0002*	-0.009***	-0.00004	-0.003***	-0.0002***	0.003***	-0.003***	-0.0001	-0.007***	-0.042***	-0.005***
Median age	-0.100***	-13.27***	0.053***	-0.181***	-0.011**	-0.602***	-0.046***	0.585***	0.396***	-0.004	0.319***	-9.345***	-0.278***
Unemployment rate	0.021	-3.166***	-0.005	0.569***	-0.003	-0.244***	-0.036**	-0.533***	-0.592***	-0.017	0.527***	-22.54***	-0.088
Bachelor's degree %	0.086***	-4.197***	0.146***	0.978***	-0.00001	-1.101***	-0.048***	-0.662***	0.450***	0.004	-4.168***	1.563***	-0.183***
ln(Population)	3.644***	259.6***	2.688***	34.50***	0.317***	16.60***	0.902***	45.85***	11.42***	0.810***	165.7***	294.2***	20.01***
Population density	-0.0002	-0.106	-0.018**	0.274***	-0.034***	-0.429***	-0.037*	-0.346***	-0.150***	-0.026***	-0.179*	-5.858***	-0.018
Per capita income	0.003	0.136***	0.008***	-0.013	0.004***	0.322***	0.016***	0.051***	0.022***	-0.002	0.649***	-0.884***	-0.018
Hispanic %	0.048***	0.325***	0.019***	0.111***	0.004***	-0.080***	0.001	0.487***	0.229***	0.010***	1.981***	3.276***	0.205***
Black %	0.020***	-0.203***	0.005	0.015	-0.0009	0.084***	0.017***	0.073***	0.075***	0.003	0.151***	1.576***	-0.019
Home Value	-0.005***	-0.554***	-0.001**	-0.030***	-0.000003	-0.036***	-0.004***	0.032***	-0.011***	0.0004	-0.339***	-0.642***	-0.024***

Significance levels: *** p <1%, ** p <5%, * p <10%

Note: Industry size measure abbreviations: non-employer establishments (Non-Emp.); employer establishments (Est.); total employment (Emp.). Regressors in Table A.3 are included in same respective regressions as Table A.4.

Table A.4: Poisson Marginal Effects for Locational Determinants of T&W Sectors

Industry (NAICS)	General Warehousing & Storage (493110)		Process, Physical Distribution, & Logistics Consulting (541614)		Pipeline Transportation (486)			Support Activities for Road Transportation (488490)			General Freight Trucking (4841)		
Size Measure	Est.	Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.
Location Quotients													
TW	1.102***	66.41***	-2.497***	-72.76***	0.049***	1.195***	0.035	4.571***	5.500***	0.247***	15.78***	82.31***	3.767***
Finance	-0.305***	3.089***	-0.172***	-4.355***	-0.263***	-1.430***	0.001	-0.991***	-0.966***	0.033	4.882***	14.45***	-0.394**
Real Estate	-0.283***	-48.51***	0.009	-1.288***	0.051***	2.287***	0.223***	2.329***	-0.282*	0.047	-4.488***	5.991***	0.117
Professional and tech	-0.552***	-68.38***	1.850***	55.11***	-0.073**	2.016***	-0.056	-1.453***	-3.574***	-0.037	-4.804***	-80.04***	-3.565***
Education	-0.181***	-4.207***	-0.077*	-2.064***	-0.055**	-2.163***	-0.117***	-1.191***	0.219***	-0.012	-8.694***	-9.805***	-1.545***
Health services	-0.776***	-33.54***	-0.825***	-13.27***	0.126***	1.005***	0.111**	-6.506***	-3.118***	-0.031	-19.85***	-73.12***	-2.183***
Art and recreation	-0.087	9.509***	0.032	-3.366***	0.017	-0.987***	-0.052**	0.213	-0.663***	0.010	-3.518***	-12.62***	-0.548***
Accommodation & Food	-0.237**	-24.41***	-0.190**	-2.526***	-0.146***	-3.186***	-0.098*	-1.369***	2.705***	0.017	-20.45***	-118.9***	-5.207***
Mining and gas	-0.082***	-6.507***	0.013**	0.167***	0.003**	0.230***	0.021***	0.087***	0.103***	0.010***	-0.542***	-3.890***	-0.034**
Construction	-0.625***	-45.65***	-0.268***	-3.843***	0.022	2.388***	0.173***	-1.003***	-2.726***	-0.045	-0.880**	-11.95***	0.235
Retail	-0.683***	10.30***	0.061	-0.839	0.056	-5.767***	-0.075	1.937***	-1.395***	0.074	12.20***	-45.02***	1.097***
Regional FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
n	3,063	3,063	3,063	3,063	3,063	3,063	3,063	3,063	3,063	3,063	3,063	3,063	3,063

Significance levels: *** p <1%, ** p <5%, * p <10%

Note: The exact observation count is suppressed by U.S. Census Bureau disclosure review process. We use all counties in the continental U.S. in 2014. Industry size measure abbreviations: non-employer establishments (Non-Emp.); employer establishments (Est.); total employment (Emp.). TW LQs are calculated on all of NAICS 48, 49, and 541614, except for the respective NAICS under consideration. TW LQs are calculated on all of NAICS 48, 49, and 541614, minus the respective NAICS under consideration. Regressors in Table A.4 are included in same respective regressions as Table A.3. Regional fixed effects (FE) based on Census regions.

Table A.5: Inflation Stage Marginal Effects for Locational Determinants of T&W Sectors

Industry (NAICS)	General Warehousing & Storage (493110)		Process, Physical Distribution, & Logistics Consulting (541614)		Pipeline Transportation (486)			Support Activities for Road Transportation (488490)		
Size Measure	Est.	Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.
Interstate Density	-0.011	-0.027***	-0.053*	-0.02	0.002	-0.020*	0.037	-0.015**	-0.026***	-0.066*
Highway Density	-0.0006	0.002*	0.004	0.003	-0.0001	0.002	-0.022	0.002**	0.003**	0.007*
Water coverage	-0.066	-0.137	1.752***	0.761***	0.265***	0.260*	-0.223	0.238*	0.495***	0.911
Sales tax	0.232	0.119	-1.870**	-0.812***	-0.205***	0.025	0.443	-0.265	-0.430**	-1.536
Property tax rate	-0.0002	-0.00001	-0.031*	-0.0004	-0.0005	0.005***	0.001	-0.001*	0.001	-0.006
ISP count	0.011	0.004	-0.00003	0.0009	-0.032***	-0.029***	-0.010*	-0.008**	-0.002	-0.013
Micro Metro-Adj.	-0.016	0.0005	0.030	0.025	-0.013	0.006	-0.012	0.067***	-0.005	-0.111
Metropolitan	0.018	-0.005	-0.005	-0.005	-0.003	0.025**	0.022***	0.002	-0.010	0.022
ln(Population)	-0.016	0.007	0.019	-0.034	0.023	0.036	-0.982	-0.019	0.007	-0.159*
Population density	-0.047	0.022	-0.003	-0.025	0.042**	0.010	-0.040	-0.048***	-0.014	-0.147
Per capita income	-0.131***	-0.195***	-0.031	-0.111***	-0.052***	-0.159***	-0.064***	-0.203***	-0.147***	-0.080*
Home Value	-2.568**	-0.582**	-0.985**	-1.037***	0.015**	-0.154*	-0.131	0.007	-0.164	-0.187

Significance levels: *** p <1%, ** p <5%, * p <10%

Note: Industry size measure abbreviations: non-employer establishments (Non-Emp.); employer establishments (Est.); total employment (Emp.). No inflation stage for the General Freight Trucking (4841) industry. Regressors in Table A.5 are included in same respective regressions as Tables A.6 and A.7.

Table A.6: Amount Stage Marginal Effects for Locational Determinants of T&W Sectors

Industry (NAICS)	General Warehousing & Storage (493110)		Process, Physical Distribution, & Logistics Consulting (541614)		Pipeline Transportation (486)			Support Activities for Road Transportation (488490)			General Freight Trucking (4841)		
Size Measure	Est.	Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.
Interstate Density	0.194***	31.01***	-0.014		0.067*	0.413	-0.005	0.156	-1.086	0.012	-1.350	6.508	0.052
Interstate Density2	-0.014**	-2.739***	0.0003		-0.015**	0.047	0.019	0.004	-0.038	-0.001	0.181	-0.133	0.007
Highway Density	3.740***	368.0***	0.911		-0.381	-2.822	0.16	-1.714	10.98	-0.040	10.93	174.1**	2.485
Highway Density2	-1.786***	-176.5***	0.249		0.315	-3.607	-0.555	0.149	-0.646	0.220	-15.30*	-97.97**	-2.447
Water coverage	-0.026***	-5.346***	0.006		-0.002	-0.115	-0.009**	-0.066***	-0.138*	-0.001	-0.831***	-3.033***	-0.097***
Sales tax	-0.051	4.84	-0.038		-0.157***	0.032	0.026	-0.209*	-0.991	-0.002	-2.731***	-11.10**	-0.513***
Property tax rate	-0.17	-10.13	-0.17		-0.112*	-0.902	0.017	-2.605***	-2.032	-0.014	-0.065	-23.88	0.206
Military bases	-0.248	22.59	0.094		0.060**	3.857	-0.029	-2.331***	5.225*	-0.108**	-7.913	-40.29	-1.690*
Community colleges	0.047	6.841	-0.043		0.002	2.224	0.205***	-0.362***	-0.060	-0.0003	5.200**	-2.626	0.124
Universities	-0.031	1.958	0.019		0.002	0.785	-0.022	0.400***	0.739	0.005	0.472	-2.849	0.208
ISP count	0.027	5.501	-0.144***		-0.053**	-0.535	-0.053	-0.703***	-0.559	0.023	-0.944	-8.057	0.506**
Social capital	0.108	7.375	-0.122		0.031	3.832**	0.194***	-2.504***	-0.894	0.047	5.065***	31.12***	1.630***
Micro Metro-Adj.	-0.468	-67.24*	0.363		-0.012	-1.479	0.416	-5.784***	-4.664	-0.373**	-8.256**	-24.41	-3.122***
Metropolitan	-0.552	-117.5***	0.275		-0.061	-1.312	-0.243*	-12.66***	-0.566	-0.172	-21.39***	-22.99	-4.500***
Out-commute %	-0.017***	1.018	-0.005		-0.001	-0.106	-0.004	0.204***	0.051	-0.003*	0.523***	-2.661***	-0.018
Opioid RX rate	0.006**	-0.917**	-0.0004		-0.001	0.003	0.0007	-0.036***	0.023	0.0008	-0.200***	0.144	-0.015**
Poverty rate	-0.001***	-0.096***	-0.0002		0.00004	-0.006*	-0.0002**	0.002***	-0.002	-0.00004	-0.008**	-0.080***	-0.004***
Median age	-0.052**	-3.915	0.053***		0.009	-1.189**	-0.055***	0.764***	0.687**	-0.0007	-0.089	-10.76***	-0.237***
Unemployment rate	0.105*	-22.52**	-0.021		0.003	0.961	0.019	-0.638***	-0.586	-0.011	-1.903**	-28.53***	-0.790***
Bachelor's degree %	0.061**	-4.458	0.134***		0.017*	-0.144	-0.033**	-0.684***	0.028	0.002	-5.332***	-8.055***	-0.435***
ln(Population)	3.699***	236.2***	2.593***		0.260***	11.99***	0.867***	45.38***	9.421***	0.796***	138.4***	369.2***	20.44***
Population density	1.279**	91.58***	0.421*		0.006	1.14	0.100	-0.286	1.904	0.019	2.563**	0.712	0.201
Per capita income	-0.003	-0.146	0.008		0.0004	0.227**	0.015***	0.046***	0.005	-0.003	0.947***	0.047	0.056*
Hispanic %	0.039***	1.038	0.019***		0.002	-0.119	-0.002	0.486***	0.271**	0.009***	1.123***	0.524	0.093***
Black %	0.037***	2.380*	0.005		-0.004	-0.086	0.012***	0.099***	0.245*	0.004	0.528***	2.291***	0.02
Home Value	-0.003*	-0.643**	-0.0002		-0.001	-0.064**	-0.004***	0.027***	-0.002	0.001	-0.185***	-0.479**	-0.021***

Significance levels: *** p <1%, ** p <5%, * p <10%

Note: Industry size measure abbreviations: non-employer establishments (Non-Emp.); employer establishments (Est.); total employment (Emp.). There is no inflation stage for the General Freight Trucking (4841) industry because it did not need to be zero-inflated (it is modeled as NB). Regressors in Table A.6 are included in same respective regressions as Tables A.5 and A.7.

Table A.7: Amount Stage Marginal Effects for Locational Determinants of T&W Sectors

Industry (NAICS)	General Warehousing & Storage (493110)		Process, Physical Distribution, & Logistics Consulting (541614)		Pipeline Transportation (486)			Support Activities for Road Transportation (488490)			General Freight Trucking (4841)		
Size Measure	Est.	Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.	Non-Emp.	Est.	Emp.
Location Quotients													
TW	1.315***	101.0***	-3.332***		0.047*	1.518	0.020	4.572***	8.460***	0.247***	6.303***	69.34***	2.594***
Finance	-0.207*	-0.032	-0.116		-0.135**	-1.94	0.140*	-0.664***	2.174	0.053	6.334***	10.69	-0.483
Real Estate	-0.396**	-81.95***	0.007		0.021	1.268	0.212***	2.399***	2.695	0.064	-1.527	-9.462	0.345
Professional and tech	-0.589***	-49.66**	2.560***		-0.026	1.363	-0.049	-1.286***	-0.283	-0.013	-11.18***	-58.93***	-3.313***
Education	-0.116	-1.873	-0.087		0.007	-2.107**	-0.093**	-1.254***	0.492	-0.029	-3.335***	-20.54***	-1.155***
Health services	-0.566***	36.09	-0.661***		-0.070	3.703*	0.199**	-5.707***	-4.684*	-0.030	-8.907***	-64.94***	-1.977***
Art and recreation	0.020	12.61	0.017		-0.010	-0.834	-0.045	0.484***	-1.752*	0.003	-2.238***	-18.93***	-0.745***
Accommodation & Food	-0.227	-60.12**	-0.215		-0.081	-2.495	-0.072	-1.788***	-1.174	-0.006	-14.20***	-45.68***	-3.201***
Mining and gas	-0.075***	-4.745***	0.015*		0.004*	0.394**	0.030***	0.103***	-0.081	0.010***	-0.882***	-2.506***	-0.096***
Construction	-0.540***	-55.36***	-0.201**		0.006	2.133*	0.168***	-0.886***	-1.958	-0.050	-3.695***	-13.39**	-0.229
Retail	-0.922***	49.48	-0.153		0.017	-4.057*	-0.131	0.595	-0.31	0.031	3.422	-120.8***	-1.468**
Regional FE	YES	YES	YES		YES	YES	YES	YES	YES	YES	YES	YES	YES
n	3,063	3,063	3,063		3,063	3,063	3,063	3,063	3,063	3,063	3,063	3,063	3,063

Significance levels: *** p <1%, ** p <5%, * p <10%

Note: The exact observation count is suppressed by U.S. Census Bureau disclosure review process. We use all counties in the continental U.S. in 2014. Industry size measure abbreviations: non-employer establishments (Non-Emp.); employer establishments (Est.); total employment (Emp.). TW LQs are calculated on all of NAICS 48, 49, and 541614, except for the respective NAICS under consideration. No inflation stage for the General Freight Trucking (4841) industry. TW LQs are calculated on all of NAICS 48, 49, and 541614, minus the respective NAICS under consideration. Regressors in Table A.7 are included in same respective regressions as Tables A.5 and A.6. Regional fixed effects (FE) based on Census regions. The employment model for 541614 did not converge – likely due to lack of variation in public data.

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EU funds as a catalyst of change for the Slovak healthcare system?

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Abstract. In the programming period 2007-2013, the European Structural and Investment Funds (ESIF) invested €237 million in Slovak hospitals. We investigate whether this injection of additional funds has improved the quality of healthcare in the targeted hospitals. As a measure of healthcare quality, we use the readmission rate (ratio of readmissions within 30 days over total hospitalizations) and the mortality rate. Our results show a statistically significant but small effect of ESIF on the readmission rate but not on the mortality rate. We argue that these results suggest that the main problem in Slovak healthcare is low productivity rather than a lack of funding.

JEL classification: H51, H87, I18, F36

Key words: healthcare, public finance, productivity, difference in differences

1 Introduction

The quality of healthcare provision in Slovakia is underwhelming. Despite Slovakia undergoing a substantial degree of development since its accession to the EU, its healthcare system continues to lag behind those of other EU Member States. This can be seen especially in terms of its relatively high amenable mortality rate, which is among the highest in the EU. Furthermore, Slovakia lags behind other EU countries in preventative healthcare and in the quality of primary care provision, which, in turn, leads to unnecessarily frequent admissions to hospital (OECD, European Observatory on Health Systems Policies 2017).

In this paper, we seek to identify the causes for the underperformance of the Slovak healthcare system. The basic premise motivating this analysis is that poor performance of healthcare could be attributable to one of the following two reasons. First, the healthcare system could be underfunded. If this is the case, some patients may not receive the required treatment because of a lack of funds. They may instead receive treatment that is cheaper but less effective than the best-possible course of action, or the healthcare providers lack the necessary equipment to diagnose and treat patients appropriately.

Second, the resources within the healthcare system could be used inefficiently. For example, healthcare providers may be allocating a significant share of available funds to relatively unproductive aspects of their work. This could include filling out forms and reporting, instead of looking after patients. Expensive equipment may also be allocated to hospitals that do not need it while hospitals that could better utilize them remain without. The remedy aimed at improving the quality of healthcare should address the cause of its deficiency. If the healthcare system is underfunded, then injecting additional funds would be productive. In contrast, inefficient use of existing resources will not be improved by giving the hospitals additional funds; instead, the underlying causes of inefficiency should be identified.

We model the provision of healthcare as a production process transforming measurable inputs into measurable outcomes. Thus, we estimate a production function to observe the effect of injecting additional funds on hospital-specific readmission and mortality rates. During the 2007-2013 programming period, around €265 million from the European Structural and Investment Funds (henceforth ESIF or EU Funds) were invested in Slovak healthcare facilities, of which the vast majority (€237 million) went to hospitals[1]. We investigate the impact of the overall amount of ESIF spent, and the impact of spending according to the different categories of ESIF (infrastructure, equipment, and personnel and other expenses).

Our results reveal a small but statistically significant favorable effect of the ESIF on the readmission rate one year after the allocation of the funds. In contrast, we find no effect on the overall mortality rate. When we divide the EU funds according to the expenditure categories, we find that only investments into construction and reconstruction of hospitals have had a statistically significant effect on the readmission rate. Furthermore, while the ESIF seem to affect some sub-categories of mortality, the results are mixed – we find both positive and negative effects. Moreover, even when the results are statistically significant, they are very small in magnitude.

The small magnitude of the estimated effects suggests that the Slovak healthcare system is on the predominantly flat segment of the production function, where injections of additional funds are associated only with limited improvements in the quality of outputs. Therefore, the unfavorable performance of the Slovak healthcare system does not seem to be primarily due to underfunding. Rather, the problem is inefficient use of the available funds: what is needed is an improvement that would shift the production function upwards.

2 Conceptual Framework

A popular way of evaluating the impact of spending on healthcare quality is by means of a production function, which relates the amount of spending on healthcare (inputs) to the health of the inhabitants of an economy (output). The main input factor is typically the expenditure on healthcare. To control for specific conditions and other inputs, socio-economic, lifestyle and environmental factors can also be used in the model. Outcomes are usually measured in terms of life expectancy, hospital readmissions, or mortality. Life expectancy can be either estimated at birth or at a higher age (such as 65+ life expectancy, life expectancy adjusted for quality of life, or considering only healthy life expectancy). Life expectancy measures are the most comprehensive indicators of health and quality of life, reflecting the combined effect of healthy lifestyles, nutrition, healthcare and other factors, over long periods (Thornton 2002, Lubitz et al. 2003, Nixon, Ulmann 2006, Gallet, Doucouliagos 2016). As such, they are well suited for analyses of long-term trends or comparative multi-country analyses. On the other hand, short-lasting interventions are unlikely to be reflected in changes in life expectancy. Therefore, to analyze short-term aspects of healthcare provision, hospital readmission and mortality rates may be more suited. Hospital readmissions, typically measured as readmission of

[1] Although the 2007-2013 Programming period ended in 2013, EU Member States had the possibility to draw on funds allocated within this period until 2015 under the so-called "n+2 rule", with Romania and Slovakia gaining an extension to n+3, to mitigate the possible risk of losing funds. See http://europa.eu/rapid/press-release_IP-13-446_en.htm.

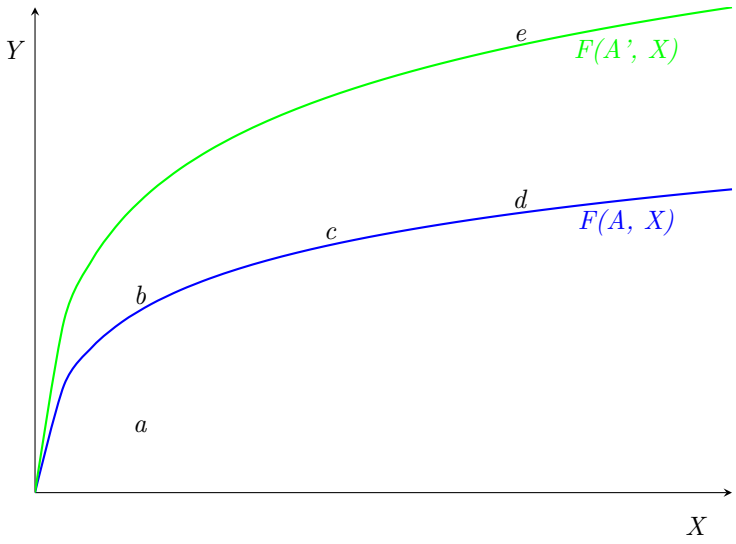
the same patient with 30 days of having been discharged, are a particularly good measure, as a significant proportion of such readmissions have been found to be avoidable: more than half, according to some studies (Benbassat, Taragin 2000, Van Walraven et al. 2011). Because of this, hospital readmissions were chosen as a criterion of quality of hospital performance under the US Affordable Care Act (McIlvennan et al. 2015, Zuckerman et al. 2016). Finally, mortality – either overall or by specific cause of death – is another valuable indicator of quality of healthcare, which is also suited for analyses of short-term trends and variations (Or 2001, Nolte, Mckee 2004, Prentice, Pizer 2007). A potential downside is that it can be subject to endogeneity and measurement/reporting issues (Dreger, Reimers 2005). For example, a poorly run healthcare system may result in a large share of the elderly dying in their homes rather than in hospitals, with their passing attributed to old age rather than to the true cause of death. Inasmuch as healthcare improvements lead to an increase in hospital admissions of the elderly, such improvements can actually translate into an increase in reported mortality in hospitals and/or mortality due to specific ailments.

In their meta-analysis of production function-based models, Gallet, Doucouliagos (2016) show that healthcare spending has a greater impact on mortality than on life expectancy: the elasticities of spending with respect to mortality rate and life expectancy are around -0.13 and 0.04 respectively. Gallet, Doucouliagos (2016) note that these relatively low elasticities may be due to other factors (income, demographics and lifestyle choices) playing significant roles. Similarly, Nixon, Ulmann (2006), looking at the 15 Member States of the European Union in 1980-1995, find that increases in health-care expenditure are significantly associated with lower child mortality, but only with modest improvements in life expectancy. At the same time, however, they note that these relatively low elasticities may signify an importance of other factors (income, demographics and lifestyle choices). Martin et al. (2008) looked at spending on two special care programs, cancer patients and patients with cardiovascular diseases, with the latter having a higher elasticity of spending with respect to disease related deaths. Thornton (2002) also points out that the additional spending on medical care is relatively ineffective in reducing patient mortality and prolonging life expectancy; with the most important factors affecting mortality rates being socio-economic status and lifestyle. They also suggest that the effect of healthcare spending may have diminishing returns.

A number of analyses aim to define, measure and improve the organizational efficiency of healthcare facilities around the world. Palmer, Torgenson (1999) define three main aspects of efficiency in healthcare facilities: technical, allocative and productive efficiency. Technical efficiency refers to the use of given inputs in the most efficient way, given the currently available technology. A production process is technically efficient if reducing the amount of any input would lead to a reduction in output. Productive efficiency, in turn, refers to achieving a given outcome with the lowest possible cost. For example, if the same outcome could be achieved with two or more different combinations of inputs, the least costly input combination is productively efficient. Allocative efficiency, finally, reflects the ability to allocate its resources in a manner that maximizes social welfare.

The generally low estimated elasticities of healthcare spending suggest that the production of healthcare may be inefficient: the available resources and technologies are not used optimally, so that the same outputs could be produced with lower cost. Injections of additional funds have the potential to improve all three aspects of efficiency. New healthcare infrastructure and equipment can improve the quality of healthcare, new skills and techniques acquired through additional training help improve the utilization of available resources, and improvements in the provision of healthcare can help remove disparities in the quality of healthcare received by different individuals.

The previous literature assessing the impact of EU funds on healthcare in Slovakia relies primarily on descriptive analyses. The evaluation of the impact of EU funds on healthcare by KPMG (2013) concludes that the EU funds from Operational Programme Health (OPH) improved the healthcare in Slovakia by 58% in terms of quality, 24% in terms of efficiency, and 18% in terms of availability. The authors had to deal with several limitations. First, the OPH does not define criteria for quality, availability or efficiency. For that reason, the authors themselves had to define these terms and the causal links



Notes: The graph depicts output, Y, as a function of a factor of production, X, and technology (efficiency) A. An increase in inputs corresponds to moving to the right along the horizontal axis. An improvement in technology is associated with a vertical shift of the production function profile. Points a through d thus correspond to outcomes with different inputs but the same technology (efficiency), while point e is on a production function associated with more advanced technology (higher efficiency).

Figure 1: Production function and injection of additional funds

between them. This was undertaken through a structured approach of identifying the relationship and contribution of projects and their outputs to the quality, effectiveness, and availability of healthcare. It is, however, questionable whether descriptive analysis is a suitable method for finding causal linkages.

Furthermore, there is also a lack of quantitative assessments of the effect of ESIF on healthcare in other EU countries. Murauskiene, Karanikolos (2017) use a simple comparison of targeted indicators before and after the 2007-2013 programming period in Lithuania, such as the number of beds or life expectancy. A more common approach is to evaluate case studies: for instance, Pasowicz et al. (2009) look at the role of ESIF in the modernization of John Paul II Hospital in Krakow, while Glinos, Baeten (2014) mention the function of ESIF in their case studies of cross border hospital cooperation in the EU.

Our study aims to address this dearth of quantitative assessments of the impact of spending on healthcare. We follow the rest of the literature by adopting the production-function approach: we relate the outputs of healthcare establishments to the available inputs (equipment, labor, and financial resources). The health outcomes we consider are the rate of readmission within 30 days, and the mortality rate (both overall and by different causes of death). We depict our conceptual framework in a stylized form in Figure 1, wherein the graph shows the production function transforming healthcare inputs, X, into an output (health), Y, using available technology, A. The magnitude of the impact that the injection of funds achieves thus depends on where the healthcare system is situated relative to the production function. Consider points a through e; points a and b are both associated with the same (relatively low) level of inputs, while a is well below the production function, suggesting that the available resources are spent inefficiently. An injection of additional resources that moves the economy from point b to c is associated with a significant improvement in the level of output. The additional funds help move the healthcare system from the upward sloping segment of the production function (an indication that the healthcare system may be underfunded), to a flatter segment. In contrast, a similar injection of funds moving the healthcare system from c to d only leads to a modest increase in output. At c, the healthcare system is not particularly deprived of resources and is already on the flat segment of the production function. A more substantial increase in output can be achieved only by a productivity improvement,

signified by an upward shift in the production function. This would occur if the injection of additional funds is associated with the adoption of a more efficient technology (A' instead of A). The healthcare system can thus move from c to e instead of d. Indeed, adopting a more efficient technology alone could lead to a significant increase in output: movement from d to e, even without additional resources (although the resource injection may prove a catalyst of an improvement in productivity).

In line with the preceding discussion, we hypothesize that finding evidence of small returns to spending increases would indicate that the healthcare system is on the relatively flat part of the production function. As such, it would not appear substantially underfunded. In contrast, finding large increases in the quality of healthcare outputs would be ambiguous. It could either imply that the healthcare system was on the upward sloping part of the production function (that is, that it was originally underfunded), or that the spending increase translated into a significant productivity improvement. In the latter case, further analysis would be required to identify which of these two cases applies to Slovak healthcare.

3 Overview of the Slovak Healthcare System

The Slovak healthcare system[2] is based on statutory health insurance, which guarantees the same basic benefit package for all insured individuals. The insurance works by means of selective contracting between health insurance companies and healthcare providers. Health insurance companies are obliged to ensure adequate healthcare for their insurant, and compete on both quality and prices. There are three health insurance companies, one public and two private. The Ministry of Health mandates the basic benefit package and maximum waiting lists, and ensures that the health insurance companies contract sufficient numbers of healthcare providers.

Healthcare services can be distinguished as either ambulatory (outpatient) care, or inpatient and other healthcare. Ambulatory care provides care to patients not admitted to the healthcare institutions. Inpatient care includes all types of hospitals, professional medical institutions and specialized sanatoriums, palliative care, spas and health resorts. Other care includes emergency medical services, home nursing care and dialysis centers. Thus, a broad range of establishments are involved in providing healthcare services, from general practitioners, through narrowly-focused clinics to hospitals with a large number of diverse wards.

When comparing Slovakia to neighboring countries or the EU as a whole, the Slovak healthcare sector appears to underperform on a number of criteria. The Ministry of Health of the Slovak Republic (2007) notes that healthcare infrastructure is often outdated. For instance, medical equipment had an average age of 10 years, in some regions even 12 years. As a result, Slovakia lags behind the other EU countries in terms of the health status of its population. According to Medeiros, Schwierz (2015), if Slovakia were to reduce its inefficiencies in healthcare, life expectancy could be 6.4 years higher at birth and 3.2 years higher at age 64. Hence, EU Funds have the potential to improve the quality of healthcare and increase the effectiveness.

Overall, €237 million were invested in Slovak hospitals during the 2007-2013 programming period, 95% of which was disbursed under Operational Programme Health (OPH). The stated objectives of OPH included, according to the Ministry of Health of the Slovak Republic (2007), improving the quality, accessibility and effectiveness of healthcare and health support, and to reduce the relatively high morbidity and mortality rates due to circulatory system diseases, carcinomas, respiratory system diseases, digestive system diseases and external causes. It aims to achieve this by investing into healthcare infrastructure (construction of new capacities, reconstruction of buildings, delivery of medical equipment and IT equipment).

Allocated EU funds have to be accompanied by matching spending from domestic sources (private, public, or a combination of the two)[3]. The co-financing share was

[2]For further details about Slovak healthcare, see Kuenzel, Solanič (2018).

[3]Specific rules on the co-financing rate depend on the specific fund of the EU budget, from which the finances stem. For details consult Council Regulation (EC) No. 1083/2006 of 11 July 2006 available at

between 15% and 19.25% of the projected amount, depending on the ownership structure (Ministry of Health of the Slovak Republic 2007). For privately held hospitals, the EU contribution was 80.75%, with 14.25% contributed from national public sources and the remaining 5% by the hospital itself. In the case of publicly owned hospitals, the EU contribution was 85%, with 15% coming from governments at the federal and local levels.

4 Data and methodology

Our goal is to investigate the impact of the ESIF on the performance of hospitals in Slovakia. To observe the impact of the ESIF, we have obtained a detailed list of all ESIF-financed projects in Slovakia during the 2007-2013 programming period. The data were provided by the Central Coordination Body, a department at the Deputy Prime Minister's Office[4] responsible for the oordination of the ESIF in Slovakia, who extracted this information from the central information systems of EU funds (ITMS). For the purposes of our analysis, we define a hospital as a healthcare facility that contains at least the following departments: internal medicine, surgical department, central admissions office, and department of anesthesia and intensive medicine. In this way, we exclude small and narrowly focused establishments such as dermatology clinics, cosmetic surgery clinics, or centers treating addiction. Based on these criteria, we identify 67 hospitals in Slovakia.

We used the hospitals' identification numbers to match EU funds received with each individual hospital. However, we encountered some cases in which several hospitals had the same identification number; this was due to some of them having the same owner. This problem was solved by contacting the managerial authorities responsible for the operational programs and asking them about the recipient of the funds. Furthermore, one project involved two separate hospitals. In this case, we divided the total amounts based on the number of doctors working in each hospital[5].

Overall, 30 of the 67 hospitals received EU funds during the 2007-2013 programming period. Figure 2 presents the number of hospitals that have drawn ESIF in each year as well as the amount that was disbursed in each year[6]. The absorption of funds by Slovak hospitals was quite low at the beginning of the 2007-2013 programming period, with peak spending occurring in 2012[7].

Figure 3 presents the regional distribution of the ESIF. Hospitals in Prešov, Banská Bystrica, and Košice regions received the greatest funding levels. On the other hand, no funds were allocated to hospitals in the Bratislava region. This is due to its status as a more developed region, meaning its GDP per capita exceeds 90% of the EU average[8]. Therefore, the Bratislava region was eligible for support only under the regional competitiveness and employment objectives, making it more difficult to invest ESIF in hospitals in this region.

Figure 3 also depicts the regional distribution of ESIF by categories of expenditure. Notice that the bulk of ESIF were spent on infrastructure (construction and reconstruction work) and medical equipment. Only in two regions, Trnava and Trenčín, were more ESIF invested in medical equipment than in infrastructure[9]. Investments in personnel,

https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32006R1083. In this paper we summed all sources of finance together.

[4]From 1 July 2020, the Deputy Prime Minister's Office has been transformed to Ministry of Investments, Regional Development and Informatisation of the Slovak Republic.

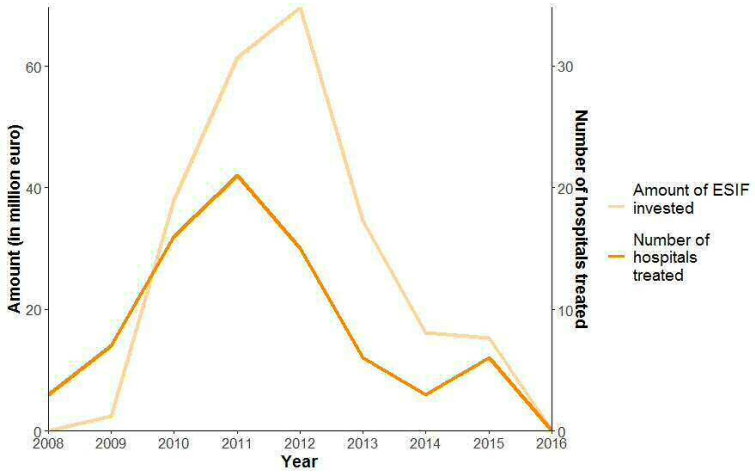
[5]The project "Further education of hospital staff", No. 27140130038, financed educational and training sessions in hospitals in Žiar nad Hronom and Rimavská Sobota.

[6]A hospital applying for ESIF at first finances the expenditure by themselves, and submits a request for reimbursement that is then assessed by the managing authority. In Figure 4 as well as throughout the whole paper we allocate the funds to the year in which the beneficiary paid the contractor.

[7]Recall that EU allowed Member States to draw unspent funds allocated in the 2007-2013 budget also during the 2-3 years immediately following the end of the programming period (see footnote 1).

[8]The EU classifies regions into less developed (with GDP per capita up to 75% of the EU average), transition regions (75 to 90%) and more developed regions (GDP per capita exceeding more than 90% of the EU average).

[9]This reflects a government assessment of the needs of the individual regions, which found that Trnava and Trenčín were especially in need of new medical equipment (see Ministry of Health of the Slovak Republic 2007).



Data source: ITMS.

Figure 2: Development of absorption of ESIF in hospitals

comprising spending on wages and training, and other expenditures, were comparatively small. As the distribution by categories suggests, the highest amount, €225 million or 95 % of the whole allocation, was drawn from the OPH. The main objective of this operational programme was to improve the quality of healthcare through construction and reconstruction of healthcare infrastructure.

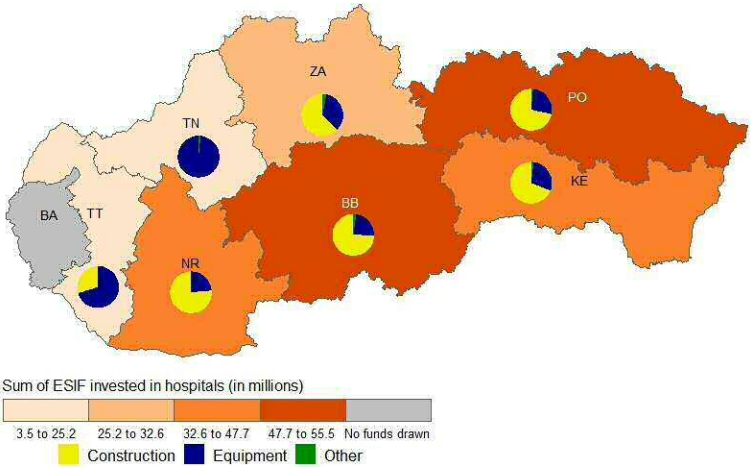
As the majority of the ESIF were spent on modernizing hospital infrastructure (construction or reconstruction), the impact on readmission rates is not entirely straightforward. Staying in a newly built or refurbished building might increase the enjoyability of one's stay in a hospital, but the improved infrastructure should only have a limited impact on the quality of the treatment provided. However, infrastructure improvements also serve to decrease a hospital's running costs, and such savings can be used to improve the quality of healthcare. Furthermore, in as much as the improvements were necessary to maintain the functionality of a hospital, obtaining external financing reduces the need to finance such planned expenditure from a hospital's own budget. Thus, funds freed up in this way can be redirected to other uses where they can have a direct impact on the readmission or mortality rates[10].

Although many previous studies used life expectancy as the outcome variable, as we discuss above, life expectancy can be attributed to numerous other factors besides the quality of healthcare system or the expenditure on it. It is also a long-term measure, and as such it would be ill-suited for an analysis of the impact of a relatively short-lasting intervention. Instead, we use the readmission rate, which we define as the rate of readmissions within 30 days of the original hospitalization, and the mortality rate, including its subcategories.

Data on readmission and mortality rates in Slovak hospitals during 2010-2017 cover the healthcare treatments recorded by Všeobecná zdravotná poisťovňa (VšZP, the public health insurance company) and were provided to us by the Ministry of Health of the Slovak Republic. VšZP is the oldest and largest health insurance provider, with a market share of 57.73% as of 1.1.2020 (this share was even higher during the years covered by the analysis)[11]. The data show insurance claims by clients of the VšZP at the level

[10]Such spillover effects are similar to the crowding out of investment by development aid. The literature studying the effect of aid on investment in less developed countries routinely finds that receiving aid for investment projects leads to a reduction in investment by the recipient country and an increase in government consumption. In other words, the aid received allows the recipient country to free up some of its own resources originally earmarked for investment and redirect them to other uses (see Section 5 in Doucouliagos, Paldam 2009). It is reasonable to expect a similar pattern at the level of hospitals.

[11]Since 2013 around 200,000 switched to one of the two private insurance companies. For more information see: https://www.vszp.sk/showdoc.do?docid=2219&forceBrowserDetector=blind and http://www.udzs-sk.sk/documents/14214/29608/OZNAMENIE_podiel+PP_web_1.1.2020.pdf/d1b10048-34f5-4a0a-ba72-83c85c51bd30.



Data source: ITMS.
Note: Hospitals in Bratislava region were not eligible for EU funds. The abbreviations in Figure 3 represent the names of the regions: Bratislava region (BA), Trnava region (TT), Trenčín region (TN), Nitra region (NR), Žilina region (ZA), Prešov region (PO) and Košice region (KE).

Figure 3: ESIF invested in hospitals (in millions of Euros) and breakdown by type of expenditure

of hospital departments; these were added up to compute the hospital-level aggregates. However, the data on readmission rates are incomplete for 17 hospitals. We imputed the missing observations by bootstrapping from the existing data using the hospitals trends.

We have also included various additional control variables to ensure the model is well specified and free of omitted variable bias by accounting for the possible impact of hospital specific factors on the readmission and mortality rates. Quality of healthcare might be affected by the nature of ownership of the healthcare facility (Czypionka et al. 2014, Berger, Messer 2002) and the number of medical devices available at the hospital (Retzlaff Roberts et al. 2004, Samut, Cafri 2016, Stefko et al. 2018). Hospitals with an oncology department or an intensive care unit tend to deal with more serious cases so they are likely to have higher readmission and mortality rates. Similarly, the capacity and occupancy of the hospital might influence the readmission rate. Furthermore, we also control for the effects of several socio-economic variables at the district level: the average wage, perinatal mortality, economic dependency ratio (number of people in retirement age divided by the number of people of working age), population density, and the share of people of the Roma ethnicity (who tend to suffer from significant economic and social exclusion) in the district's population. We obtained these data from the Statistical Office of the Slovak Republic[12].

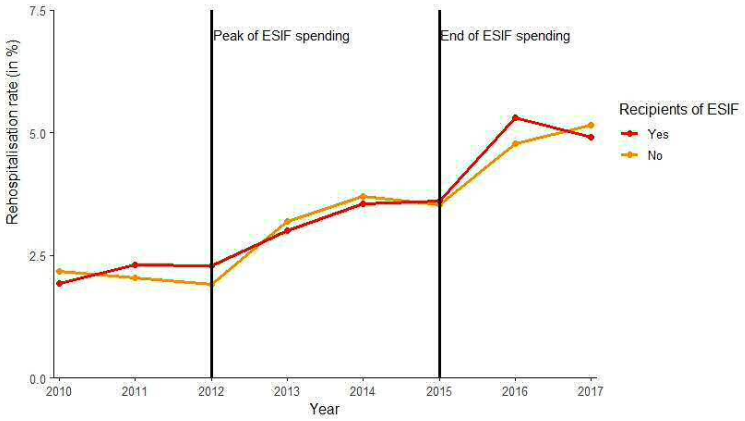
In order to estimate the impact of ESIF investments on the quality of healthcare, we estimate the production function of healthcare quality for hospital i located in district j in time period t:

$$\ln Y_{it} = \beta_0 + \beta_1 \ln ESIF_{it} + \gamma hos\_controls_{it} + \delta socecon\_controls_{jt} + \tau_t + \mu_i + u_{it}$$

ESIF denotes the cumulative sum of all ESIF invested by period t in a given hospital: adding-up the EU funds in this way allows us to evaluate their long-term effect. The reason is that the expenditure should not only impact the quality of healthcare in the same year but also in the following years[13]. Furthermore, *hosp_controls* and *soc-*

[12]In the discussion of our findings below, we focus on the ESIF effect. The full regression results for all control variables can be found in the Appendix.

[13]The alternative would have been to consider different lag length to see which yields the best results. However, as we explain above, we are precluded from doing this by the changes in how the data were collected in 2016 and subsequent years.



Data source: National health information center.

Figure 4: Development of the readmission rate in Slovak hospitals in 2010-2017

econ_controls represent the hospital and district controls, respectively[14]. Lastly, τ_t denotes the time fixed effects and μ_i stands for the individual fixed effects.

As we are also interested in the impact of different categories of ESIF, we also estimate the following model:

$$\begin{aligned} \ln Y_{it} \quad = \quad & \beta_0 + \beta_1 \ln constr_{it} + \beta_2 \ln equip_{it} + \beta_1 \ln persother_{it} + \\ & \gamma hos\_controls_{it} + \delta socecon\_controls_{jt} + \tau_t + \mu_i + u_{it} \end{aligned}$$

where *constr*, *equip* and *persother* represent the ESIF invested in infrastructure, equipment, and other expenses (which also includes personnel expenses that are too small to be used as a separate category), all expressed as cumulative sums.

We adjust the data in a number of ways. First, although the hospitals were also receiving EU funds in 2008 and 2009, due to limited availability of data on the quality of healthcare in hospitals in these years we cannot include them in our model. However, not considering the funds utilized by hospitals in 2008 and 2009 should not affect our results much because, as Figure 2 shows, the drawing rate of ESIF in these two years was negligible. Second, we exclude the years 2016 and 2017 from our model, because in these two years the ESIF from the programming period 2007-2013 were no longer drawn. As can be seen in Figure 4, the readmission rate increased in 2016 and 2017. This increase is not caused by changes in Slovak healthcare, but rather by an improvement in data collection. Hence, the inclusion of these two years might distort the results. Due to missing data on the hospital controls we have an unbalanced panel[15]. Lastly, we take logarithms of variables, with the exception of binary variables, and added 1 to the variables expressed as ratios before taking logarithms of them to prevent additional loss of data as they contained numerous zeros.

We estimate models with contemporaneous cumulative ESIF and with its first lag. All in all, our two models cover 67 hospitals, of which 30 were drawing ESIF over the period 2010-2015.

In Table 1, we present the descriptive statistics for both groups of hospitals, that is, hospitals that were recipients of funds, and those that did not receive any funds during our observation period. The two groups of hospitals are similar, but some important differences stand out. The hospitals that drew EU funds have a higher capacity in terms of beds as well as more medical personnel and specialized medical

[14]Some of the control variables at the hospital level (new patients, capacity of the hospital and the number of medical devices) were divided by the number of medical personnel to control for the size of the hospital.

[15]Out of the 67 hospitals in our dataset we are missing complete times series for several variables in the case of seven hospitals, with two of them belonging to the treatment group. For approximately ten others we have incomplete time series.

Table 1: Comparison of mean values of variables between ESIF recipients and other hospitals

	2010			2015		
ESIF recipients	Yes	No	Difference	Yes	No	Difference
Number of hospitals	17	50	-33	30	37	-7
ESIF [euros]	1,346,473.15	0.00	1,346,473.15	7,913,732.23	0.00	7,913,732.23
Readmission rate1	1.83%	2.15%	-0.32 p.p.	3.50%	3.41%	0.10 p.p.
Mortality rate2	2.06%	2.53%	-0.48p.p.	2.07%	2.27%	-0.21 p.p.
Capacity3	493.52	368.80	124.72	452.75	327.86	124.89
Occupancy4	66.99%	61.83%	5.16 p.p.	67.46%	64.87%	2.59 p.p.
Intensive Care [0/1]	0.53	0.49	0.05	0.67	0.59	0.07
Oncology [0/1]	0.10	0.03	0.07	0.03	0.03	0.01
CT5	1.13	0.73	0.40	1.17	0.91	0.26
MR5	0.52	0.15	0.37	0.38	0.15	0.23
Perinatal mortality6	5.87	5.54	0.33	5.96	5.15	0.82
Average wage7	730.50	814.84	-84.34	884.07	956.62	-72.55
Population density8	205.49	514.93	-309.45	201.83	505.92	-304.09
Old age dependency9	17.22	18.12	-0.91	20.91	21.64	-0.73
Roma share10	2.32	2.21	0.11	2.41	1.95	0.46
State hospital [0/1]	0.67	0.32	0.34	0.67	0.38	0.29
Regional hospital [0/1]	0.20	0.57	-0.37	0.07	0.38	-0.31

Data source: National health information center and Statistical Office of the Slovak Republic.
Notes: Hospital controls: 1 Percentage of patients readmitted within 30 days after being discharged from hospital. 2 Percentage of patients who pass away while in hospital. 3 Capacity in terms of number of patients that can be accommodated. 4 Patients admitted as percentage of capacity. 5 Number of devices in the hospital. District controls: 6 Perinatal mortality in the district the hospital is located in. 7 Average salary in the district the hospital is located in. 8 Persons per square kilometer in the district the hospital is located in. 9 Old persons (65+), as percentage of population in economically active age in the district the hospital is located in. 10 Percentage of Roma ethnicity in the population of the district the hospital is located in.

equipment (MRI scanners and CT scanners). Apart from that, we can see that they are located in poorer regions (in terms of the average wage). The OPH prioritized hospitals that urgently needed repairs or construction works or were located in regions that had high mortality rates due to cardiovascular, respiratory and oncological diseases (Ministry of Health of the Slovak Republic 2007). Therefore, our model may suffer from endogeneity bias due to omitted variables. Because of the lack of data, we are not able to control for all these characteristics. Nevertheless, if endogeneity is present, it would bias the estimates downwards, given that EU funds were prioritized for poorly performing hospitals. Therefore, our results can be interpreted as the lower bound of the impact of ESIF.

Besides the overall mortality rate, we also have information on the main causes of death. These are summarized in Table 2. Note that, given some hospitals have a limited range of departments, not all causes of death are observed in each hospital.

5 Results

Table 3 presents the results with contemporaneous effect of the cumulative EU funds on the rate of readmission of patients within 30 days. Columns (1-2) present the results obtained with hospital fixed effects only, while columns (3-4) also feature time fixed effects. In Columns (1) and (3), we report the regression results obtained with the total ESIF, while the results with subcategories of spending are reported in Columns (2) and (4) [16]. The effect of EU spending overall is insignificant; when looking at subcategories, only ESIF invested into construction and reconstruction of hospitals seem to have a statistically significant negative effect on the readmission rate. Thus, it appears that investing more funds in construction and reconstruction of hospital premises results in a lower rate of patient readmissions. Controlling for time fixed effects makes little difference, which is reassuring. Our results do not capture some unobserved nation-wide

[16] In the main body of the paper, we only report the coefficient estimates for the EU Funds. The full results, with all control variables, are available in the Appendix.

Table 2: Descriptive statistics: mortality by cause of death and other indicators

Variable	Obs.	Mean	Std. Dev.	Min	Max
Mortality after femur fracture (age over 65)	283	0.11	0.08	0	1
Mortality caused by myocardial infarction after emergency (age 35-74)	292	0.07	0.09	0	1
Mortality after acute stroke	320	0.14	0.10	0	1
Mortality after interventions	329	0.02	0.02	0	0.10
Mortality in ICUs	309	0.05	0.04	0	0.25
Ratio of transfers to ICUs	308	0.22	0.25	0	2.00
Mortality in regular wards after transfer from ICU	352	0.00	0.00	0	0.01
Pressure ulcer	353	0.00	0.00	0	0.08
Ratio of transfers to ICUs *	308	0.22	0.25	0	2.00
Operation rate **	299	0.57	0.17	0	1

Data source: National health information center.
Notes: * Ratio of patients transferred to an ICU over total number of hospitalizations. ** Ratio of patients undergoing surgery over total number of hospitalizations.

Table 3: Contemporaneous effect of cumulative ESIF on the readmission rate

	(1) Readmission rate 30 days	(2) Readmission rate 30 days	(3) Readmission rate 30 days	(4) Readmission rate 30 days
Constant	-0.265543*	-0.269996*	0.373888	0.329155
	(0.138624)	(0.136596)	(0.225511)	(0.215518)
ESIF	0.000219		0.000092	
	(0.000437)		(0.000416)	
Construction		-0.001070***		-0.001093***
		(0.000291)		(0.000332)
Equipment		0.000627*		0.000713*
		(0.000323)		(0.000367)
Persother		0.000860		0.000585
		(0.000636)		(0.000620)
Hospital controls	Yes	Yes	Yes	Yes
Socioeconomic controls	Yes	Yes	Yes	Yes
Observations	333	333	333	333
Individual FEs	Yes	Yes	Yes	Yes
Time FEs	No	No	Yes	Yes
R-squared	0.2675	0.2936	0.3667	0.3919
Adjusted R-squared	0.230362	0.253093	0.323977	0.346663
F statistics	475.65***	40.68***	5.33***	6.02***

Notes: Robust standard errors in parentheses. Full results in the Appendix. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

policy trends in the organization or financing of healthcare.

In Table 4, we lag the EU funds by one year: this is intended to allow for a delay in the investments bearing fruit. The impact of EU funds now appears stronger and is more precisely estimated. In Column (3), when time fixed effects are taken into account, a one-percent increase in the EU funds reduces the readmission rate in the following year by 0.000775%. If we consider that the average readmission rate was 2.68% during this period, then this is equivalent to a decline of 0.0021 percentage points. Without including time effects, the impact falls just short of being statistically significant. We obtain a slightly higher coefficient when we divide the EU funds into three categories, among which construction and equipment are the most significant. Interestingly, their estimated effects have the opposite signs. Investment in construction, which is the category with the largest proportion of EU funds, lowers the readmission rate, as expected. The positive coefficient for EU funds invested in equipment can be rationalized as an effect of an increased capacity of the hospital. After installing new and more modern equipment, the hospital may receive additional patients and/or is likely to admit patients with more complicated ailments. Being required to treat more complicated cases may then translate into a higher incidence of readmissions.

We also examine the impact of EU funds on the overall mortality rate as well as the main causes of death (Tables 5-7). In case of the overall mortality rate, the results

Table 4: Lagged effect of cumulative ESIF on the readmission rate

	(1) Readmission rate 30 days	(2) Readmission rate 30 days	(3) Readmission rate 30 days	(4) Readmission rate 30 days
Constant	-0.785390	-0.792601	1.154970	1.178965
	(0.626623)	(0.629372)	(0.852947)	(0.842379)
Lag_ ESIF	-0.000463		-0.000757***	
	(0.000287)		(0.000272)	
Lag_construction		-0.000775***		-0.000906***
		(0.000192)		(0.000237)
Lag_equipment		0.000652***		0.000740***
		(0.000239)		(0.000250)
Lag_persother		-0.000407		-0.000771**
		(0.000370)		(0.000324)
Hospital controls	Yes	Yes	Yes	Yes
Socioeconomic controls	Yes	Yes	Yes	Yes
Observations	279	279	279	279
Individual FEs	Yes	Yes	Yes	Yes
Time FEs	No	No	Yes	Yes
R-squared	0.3214	0.3322	0.4365	0.4497
Adjusted R-squared	0.279996	0.285952	0.392766	0.402433
F statistics	4.11 ***	5.45 ***	16.42 ***	13.96 ***

Notes: Robust standard errors in parentheses. Full results in the Appendix. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

show no statistically significant relationship with the EU funds (Table 5). Looking at the various sub-categories of mortality, we find that the absorption of financial resources in hospitals is positively correlated with mortality after femur fracture in the case of patients over 65, mortality due to myocardial infarction and mortality after transfers from ICU. Femur fracture is a common injury among the elderly associated with significant morbidity, mortality and disability (Bouchard et al. 1996). The positive effects for these two categories could be explained by the fact that hospitals that underwent improvements are likely to receive additional and more serious cases which, in turn, are more likely to end up with the patient passing away. On the other hand, additional financial resources in hospitals are negatively correlated with mortality in ICUs. The remaining categories appear unaffected by EU funds[17]. The mixed effects of investments financed by the ESIF on the various categories of mortality can explain the lack of significance of EU funds with respect to the overall mortality rate.

6 Conclusions

In this paper, we evaluate the impact of injecting additional EU funding into hospitals on the quality of healthcare in Slovakia. Between 2010 and 2015, €237 million of EU grants were invested in 30 Slovak hospitals, with most of these funds utilized for reconstruction of hospital premises or construction of new buildings. We measure the quality of hospital care by means of the readmission rate, defined as the ratio of readmissions within 30 days over total hospitalizations, and the mortality rate. These are outcomes that are unambiguously important for the patients' wellbeing and quality of life. Slovakia is a particularly well-suited subject for such analysis as the performance of its healthcare system compares rather unfavorably to similar countries in the region and to the EU as a whole. One possible explanation for this is lack of funding, as Slovakia spends a lower share of its GDP on healthcare compared to the EU average. In this paper, we aim to shed light on whether the poor performance of the Slovak healthcare system is indeed

[17] When we again split the ESIF by categories (construction, equipment, and personnel/other), we find that mortality after femur fracture is positively correlated with ESIF spending on equipment. Mortality due to myocardial infarction shows a negative correlation with purchases of equipment and a positive (and larger) correlation with spending on personnel and other uses. Mortality after interventions falls with expenditure on construction and equipment but increases with personnel and other spending. Mortality in ICUs is weakly negatively correlated with equipment spending, and, finally, the ratio of transfers to ICUs depends negatively on ESIF in construction. These results are available upon request.

Table 5: Contemporaneous and lagged effects of cumulative ESIF on the mortality rate

	(1) Mortality rate	(2) Mortality rate	(3) Mortality rate	(4) Mortality rate
Constant	-0.0164	-0.0167	0.2276	0.2346
	(0.0263)	(0.0262)	(0.1441)	(0.1469)
ESIF	0.0000			
	(0.0001)			
Lag_ESIF			0.0000	
			(0.0001)	
Construction		-0.0000		
		(0.0001)		
Equipment		0.0000		
		(0.0001)		
Persother		0.0001		
		(0.0001)		
Lag_construction				0.0000
				(0.0001)
Lag_equipment				0.0000
				(0.0001)
Lag_persother				-0.0001
				(0.0001)
Hospital controls	Yes	Yes	Yes	Yes
Socioeconomic controls	Yes	Yes	Yes	Yes
Observations	344	344	289	289
Individual FEs	Yes	Yes	Yes	Yes
R-squared	0.0851	0.0880	0.1352	0.1384
Adjusted R-squared	0.0403	0.0376	0.0843	0.0809
F statistics	1.93**	1.51	2.39***	2.17**

Notes: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Regressions with time-fixed effects did not differ significantly from those with individual fixed effects.

caused by the low level of funding, or whether it is a sign of low overall productivity of healthcare facilities.

Our results indicate that the injection of EU funds has led to a significant but small decrease in the readmission rate in the following year. An increase in EU funds by one percent is associated with a decrease in the readmission rate by 0.0007% in the following year. When looking at the break-down of EU-financed investments by category of spending, we see that the favorable impact is driven primarily by spending on the construction and reconstruction of hospital premises. In contrast, we find that investments in equipment are correlated with slightly higher readmission rates in the next year. We think that this latter result may be caused by hospitals with new equipment receiving more acute patients from other hospitals. The impact of ESIF on mortality rates is statistically insignificant. When we look at the various subcategories of mortality, the results are mixed: we observe some positive but also negative effects, all of which tend to be rather small.

How are we to make sense of the result that injections of EU funds are associated with only small improvements in healthcare outcomes? First, it suggests that the Slovak healthcare system is at present on the relatively flat segment of the production curve. For this reason, increases in inputs lead only to modest gains in performance. In turn, that means that the healthcare system is not at present underfunded, had that been the case, we would expect much larger gains after the hospitals received additional resources. Rather, what the Slovak healthcare system needs is efficiency improvements. Returning to the production-function paradigm, what is needed is an upward shift in the production function, not movement alongside the existing (and low) production function.

The small gains can also be related to the fact that the bulk of EU funds were spent on construction and reconstruction of hospital facilities, that is, on purposes not directly related to provision of healthcare. Such funding can affect the quality of healthcare only indirectly, by freeing up hospitals' own funds to be redirected to other uses. Our findings suggest that such indirect effects are not present or very limited. Nevertheless, it is important to note that several other contributions also find small or zero effects of

Table 6: Contemporaneous effect of ESIF on the mortality rate in selected categories (part 1)

	(1) Mortality after femur fracture (age over 65)	(2) Mortality caused by myocardial infarction after emergency (age 35-74)	(3) Mortality after acute stroke	(4) Mortality after interventions
Constant	-1.4762*	0.0512	2.3563	0.0355
	(0.8261)	(0.8355)	(1.4376)	(0.1353)
ESIF	0.0027*	0.0028**	0.0015	-0.0001
	(0.0014)	(0.0012)	(0.0022)	(0.0002)
Hospital controls	Yes	Yes	Yes	Yes
Socioeconomic controls	Yes	Yes	Yes	Yes
Observations	271	282	306	319
Individual FEs	Yes	Yes	Yes	Yes
R-squared	0.1142	0.0974	0.0781	0.1212
Adjusted R-squared	0.0585	0.0429	0.0271	0.0747
F statistics	441.71***	4.19***	22.90 ***	335.94 ***

Notes: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 7: Contemporaneous effect of ESIF on the mortality rate in selected categories (part 2)

	(5) Mortality in ICUs	(6) Ratio of transfers to ICUs	(7) Mortality in regular wards after a transfer from ICU	(8) Pressure ulcer	(9) Operation rate
Constant	0.3189	-5.3445*	-0.0042	0.0107	-0.1128
	(0.1901)	(2.9647)	(0.0085)	(0.0091)	(2.7022)
ESIF	-0.0014**	-0.0072	0.0000477*	0.0000	-0.0043
	(0.0005)	(0.0044)	(0.0000259)	(0.0000)	(0.0029)
Hospital controls	Yes	Yes	Yes	Yes	Yes
Socioeconomic controls	Yes	Yes	Yes	Yes	Yes
Observations	220	220	221	339	291
Individual FEs	Yes	Yes	Yes	Yes	Yes
R-squared	0.1465	0.3663	0.1405	0.0541	0.1399
Adjusted R-squared	0.0838	0.3198	0.0776	0.0072	0.0897
F statistics	31.97***	41.83***	4.45***	1.91**	5.23***

Notes: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

spending increases on the quality of healthcare (Or 2001, Nixon, Ulmann 2006, Gallet, Doucouliagos 2016).

Our analysis sheds light on correlation between the EU funds and the quality of healthcare; it does not reflect a causal relationship. Nevertheless, our findings suggest that the unfavorable performance of the Slovak healthcare system (in international comparison) is not due to lack of funding but is attributable to low efficiency. This likely reflects the general lack of qualified healthcare practitioners, both doctors and especially nurses. The lack of qualified staff will worsen over time as a significant proportion of existing doctors and nurses are above 60 years old (ÚHP 2019). Graduates of medical schools tend to migrate to other countries, which will further exacerbate the shortage of medical personnel in Slovakia (Haluš et al. 2017). The low efficiency also reflects a misallocation of resources, with the ratio of general practitioners to specialists at 3 compared to the EU average of 0.6 (ÚHP 2019). If the objective of EU Funds is to generate significant improvements in the quality of healthcare, then future funding programs should focus on fostering knowledge transfer, technology acquisition, and training healthcare professionals rather than (or in addition to) rebuilding facilities. Future research, and the attention of policy makers, should therefore be directed towards identifying potential avenues to improve efficiency and to ensure the healthcare system does not suffer staff shortages.

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A Appendix:

Table A.1: Contemporaneous effect of cumulative ESIF on the readmission rate – full model

	(1) Readmission rate 30 days	(2) Readmission rate 30 days	(3) Readmission rate 30 days	(4) Readmission rate 30 days
Constant	-0.265543*	-0.269996*	0.373888	0.329155
	(0.138624)	(0.136596)	(0.225511)	(0.215518)
ESIF	0.000219		0.000092	
	(0.000437)		(0.000416)	
Construction		-0.001070***		-0.001093***
		(0.000291)		(0.000332)
Equipment		0.000627*		0.000713*
		(0.000323)		(0.000367)
Persother		0.000860		0.000585
		(0.000636)		(0.000620)
Capacity	-0.000310	-0.000326	0.000049	0.000017
	(0.000385)	(0.000351)	(0.000407)	(0.000372)
Occupancy	0.042628	0.039042	0.036114	0.030490
	(0.035229)	(0.035018)	(0.034315)	(0.034642)
New patients	-0.014553*	-0.014867*	-0.009925	-0.010003
	(0.007949)	(0.007624)	(0.007703)	(0.007448)
Medical devices	0.004416	0.007104	-0.000381	0.002303
	(0.012546)	(0.012119)	(0.011726)	(0.011287)
IC	0.002146	0.003078	-0.002637	-0.001697
	(0.005749)	(0.005934)	(0.005070)	(0.005225)
Oncology	0.014272*	0.013181	0.011428**	0.010773*
	(0.007332)	(0.008856)	(0.004535)	(0.005455)
CT	0.000586	0.001850	0.001625	0.002864
	(0.002468)	(0.002517)	(0.002456)	(0.002480)
MR	-0.006358	-0.006880*	-0.006177**	-0.006728**
	(0.003985)	(0.003935)	(0.002540)	(0.002545)
State hospital	-0.010493***	-0.010833***	-0.016054***	-0.016175***
	(0.001885)	(0.001961)	(0.004352)	(0.004235)
Regional hospital	-0.000886	-0.000823	0.003683	0.003296
	(0.002866)	(0.002919)	(0.003071)	(0.003208)
Perinatal mortality	0.001077	0.000593	0.000693	0.000276
	(0.001689)	(0.001648)	(0.001611)	(0.001579)
Average wage	0.018057	0.016919	-0.026035	-0.023398
	(0.021607)	(0.020930)	(0.024024)	(0.023672)
Roma share	0.007260	0.008703*	0.003990	0.005766
	(0.004546)	(0.004468)	(0.004398)	(0.004298)
Econ dependency	0.071239**	0.069779**	-0.006601	-0.005288
	(0.031568)	(0.029800)	(0.025260)	(0.023932)
Population density	-0.000585	0.002908	-0.025804	-0.020925
	(0.020684)	(0.020219)	(0.019709)	(0.018752)
Observations	333	333	333	333
Individual FEs	Yes	Yes	Yes	Yes
Time FEs	No	No	Yes	Yes
R-squared	0.2675	0.2936	0.3667	0.3919
Adjusted R-squared	0.230362	0.253093	0.323977	0.346663
F statistics	475.65 ***	40.68 ***	5.33 ***	6.02 ***

Notes: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A.2: Lagged effect of cumulative ESIF on the readmission rate – full model

	(1) Readmission rate 30 days	(2) Readmission rate 30 days	(3) Readmission rate 30 days	(4) Readmission rate 30 days
Constant	-0.785390	-0.792601	1.154970	1.178965
	(0.626623)	(0.629372)	(0.852947)	(0.842379)
Lag_ ESIF	-0.000463		-0.000757***	
	(0.000287)		(0.000272)	
Lag_construction		-0.000775***		-0.000906***
		(0.000192)		(0.000237)
Lag_equipment		0.000652***		0.000740***
		(0.000239)		(0.000250)
Lag_persother		-0.000407		-0.000771**
		(0.000370)		(0.000324)
Capacity	0.000052	0.000091	0.000427	0.000459
	(0.000312)	(0.000297)	(0.000334)	(0.000314)
Occupancy	0.050533	0.042946	0.025954	0.015898
	(0.039044)	(0.039733)	(0.033427)	(0.032614)
New patients	-0.021922***	-0.022567***	-0.013669*	-0.014256*
	(0.007937)	(0.007844)	(0.008074)	(0.008105)
Medical devices	0.004876	0.003975	0.000499	-0.000901
	(0.011617)	(0.011693)	(0.010795)	(0.010615)
IC	-0.000544	-0.000401	-0.007310	-0.007221
	(0.005786)	(0.005946)	(0.004887)	(0.005034)
Oncology	0.007604	0.008716	-0.002632	-0.000670
	(0.009528)	(0.009006)	(0.006267)	(0.005412)
CT	-0.001968	-0.001622	-0.000822	-0.000425
	(0.003111)	(0.003101)	(0.002922)	(0.002855)
MR	-0.006329	-0.005996	-0.005077**	-0.004690**
	(0.003889)	(0.003829)	(0.002339)	(0.002260)
State hospital	-0.011444***	-0.011232***	-0.016106***	-0.015946***
	(0.003733)	(0.003830)	(0.002924)	(0.002899)
Regional hospital	-0.004278	-0.004157	0.000508	0.000717
	(0.003745)	(0.003809)	(0.003117)	(0.003150)
Perinatal mortality	0.001440	0.001366	0.000229	0.000119
	(0.001615)	(0.001652)	(0.001431)	(0.001443)
Average wage	0.029405	0.033204	0.004548	0.008963
	(0.028528)	(0.028508)	(0.027010)	(0.026846)
Roma share	-0.056345	-0.054630	-0.047380	-0.045273
	(0.037615)	(0.037073)	(0.029981)	(0.028874)
Econ dependency	0.083215**	0.080566**	-0.015373	-0.019533
	(0.040359)	(0.040026)	(0.035883)	(0.034995)
Population density	0.077464	0.076632	-0.209844	-0.216376
	(0.128693)	(0.129861)	(0.156662)	(0.155700)
Observations	279	279	279	279
Individual FEs	Yes	Yes	Yes	Yes
Time FEs	No	No	Yes	Yes
R-squared	0.3214	0.3322	0.4365	0.4497
Adjusted R-squared	0.279996	0.285952	0.392766	0.402433
F statistics	4.11 ***	5.45 ***	16.42 ***	13.96 ***

Notes: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A.3: Contemporaneous and lagged effect of cumulative ESIF on the mortality rate – full model

	(1) Mortality rate	(2) Mortality rate	(3) Mortality rate	(4) Mortality rate
Constant	-0.0164	-0.0167	0.2276	0.2346
	(0.0263)	(0.0262)	(0.1441)	(0.1469)
ESIF	0.0000			
	(0.0001)			
Lag_ESIF			0.0000	
			(0.0001)	
Construction		-0.0000		
		(0.0001)		
Equipment		0.0000		
		(0.0001)		
Persother		0.0001		
		(0.0001)		
Lag_construction				0.0000
				(0.0001)
Lag_equipment				0.0000
				(0.0001)
Lag_persother				-0.0001
				(0.0001)
Capacity	0.0000	0.0000	-0.0000	-0.0000
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Occupancy	0.0015	0.0014	-0.0102*	-0.0106*
	(0.0078)	(0.0078)	(0.0055)	(0.0057)
New patients	-0.0020	-0.0020	-0.0032**	-0.0031**
	(0.0017)	(0.0017)	(0.0014)	(0.0014)
Medical devices	-0.0004	-0.0003	-0.0020	-0.0022
	(0.0030)	(0.0030)	(0.0036)	(0.0037)
IC	-0.0004	-0.0003	-0.0011	-0.0011
	(0.0015)	(0.0016)	(0.0015)	(0.0015)
Oncology	0.0002	0.0002	-0.0003	0.0000
	(0.0007)	(0.0007)	(0.0009)	(0.0007)
CT	0.0005	0.0005	0.0011	0.0011
	(0.0009)	(0.0009)	(0.0009)	(0.0009)
MR	0.0001	0.0001	0.0005	0.0006
	(0.0005)	(0.0005)	(0.0005)	(0.0005)
State hospital	-0.0025**	-0.0025**	-0.0026**	-0.0026**
	(0.0011)	(0.0011)	(0.0012)	(0.0012)
Regional hospital	-0.0008	-0.0009	-0.0006	-0.0006
	(0.0007)	(0.0007)	(0.0007)	(0.0007)
Perinatal mortality	-0.0001	-0.0002	-0.0003	-0.0003
	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Average wage	-0.0025	-0.0026	-0.0035	-0.0035
	(0.0024)	(0.0025)	(0.0032)	(0.0032)
Roma share	0.0029*	0.0030*	0.0027	0.0020
	(0.0016)	(0.0016)	(0.0067)	(0.0069)
Econ dependency	0.0039	0.0037	0.0038	0.0037
	(0.0024)	(0.0024)	(0.0024)	(0.0024)
Population density	0.0102**	0.0105**	-0.0335	-0.0349
	(0.0047)	(0.0048)	(0.0298)	(0.0305)
Observations	344	344	289	289
Individual FEs	Yes	Yes	Yes	Yes
R-squared	0.0851	0.0880	0.1352	0.1384
Adjusted R-squared	0.0403	0.0376	0.0843	0.0809
F statistics	1.93**	1.51	2.39***	2.17**

Notes: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Regressions with time-fixed effects did not differ significantly from those with individual fixed effects.

Table A.4: Contemporaneous effect of cumulative ESIF on the mortality rate in selected categories – full model (part 1)

	(1) Mortality after femur fracture (age over 65)	(2) Mortality caused by myocardial infarction after emergency (age 35-74)	(3) Mortality after acute stroke	(4) Mortality after interventions
Constant	-1.4762*	0.0512	2.3563	0.0355
	(0.8261)	(0.8355)	(1.4376)	(0.1353)
ESIF	0.0027*	0.0028**	0.0015	-0.0001
	(0.0014)	(0.0012)	(0.0022)	(0.0002)
Capacity	-0.0006	-0.0036**	-0.0028	0.0005*
	(0.0010)	(0.0015)	(0.0033)	(0.0002)
Occupancy	-0.1777	0.0600	0.2163	0.0412
	(0.2148)	(0.1696)	(0.2471)	(0.0274)
New patients	0.0385	0.0403	-0.0690	-0.0019
	(0.0486)	(0.0508)	(0.0934)	(0.0062)
Medical devices	-0.0143	-0.0379	0.0016	0.0014
	(0.0479)	(0.0592)	(0.0819)	(0.0089)
IC	-0.0016	0.0355	-0.0359**	0.0034
	(0.0356)	(0.0477)	(0.0145)	(0.0045)
Oncology	0.0306**	0.0522***	0.0138	-0.0041*
	(0.0138)	(0.0190)	(0.0270)	(0.0022)
CT	-0.0218	0.0255*	-0.0125	0.0037*
	(0.0164)	(0.0139)	(0.0095)	(0.0021)
MR	-0.0044	0.0310**	-0.0246*	0.0008
	(0.0084)	(0.0147)	(0.0128)	(0.0018)
State hospital	-0.1664***	0.0049	-0.1163**	0.0163***
	(0.0431)	(0.0329)	(0.0447)	(0.0048)
Regional hospital	0.0048	0.0072	-0.1025	0.0001
	(0.0183)	(0.0158)	(0.0774)	(0.0033)
Perinatal mortality	-0.0092	-0.0040	0.0075	-0.0001
	(0.0088)	(0.0104)	(0.0070)	(0.0017)
Average wage	-0.0798	-0.2210**	0.0081	0.0025
	(0.0885)	(0.0882)	(0.0929)	(0.0158)
Roma share	0.0374	-0.0368	-0.0125	-0.0036
	(0.0292)	(0.0249)	(0.0243)	(0.0036)
Econ dependency	-0.0027	-0.0051	-0.1712*	0.0174
	(0.0941)	(0.0809)	(0.0983)	(0.0110)
Population density	0.4375***	0.2483	-0.2909	-0.0217
	(0.1611)	(0.1558)	(0.2536)	(0.0203)
Observations	271	282	306	319
Individual FEs	Yes	Yes	Yes	Yes
R-squared	0.1142	0.0974	0.0781	0.1212
Adjusted R-squared	0.0585	0.0429	0.0271	0.0747
F statistics	441.71***	4.19***	22.90***	335.94***

Notes: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A.5: Contemporaneous effect of cumulative ESIF on the mortality rate in selected categories – full model (part 2)

	(5) Mortality in ICUs	(6) Ratio of transfers to ICUs	(7) Mortality in regular wards after a transfer from ICU	(8) Pressure ulcer	(9) Operation rate
Constant	0.3189	-5.3445*	-0.0042	0.0107	-0.1128
	(0.1901)	(2.9647)	(0.0085)	(0.0091)	(2.7022)
ESIF	-0.0014**	-0.0072	0.0000477*	0.0000	-0.0043
	(0.0005)	(0.0044)	(0.0000259)	(0.0000)	(0.0029)
Capacity	0.0010	0.0009	-0.0000	-0.0000	-0.0028
	(0.0006)	(0.0049)	(0.0000)	(0.0000)	(0.0025)
Occupancy	-0.0022	0.0468	-0.0039	-0.0007	-0.0237
	(0.0275)	(0.4603)	(0.0042)	(0.0028)	(0.2116)
New patients	0.0076	-0.0163	0.0003	0.0004	0.0896
	(0.0133)	(0.1331)	(0.0006)	(0.0006)	(0.0933)
Medical devices	0.0443**	-0.1093	-0.0008	-0.0002	0.0162
	(0.0200)	(0.1892)	(0.0018)	(0.0017)	(0.1275)
IC				-0.0003	0.1389**
				(0.0003)	(0.0546)
Oncology	-0.0088	0.0023	-0.0001	0.0001	0.0667
	(0.0065)	(0.0428)	(0.0002)	(0.0003)	(0.0486)
CT	0.0055	0.0214	-0.0002	-0.0005	0.0103
	(0.0056)	(0.0306)	(0.0002)	(0.0004)	(0.0183)
MR	0.0059*	-0.0004	0.0000	-0.0002	-0.0395
	(0.0030)	(0.0320)	(0.0001)	(0.0003)	(0.0241)
State hospital	-0.0368***	-0.1181***	0.0008	0.0007	0.0022
	(0.0034)	(0.0372)	(0.0008)	(0.0008)	(0.0307)
Regional hospital	0.0039	0.0402	-0.0009***	-0.0004	-0.0678**
	(0.0053)	(0.0495)	(0.0002)	(0.0003)	(0.0272)
Perinatal mortality	-0.0018	0.0196	0.0001	0.0001	0.0000
	(0.0021)	(0.0186)	(0.0001)	(0.0001)	(0.0135)
Average wage	-0.0470	0.1083	0.0004	-0.0035*	-0.1388
	(0.0286)	(0.2938)	(0.0018)	(0.0018)	(0.1133)
Roma share	0.0011	0.0802	-0.0012	-0.0000	0.1027**
	(0.0068)	(0.0660)	(0.0007)	(0.0004)	(0.0432)
Econ dependency	0.0623	1.5466***	-0.0020	0.0028	0.2990**
	(0.0519)	(0.4045)	(0.0034)	(0.0017)	(0.1409)
Population density	-0.0322	0.0825	0.0020	0.0009	0.0783
	(0.0231)	(0.4155)	(0.0012)	(0.0017)	(0.5028)
Observations	220	220	221	339	291
Individual FEs	Yes	Yes	Yes	Yes	Yes
R-squared	0.1465	0.3663	0.1405	0.0541	0.1399
Adjusted R-squared	0.0838	0.3198	0.0776	0.0072	0.0897
F statistics	31.97 ***	41.83 ***	4.45 ***	1.91 **	5.23 ***

Notes: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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The fiscal capacity of local government versus government expenditure, and its impact on eliminating inter-regional social inequalities in Poland

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Abstract. Social inequalities are a significant challenge in developing countries. Therefore, they should be treated as a leading priority in boosting socio-economic development. Such inequalities are a growing challenge for Poland. It is believed that social inequalities are behind Poland's relatively low position against other European countries in the Human Development Index ranking. Many factors influence social inequalities, one being the system of financing local government units. A critical area for considering social inequalities in the context of financial phenomena is the study of fiscal inequalities resulting from the implemented vertical division of public revenues among individual levels of public authority. The paper presents the results of research on the relationship between the fiscal capacity of local government units in Poland across voivodeships and the expenditure of government institutions, as well as the relationship of these expenses with social inequalities in voivodeships. To this end, six areas of social life were distinguished, for which the degree of inequality of transferred expenditure was determined using the Gini index. The method of the total order of objects was used to assess the impact of government institutions' expenditure on an individual's social situation across voivodeships. The conducted research showed both the weak dependence of government expenditure on individual units' fiscal capacity and its low effectiveness in eliminating inter-voivodeship social inequalities.

JEL classification: H20, H5, H70, R12

Key words: fiscal capacity, tax capacity, local government units, social inequalities, interregional diversity

1 Introduction

In the past decade, the issue of social inequality has been the subject of growing interest in debates between economists (Piketty 2005). Nowadays it has reached a level where it inhibits growth, weakens the economy (Thiessen 2003) and contributes to rapidly increasing social stratification. These phenomena are exacerbated by globalisation processes, market openness, technological progress, deregulation of the financial sector,

polarisation of labour markets, erosion of labour market institutions, and a weakening of tax system progressivity.

An important domain for considering social inequalities in the context of financial phenomena is the study of fiscal inequalities resulting from the implemented vertical division of public revenues and tasks among individual levels of public authority. The theory of fiscal federalism shows that decentralisation enhances economic efficiency. Local governments know local conditions and preferences regarding the provision of public goods better than the national government sector does due to their physical and institutional proximity (Oates 2006). These information advantages should enable local governments to provide public goods and services that better match local preferences and/or deliver the same public goods and services at a lower cost. Equipping the budgets of local and regional units with the same sources of fiscal revenues does not guarantee similar levels of fiscal capacity. In economics, fiscal potential can be defined as tax capacity, i.e. the ability of local government units (LGU) to gain income from their own sources in order to finance standardised baskets of public goods and services (Martinez-Vazquez, Boex 1997). Therefore, per capita income level is considered the primary measure of LGU tax capacity (Martinez-Vazquez, Boex 1997). This income is primarily a derivative of location, natural resources, inhabitant wealth, population density and level of socio-economic development. Conversely, differences in LGU tax capacity may be reduced or increased by regionally allocating public expenditure made by government institutions (Blöchliger et al. 2016). An important factor in determining the allocation of public expenditure should be the level of LGU revenues.

Existing research carried out on the impact of government expenditure on the fiscal inequality of LGUs and, consequently, on the level of public goods and services provided to these units in a decentralised public finance system is inconclusive. Some respondents indicate that government spending does not reduce interregional inequalities (Kessler, Lessmann 2010). Other studies show that government spending may positively impact the equalisation of LGU fiscal resources necessary for the implementation of public tasks and services (Bartolini et al. 2016). The research's different outcomes are mostly due to the specific factors characterising individual countries and their regions. Consequently, the research carried out at the national level in particular countries and the conclusions drawn on this basis may differ from the results of research carried out on a regional or even local basis (Purbadharmaja et al. 2019).

Research into the economic impact of fiscal decentralization internationally, however, does not take into account the countries of Eastern Europe (Gil Canaleta et al. 2004, Lessmann 2009, 2012, Rodríguez-Pose, Ezcurra 2009). This is most often caused by the lack of available fiscal data, especially regional data for certain periods and countries. Historically, these countries had centrally planned economies, but currently they are very fast-growing agglomerations. As Lessmann (2009) rightly points out, the economic impact of fiscal decentralization in these countries may differ from other highly developed countries. This article aims to fill this gap by examining whether fiscal decentralization, which has been accepted in Poland (the largest eastern European country by population), affects fiscal inequalities between local government units in terms of voivodeships. The article does not examine the degree of fiscal decentralization; we focus on its economic effects, such as inter-regional social inequalities.

Social inequalities are becoming an increasing challenge. It is believed that social inequalities are behind Poland's relatively low position vis-à-vis other European countries in the Human Development Index (HDI) ranking (UNDP 2020). This article argues that the LGU financing model adopted in Poland does not improve inter-voivodeship social inequalities. We conducted research with the following objectives:

1. evaluation of the level of LGU tax capacity differentiation in the level of voivodeships;
2. identification of the relationship between the expenditure of government sector institutions and LGU tax capacity by voivodeships;
3. determining whether and to what extent the allocation of national public funds across voivodeships by government institutions contributes to reducing social inequalities in these voivodeships.

At the same time, we put forward the hypothesis that public expenditure of government institutions across voivodeships has low effectiveness in reducing social inequalities among regions.

In this study, we have analysed the relationship between government spending in health, science and education, welfare, infrastructure, culture and environmental protection, and social inequalities in 16 voivodeships (NUTS-2) in Poland between 2010 and 2018. At the same time, we have researched the correlation between government expenditure in Poland and LGU tax capacity across voivodeships. To this end, we used financial data obtained from reports and financial statements of central and local government institutions and data from Statistics Poland. In order to show the degree of LGU tax capacity from the perspective of voivodeships, the tax revenues of all local government units of a given voivodeship were taken into account.

The conducted research showed the different level of tax revenues of LGU and weak dependence between government expenditure and individual units' fiscal capacity, which may result in its low effectiveness in eliminating inter-voivodeship social inequalities. The allocation of public funds of government institutions in the long term does not improve differentiation between voivodeships. Minimal changes in the Gini coefficient value would instead be shown to stay at a certain level rather than improve the differentiation between LGU in terms of voivodeships.

This work is structured as follows. The literature on government expenditure and LGU fiscal inequalities is discussed in Section 2. The dataset and variables used for the analysis are presented in Section 3. Section 4 discusses the main results and conclusions.

2 Literature Review

In the theory of fiscal federalism, the issue of differences in LGU tax capacity is researched mainly from the perspective of the decentralisation of public authorities. Solutions are sought to determine the optimal degree of fiscal decentralisation of the public sector and demonstrate which functions and instruments should be within the government administration's competence and which should be entrusted to decentralised local government units. The starting point for researchers looking for the optimal degree of fiscal decentralisation are theses promoted by Musgrave (1959). When analysing the benefits and threats of fiscal decentralisation, Musgrave stated that the process might significantly impact increasing inequalities in the fiscal potential of local government units.

Fiscal decentralisation has the potential for poverty reduction when characterised by greater financial autonomy of local units with proper budgetary allocation, prioritisation, accountability and responsiveness (Agyemang-Duah et al. 2018). Otherwise, decentralisation can lead to a growing gap between regions due to the weak skills of local and regional authorities in managing public resources and services (Lessmann 2006). The local government taxes are usually less progressive than those which go to the state budget (Rubolino 2019, Wong 2004). Wong's research on the relationship between local economic growth and local government tax capacity showed that high property taxes are strongly negatively correlated with the local governments' ability to generate income (Wong 2004). If tax decentralisation leads to greater dependence of the public finance system on these instruments, then the tax system's overall progressivity usually shrinks. This, in turn, leads to the emergence of greater income inequalities. Rodríguez-Pose, Ezcurra (2009) outline a similar opinion. Their research shows that the relationship between decentralization and the evolution of disparities at the subnational level seems strongly affected by the level of wealth of a country, the dimension of its existing disparities, and the presence of solid fiscal redistribution systems. High income countries, with limited internal disparities, a strong welfare state, and territorially progressive fiscal systems can expect that decentralization will not harm their territorial cohesion. The situation can be different in low and medium income countries especially in the absence of well-established territorially progressive fiscal systems.

Government institution spending may minimise fiscal inequalities, but it depends on numerous factors and even at a high level in a particular region, this may not improve its social inequalities (Purbadharmaja et al. 2019). According to Kessler, Lessmann's (2010)

research on 22 highly developed OECD countries, significant government replenishment of LGU income can lead to increased interregional inequality. The evidence presented by the authors suggests a positive relationship between interregional transfers and regional disparities both across countries and in the longer term. According to the authors, countries with higher levels of interregional redistribution in the past show a subsequent increase in interregional disparity, while countries with lower levels of grants and transfers show less divergence or even convergence. Conversely, Bartolini et al. (2016) indicate that higher transfer dependency could help equalise the fiscal resources necessary for lagging regions to achieve minimum standards in the provision of subnational goods and services conducive to regional convergence. However, from a public choice perspective, it is not necessarily the case that a centralized system redistributes to poorer regions. Richer regions are often disproportionately stronger negotiators then poorer regions. Those regions therefore have a larger impact on the regional policies of the central government, possibly leading to a reduction in inter-governmental transfers to needy regions (Lessmann 2009). On the other hand, Bartolini et al. (2016) point out that government expenditure on behalf of LGUs should be combined with providing local governments with an appropriate base of their own revenues. According to Shah (1994), this should positively affect the reduction of government transfers' adverse effects. Otherwise, government transfers may discourage the economic development of less developed regions. The forms and scope of transferring public funds from the central level towards the implementation of public tasks of a local and regional nature are therefore aimed at the efficiency of the public sector. (Oates 1972, Buchanan 1950, Boadway 2008). Oates (1999) argues that a higher efficiency of public expenditure is achieved when the level of revenues allocated to LGUs enables the provision of public services of a similar or required standard. In particular, fiscal decentralisation fosters regional convergence under high-quality governance but, disturbingly, leads to wider regional disparities in mismanaged countries (Kyriacou et al. 2015).

The issue of fiscal inequalities between municipalities/regions is taken up in theories of local and regional development based on endogenous resources (Romer 1994). They assume that local government units affect labour markets, support the development of small and medium-sized enterprises, ensure favourable conditions for the development of enterprises located in a given territory, and undertake public investments in infrastructure. In the context of government administrations influencing development through extensive instruments of various economic policy fields (in addition to fiscal and monetary policy, also through employment, innovations and industrial policy), intervention in the socio-economic space may distort the market conditions of management (Yuanshuo, Warner 2016). Especially if the overall context of the socio-economic development of the region is not taken into account, for example, through the complex indicator of the supported development sectors (Mohiuddin, Hashia 2012). National governments need to consider how best to rationalize public investment, and new tools are necessary to guide and prioritize these investments (Márquez et al. 2017). Hence, the government administration's broader engagement in the sphere of regional development may result in an inefficient spending of the limited resources of public funds, the growth of bureaucracy supervising this activity, the consolidation of ineffective institutional structures, the introduction of regulations inhibiting entrepreneurship, and the development of bottom-up mobilisation of endogenous potentials. To propose more targeted and practicable policy, it is important to take into account the developmental characteristics of individual regions, perform research classifying smaller geographical areas and a greater number of narrower economic sectors. (Christofakis et al. 2019).

LGU financing systems differ significantly from one OECD country to another. This can be mainly seen in the structure of individual sources of income, including LGU income. The share of the latter in total income is often indicated in the literature as a measure of LGU income independence. Scandinavian countries are characterised by the greatest degree of fiscal autonomy, where the LGU income system relies on local income tax. On the other extreme, there are countries such as Ireland or the Czech Republic, where transfer revenues play a significant role. In Romania, the main problem remains the deeper decentralisation of competences and the de facto financial independence of

local government (Alexandru, Guziejewska 2020).

Among the analysed countries, Poland has one of the lowest shares of tax revenues over which LGU exercise tax control (OECD 2019). According to Polish legislation, the LGUs' own income does not involve general subsidies and specific subsidies from the state budget. In this respect, LGUs' own income is sourced from, inter alia, shares in income tax from the state budget, over which the local government has no tax control.

In the countries of Eastern Europe, a significant challenge is equalising LGU income, including transfers of funds between the central and local governments. In Poland this issue has been going on since the 1990s. However to this day, an entirely acceptable form of local government revenue system has not yet been developed. Consequently, the structure of the Polish public revenue system requires partial financing of the local government subsector's tasks with funds at the disposal of government subsector institutions. Issues regarding the coordination of Polish local government and government institutions' fiscal decisions related to the allocation of public funds in LGUs are also important (Kańduła 2017, Patrzałek et al. 2019). With insufficient knowledge of the priorities in implementing public tasks in municipalities, poviats and voivodeships, the cooperation of local government authorities with government institutions is difficult. Such a situation is not conducive to the coordination of fiscal decisions related to the allocation of public funds in the level of voivodeships, and the coherence and complementarity of individual levels' fiscal decisions concerning budgetary expenditure allocation. It also does not support the effective and economical allocation of public expenditure for purposes related to strengthening the regions' competitiveness.

3 Research Methods

We examined the relationship between the expenditure of government sector institutions, LGU tax revenues and the social situation in individual regions between 2010 and 2018.

The expenditures of government sector institutions included funds transferred to LGU in voivodeships for the following areas of social and economic life: science and education, culture, infrastructure, healthcare, social protection, and environmental protection. Health, science and education are essential areas taken into account when building the HDI index. Then, areas of economic and social life, data showing environmental pollution, and personal safety levels are recommended and used in reports published by the United Nations Development Programme as a supplement to the HDI index (see UNDP 2013).

In the study, we only included expenditure from national public sources[1]. No account was taken of resources from European Union funds. We obtained financial data from reports and financial statements of government sector institutions. The expenditure adopted in the study constitutes 80% of the total state budget expenditure. We included the expenditure of the institutions from the government sector in Table 1.

The level of LGU tax revenues in voivodeships is a characteristic of their tax capacity in each year of the analysis. As part of tax revenues, we included revenues from the following taxes and fees:

- LGU taxes and fees (real estate tax, agricultural tax, forest tax, tax on means of transport, tax on civil law transactions, tax on inheritance and donations, income tax on natural persons' businesses paid in the form of a fixed tax amount, market fee, service charge, stamp duty and revenues from other local fees charged by local government units based on separate acts)
- shares in Personal Income Tax (PIT) and Corporate Income Tax (CIT)

[1] *Sources*: Reports on the activities of the voivodeship fund for environmental protection and water management of a given voivodeship for 2010–2018; Report MRP&PS-02 – a collective report on the income and expenditure of the labour fund of voivodeship labour offices for the years 2010–2018; Report on the implementation of the material and financial plan for the activities of the State Fund for the Rehabilitation of Disabled People in 2010–2018; Report on the implementation of the state budget, part 24 – Culture and protection of national heritage for the years 2010–2018; Data provided by the Ministry of Science and Higher Education and the Social Insurance Institution for the years 2010–2018; Information on the implementation of the budget of local government units for four quarters from 2010–2018; Report on the implementation of the state budget for 2010–2018.

Table 1: List of government expenditures included in the study

Area	Variables
Science and education	Segment allocated to education of the general subsidy Earmarked and targeted subsidies for education Subsidies for teaching activities of universities Subsidies for research activities of universities Subsidies for financial support of students and doctoral candidates
Culture	Earmarked and targeted subsidies for current and capital expenses subordinate to the Ministry of Culture and National Heritage Voivodes' expenditure on culture and protection of national heritage Voivodes' expenditure on physical culture and sports
Infrastructure	Transport and communication expenses Voivodes' expenditure on housing
Healthcare	National Health Fund expenditure on healthcare, including expenses on the cost of health services and emergency medical services Voivodes' expenditure on healthcare
Social protection	Labour Fund expenditure, including unemployment benefits and programmes to help employees Social Insurance Institution expenditure, including expenses on social insurance State Fund for the Rehabilitation of Disabled People expenditure, including expenses on vocational and social rehabilitation Voivodes' expenditure on social assistance and the "Family" programme
Environmental protection	Expenditure by Provincial Funds for Environmental Protection and Water Management (WFOŚ&GW), including expenses on climate, land and water protection Voivodes' expenditure on municipal management and environmental protection

Source: see footnote 1 on page 55.

The social situation is a complex phenomenon that can be understood and characterised in various ways. In the study, we have used the variables available from the Local Data Bank to describe the phenomenon in the voivodeships under consideration (Statistics Poland 2010). The list of areas under consideration, together with the variables adopted in the study, are presented in Table 2.

The presented variables were expressed in relative terms. They were selected based on the substantive analysis of the studied phenomenon and the availability of statistical data that can be used to characterise the social situation in LGUs. As shown in Table 2, a total of 12 variables were used. For such a number of variables, the assessment of the impact of government institution expenditure on the social situation in LGUs by voivodeship required the construction of a synthetic measure that would allow the assessment of changes that took place in particular voivodeships between 2010 and 2018. To this end, we used the relative level of development index (BZW), which is a method of ordering objects used in the study of the spatial differentiation of multi-feature objects (Młodak 2006). This measure uses the sum of standardised values and is a normalised measure without a standard – its values range from 0 to 1. The closer the value is to 1, the better the studied object is according to the adopted general criterion. The following formulas are used to determine the BZW index (Grabiński et al. 1989):

$$
\begin{aligned}
W_i &= \frac{\sum_{j=1}^{k} z_{ij}}{\sum_{j=1}^{k} \max_i \{z_{ij}\}} \\
Z_{ij} &= x_{ij}^{*} + \left| \min_i \{x_{ij}^{*}\} \right| \\
x_{ij}^{*} &= \frac{x_{ij} - \bar{x}_j}{s_j}
\end{aligned}
$$

where W_i – BZW relative level of development index for the i-th object; x_{ij} – value of

Table 2: List of areas with the variables adopted in the study

Area	Variables
science and education	R&D expenditure per capita pupil per section in primary schools percentage of children aged 3–6 covered by pre-school education
culture	number of people per seat in theatres and musical institutions number of museums, including departments, per 100 thousand inhabitants
infrastructure	length of public roads per 10 thousand km
healthcare	population per 1 hospital bed number of doctors per 10 thousand residents
social protection	unemployment rate in the voivodeship number of people who were awarded social assistance per 10 thousand inhabitants
environmental protection	outlays on fixed assets for environmental protection and water management per capita total dust pollution per 1 km2 of surface

Source: Statistics Poland – Local Data Bank, http://www.stat.gov.pl/en/.

j-th trait for the i-th object (diagnostic variable)[2]; $\bar{x}_j$,S_j – arithmetic mean and standard deviation of the j-th feature respectively.

The BZW index is a synthetic measure often used to describe complex phenomena in various areas, including an analysis of the capital market and real estate market, the effects of activities using EU funds or showing the degree of differentiation in access to cultural services (Łuniewska, Tarczyński 2006, Mazur, Witkowska 2006, Szabela-Pasierbińska 2018, Gałecka, Smolny 2019).

The government sector institutions' level of expenditure and LGU budget revenues in individual voivodeships between 2010 and 2018 varied significantly. Therefore, when assessing their changes, we used relative increments, thus ensuring the comparability of these changes. Using the Gini coefficient, we determined the degree of inequality of government sector institutions' expenditure allocated to the selected areas of social life. The Gini coefficient is the most frequently used measure to assess income inequality (Gil Canaleta et al. 2004). In this case, government sector expenditure can be interpreted as a type of income, enabling the implementation of specific tasks in the LGU.

We characterised the differentiation of expenditure in subsequent years with the coefficients of variation. This statistical parameter also enabled the variability of the LGUs' social situation to be assessed against BZW in 2018 compared to the study's baseline year. In order to determine the degree of the relationship between the LGUs' tax revenues and the government sector institutions' expenditure, we used the basic measures of dependence, i.e. correlation coefficients.

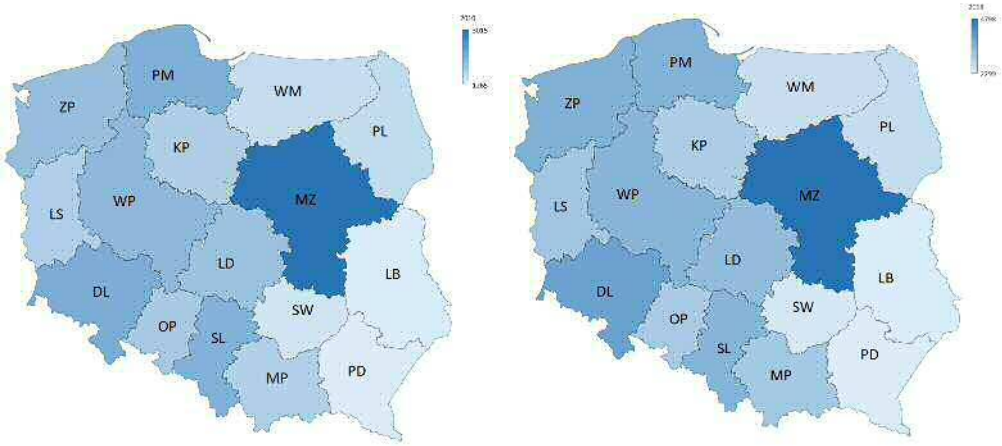
4 Results

LGU tax revenues constitute the fundamental source of funding for many social expenses and those that should provide citizens with access to many public services at a level comparable across the country, among other things. Therefore, the appropriate coordination and implementation of the system is an important issue that allows for a reduction of excessive inequalities in income, and thus limits the existing inequalities within the scope of the public services provided.

4.1 The level of LGU tax capacity differentiation in voivodeships

Between 2010 and 2018, the level of LGU tax revenues in Poland varied significantly. When analysing the ratio of tax revenues of LGU budgets per capita in terms of voivode-

[2]The variables must be stimulants.



(a) 2010 (b) 2018

Source: own study based on GUS data.

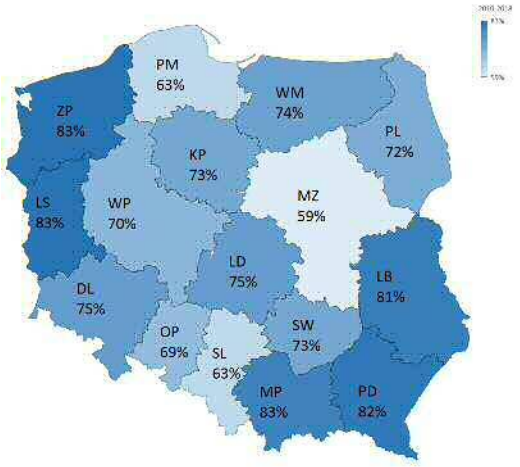
Figure 1: LGU tax revenue per capita by voivodeship in 2010 and 2018, PLN

ships, a regularity is seen indicating a better budgetary situation of LGU in western and northern Poland, i.e. where agriculture plays a less critical role then entrepreneurship (Figure 1). Western Poland has a more favourable geopolitical situation which encourages international relations. It is adjacent to Poland's largest economic partner and through the sea to the Baltic States. The units of self-government located in Western Poland are involved in numerous forms of international cooperation, such as Euroregions. The immediate neighbourhood with a developed area generates circular economic migration that the municipalities of Western Poland are subject to. These migrations have a twofold impact on the development of the areas where workforce migrates: a decrease in unemployment and the inflow of capital, which has a positive impact on tax revenues of individuals LGU. In addition, the population density in Western and Northern Poland is much higher than in the East.

The lowest values of the index are recorded in the provinces: Podkarpackie (PD), Podlaskie (PL), Lubelskie (LS), Świętokrzyskie (SW) and Warmińsko-Mazurskie (WM). At the same time these provinces constitute the macro-region of Eastern Poland. The peripherality of Eastern Poland has not only a spatial dimension (defined by the distance from the development centres of Poland and the European Union), but also a socio-economic dimension. The level of economic development of these areas is among the lowest in the European Union. Innovation, competitiveness and investment attractiveness are very low there, which is reflected in the income of units of territorial self-government. Late development of the macro-region has deep historical roots and is an example of long-term processes (Kukliński 2010). In addition, on a macro-regional scale, a higher than average proportion of its surface area nationally is covered by different legal forms of environmental protection (39.4%, with a national average of 32.5%), which also translates into lower revenues for the units of territorial self-government budget. For this reason, the index's lowest values are recorded in the eastern part of the country, where agriculture plays an important role.

In 2010, LGU tax income per capita in the richest voivodeship in Poland (Mazowieckie - MZ), from a tax revenue point of view, accounted for 138% of similar income of LGU located in the poorest voivodeship (Podkarpackie - PD). In 2018, the difference decreased to 109%, indicating a certain reduction in the disparities between voivodeships in terms of LGU tax revenue. In the western part of Poland, much smaller spatial differences in LGU tax revenues are observed. In 2010–2018, the increase in LGU tax revenues per capita, measured by relative increase, ranged from 59% to 83% (Figure 2).

Significant differentiation of the increase in tax revenues in individual voivodeships has resulted, among other reasons, from the increase in these revenues of the share of



Source: own study based on GUS data.

Figure 2: Increase in LGU tax revenue per capita by voivodeship and its increase (%) in 2010–2018

PIT and CIT (which was particularly noticeable in 2015–2018). It should be noted that in the majority of municipalities with rural areas, the CIT is minimal while the PIT in typically agricultural communes is not decisive. Despite large increases in tax revenues, interregional differentiation is still significant in the eastern part of the country. The increase in tax revenue in the Eastern Poland provinces shows the limitation of the role of agriculture in their territory (in favour of the development of tourism, for example).

4.2 Expenditure of government sector institutions and LGU tax capacity by voivodeship

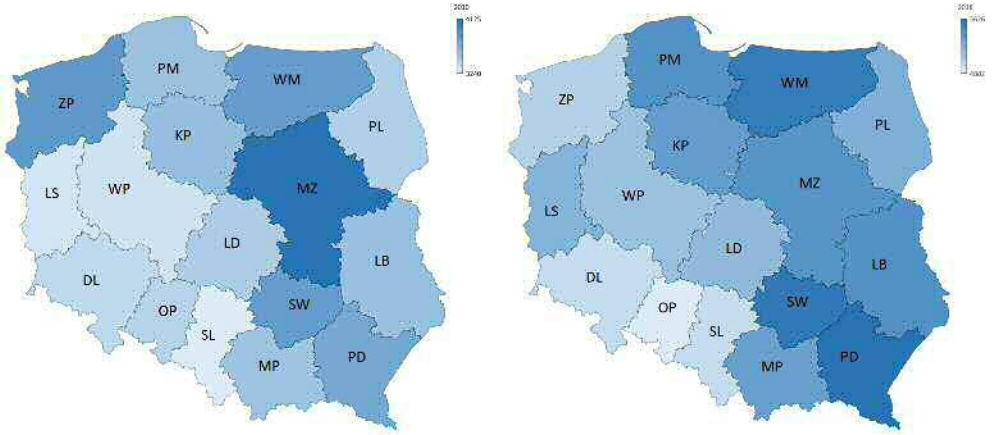
The diversified level of LGU tax revenues required a systematic increase in government expenditure by voivodeship. When analysing the relative increases in government expenditure, the lowest (below 40%) is noted in the Mazowieckie (MZ) voivodeship (Figure 3). The research showed that the differentiation of government expenditure in individual voivodeships was smaller than the differentiation of these voivodeships' tax revenues.

In 2010, the highest expenditure of government institutions was recorded in LGUs in the Mazowieckie (MZ) Voivodeship – the richest in terms of tax revenues per capita. In the following years, the expenditure policy of government sector institutions changed and, in 2018, the group of voivodeships with the highest share in government expenditure included: Podkarpackie (PD), Świętokrzyskie (SW) and Warmińsko-Mazurskie (WM). It is worth recalling that these were the voivodeships with the lowest tax revenues (per capita). Changes in the average level of government expenditure (by voivodeship) and the average level of LGU tax revenues (by voivodeship) in 2010–2018 are shown in Figure 4. The arrangement of points in the chart shows that if there is a relationship between the government sector expenditure by voivodeship and LGU tax revenues, this is weak.

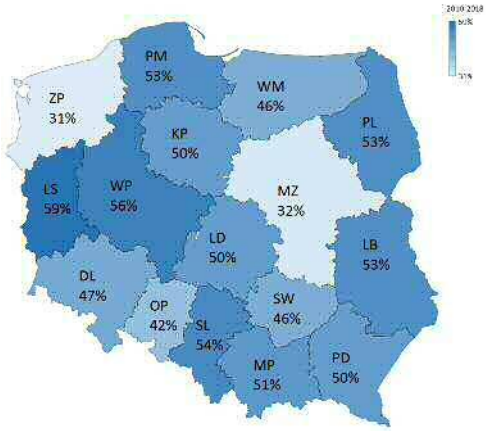
The correlation coefficients between government expenditure and LGU tax revenues in individual voivodeships for 2011–2018 were negative[3], but their values did not indicate a strong relationship (Table 3). It can even be said that in 2010 and 2011 there was no relationship between these variables. In the rest of the years, the relationship was weak, and only in 2013 was the absolute coefficient value higher than 0.5.

The negative correlation means that following the decline in LGU tax revenues in particular voivodeships, government expenditure in these regions increased. Generally, this is the right course of action and shows a weak relationship between government sector institutions' expenditure and LGU tax capacity across voivodeships. This means

[3]In 2010, the correlation coefficient was positive and amounted to 0.14.

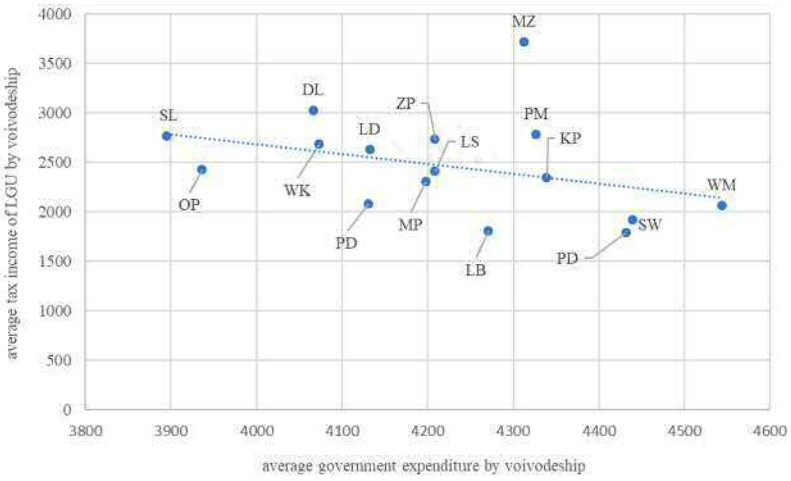


(a) 2010 (b) 2018



(c) 2010 to 2018 in %
Source: own study based on GUS data.

Figure 3: Government expenditure per capita by voivodeship and its increase (%) in 2010–2018, PLN



Source: own study.

Figure 4: Average government expenditure (in terms of voivodeship) versus average tax revenues of LGU (in terms of voivodeship) in 2010–2018 in Poland

Table 3: Correlation between government expenditure in the region and LGU tax revenues, per capita

2010	2011	2012	2013	2014	2015	2016	2017	2018
0.1431	-0.1394	-0.293	-0.5319	-0.4404	-0.3786	-0.4354	-0.3499	-0.4112

Source: Own study.

that support is provided to voivodeships with less favourable development conditions, which thus gain adequate resources to eliminate development barriers and stimulate sustainable growth. It is also consistent with the theory of welfare economics, where income disparities can be reduced not only through taxes but also transfers, so that the distribution of income is more even (Pigou 2010). The relatively low values of correlation coefficients between government expenditure and LGU tax revenues, also suggest the need to review the equalisation system and the allocation of public funds from the national level to LGU budgets currently in force in Poland. The level and direction of government expenditure by voivodeships as the primary mechanism of equalising social inequalities should take into account expenditure needs related to the implementation of public tasks in LGUs with low-income potential. In this context, however, it is necessary to take into account the scope of LGU tasks of different LGU levels and the adequacy of resources (tax revenues and other financial tools) at their disposal. This will help determine which of these tasks should be implemented solely with the use of an LGU's own resources, and which will require external support (including financing).

4.3 Allocation of national public funds versus social inequalities by voivodeships

The analysis of the coefficients of variation showed that the most extensive spread of expenditure by government institutions was in the area related to culture. Large dispersion of government spending across voivodeships also occurred in social protection, environmental protection and infrastructure. The smallest spatial differentiation of government expenditure was recorded in healthcare, education and science. The values of the coefficient of variation of expenditure in these areas of activity did not exceed 10%, indicating a slight differentiation in government institutions' expenditure across voivodeships. In the case of science and education, this decreased even more with time. Vs values reflect the spending policy applied in Poland. In areas where there are legally well-defined criteria for the redistribution of public (government) funds, the coefficient of variation is much lower than in areas where such rules are non-existent (Table 4). A good example is education, for which the government receives funds from the governmental sector as part of the so-called educational component of the general subsidy. The same is true for health protection. In other areas, where the detailed nature of the criteria for redistribution of funds is lesser or does not exist, the coefficient of variation increases. Culture is worth mentioning here. There are no criteria in Poland for allocating public funds to day-to-day activities of cultural institutions. The organizer is supposed to provide the resources needed to maintain and develop the cultural institution concerned, but there are no specific criteria for their allocation. In addition, variability is also influenced by the subsidizing of cultural events taking place in selected locations rather than in each province.

The Gini coefficient values calculated for individual areas varied (Table 5). It should be highlighted, however, that the comparison of its value in the extreme years of the period under consideration (2010 and 2018) shows that the inter-voivodeship inequalities in government institutions' expenditure in particular areas decreased slightly (except for the area of culture). This means that in the span of almost ten years, this improvement is symbolic. Simultaneously, it points to the individual nature of the support for a given area from national public funds. Lack of coordination in the areas supported by the government sector, and the support instruments and rules for their allocation, which have been operating on the same principles for many years, have not contributed to a significant improvement of the analysed inequalities. The smallest inequalities were

Table 4: Coefficient of variation (Vs) of expenditure of government institutions in individual voivodeships, by area, %

	2010	2011	2012	2013	2014	2015	2016	2017	2018
science and education	9.78	9.90	9.53	7.25	6.88	6.54	6.62	6.58	6.25
culture	124.16	145.28	136.15	131.47	127.90	130.32	125.64	138.62	142.94
infrastructure	35.97	33.89	44.93	37.89	29.98	29.74	33.11	32.85	34.48
healthcare	4.40	4.06	2.92	2.58	5.20	4.40	2.86	3.17	3.31
social protection	22.21	16.13	16.86	17.08	17.14	16.70	13.65	11.42	10.87
environmental protection	41.98	44.05	48.75	51.18	50.10	43.78	41.31	49.38	38.09

Source: own study based on GUS data.

Table 5: Gini coefficients by area

	science and education	culture	infrastructure	healthcare	social protection	environmental protection
2010	0.24	0.64	0.36	0.22	0.29	0.38
2018	0.23	0.65	0.32	0.21	0.25	0.36

Source: own study.

related to healthcare, while the largest to culture expenditure.

The research showed that the differentiation of the LGUs' social situation in the analysed areas, measured by BZW in 2018, did not change compared to the study's initial year. In 2018, the coefficient of variation of the development index was 22% compared to 21% in 2010 (Table 6). This proves the low effectiveness of expenditure by government sector institutions in reducing interregional social inequalities.

5 Discussion

The fiscal capacity of a local government unit corresponds to its ability to gain its own income in order to finance public services. As most public revenues come from taxes, this potential is often due to the LGU's ability to collect tax revenues. There are locally collected taxes, however, over which local governments have little or no control (Sorens 2011). This is the case in Poland, where municipalities have sole tax control to determine rates (within the upper rates indicated by the act) and grant reliefs or exemptions over few local taxes.

The level of Polish LGU tax capacity is hardly used to determine the allocation of funds to equalise the income of individual units and ensure adequate funds for the implementation of public tasks. Local policy activities differ basically across geographic space (Devees et al. 2003). The applied solutions do not consider factors of an endogenous nature, which strictly arise from the area's geographical location and history. This is confirmed by the diversified level of the tax revenue ratio of LGU budgets per capita in voivodeships. The indicator level noted in Western, North-Western and South-Western Poland was higher than that in eastern, north-eastern and south-eastern parts of the country. Much of this "division" is due to historical events (see more: Encyclopaedia Britannica 2020). Eastern regions do not have adequate scientific, technological or transport facilities (e.g. airports of international importance). Non-economic factors, neglected by conventional economic modelling, are of great importance in explaining fiscal decentralisation dynamics (Panizza 1999). Agriculture plays a vital role in these areas, and there are few metropolitan centres. This confirms Wong's argument (Wong 2004) that agricultural activity, and even its growth, does not positively impact on local authorities' tax capacity. In addition, rural areas are less likely than urban areas to

Table 6: The level of social inequalities in LGU

short	Voivodeship	BZW 2010	BZW 2018
DL	Dolnośląskie	0.312	0.409
KP	Kujawsko-Pomorskie	0.268	0.255
LB	Lubelskie	0.403	0.429
LS	Lubuskie	0.266	0.296
LD	Łódzkie	0.371	0.373
MP	Małopolskie	0.381	0.455
MZ	Mazowieckie	0.591	0.583
OP	Opolskie	0.283	0.314
PD	Podkarpackie	0.293	0.343
PL	Podlaskie	0.433	0.496
PM	Pomorskie	0.338	0.435
SL	Śląskie	0.349	0.378
SW	Świętokrzyskie	0.363	0.324
WM	Warmińsko-Mazurskie	0.311	0.279
WK	Wielkopolskie	0.344	0.347
ZP	Zachodniopomorskie	0.353	0.322
Average		0.354	0.377
Standard deviation		0.077	0.084
Vs		0.216	0.222

Source: own study.

undertake various economic development activities (Devees et al. 2003). Consequently, the low tax capacity of rural and urban-rural municipalities proves their weak tax base resulting from the economic profile and the tax system adopted in Poland, i.e. a large share of agriculture and a small income from PIT and CIT. This suggests that the level of regional authority and the degree of fiscal decentralization may exert an effect on the spatial distribution of income (Schneider 2003).

Significant differences in LGU tax capacity are also important from the point of view of expenses necessary to ensure a certain standard of public services. Thiessen (2003) points out that regional inequalities in infrastructure, education, healthcare and other public services may prevent the full use of production factors.

It should be stressed that the literature on the subject also includes views questioning the economic sense of transfers to rural or less urbanised regions, where the effects of the metropolitan area are absent (Boldrin, Canova 2001). The majority of representatives of the new economic geography trend claim that there is an intense conflict between economic efficiency and spatially equal distribution of income (Brakman et al. 2004).

The effectiveness of the applied fiscal tools differs from country to country, and therefore there is no universal model of successful fiscal policy in terms of reducing income differences (Paulus et al. 2009). In Poland, LGU tax capacity in terms of voivodeships is, to a small extent, compensated by government institutions' expenditure. Throughout the entire research period, the negative correlation coefficient remained practically within the range (–0.5; 0.2). The equalisation mechanisms applied in Poland differ in terms of the supported area or public services. Depending on the purpose of the equalisation mechanism (Martinez-Vazquez, Boex 1997), the subject of compensation in Poland is the income side and/or expenditure needs. The value of some transfers also depends on the number of inhabitants. Expenditure needs are determined on the basis of algorithms, using weights, taking into account factors such as tax revenues, population density, length of roads, number of schools and children in them, number of teachers, unemployment level and social welfare payments. The above method of financial support is present in Poland only in selected areas: healthcare, education and social assistance, and involves transfers of a vertical nature. In these areas, the Gini coefficient in Poland had the lowest values. Lack of optimal criteria for allocating public funds in the other areas examined by us indicates significantly higher Gini coefficient values. This is particularly evident

in Poland in the case of the Culture area. Significant cultural events that are financially supported, take place in large cities.

Regardless of the support methods used, the allocation of public funds of government institutions in the long term does not improve differentiation between voivodeships. The minimal changes in the value of the Gini coefficient indicate that the level of variation between LGU in terms of provinces is maintained rather than reduced.

The almost identically low value of the coefficient of variation in the level of LGUs' social situation over eight years indicates a minor role of government institutions' public expenditure in reducing inter-voivodeship differences. This confirms Shah's position (Shah 2007) that equalising transfers should refer to natural variation, not to cost differences reflecting deliberate decisions by local authorities, or to differences in the efficiency of using funds.

Ultimately, the conducted data analysis allows for positive verification of the hypothesis that government institutions' public expenditure across voivodeships in Poland shows low effectiveness in reducing inter-voivodeship social inequalities.

Fiscal decentralization in Poland did not take into account the disparities that had already taken place in the 1980s. The measures adopted for the vertical distribution of public funds were in no way adapted to the current economic and development conditions of the regions concerned. And as our research shows, the policy used in Poland to allocate and redistribute public funds, including government institutions, is not likely to be effective in this area. The case of Poland allows for the conclusion that in the case of Eastern European countries fiscal decentralization may not have a positive effect on improving inter-regional disparities as is the case in highly developed countries (cf. Gil Canaleta et al. 2004, Lessmann 2009, 2012, Rodríguez-Pose, Ezcurra 2011). On the contrary, it can increase disparities between regions. To a large extent, this impact will depend on historical factors and the model of decentralization adopted (mainly fiscal but also on competence-related and political ones) at the very beginning of the change process. Failure to take into account the state and development potential of individual regions in the distribution of public funds may result in an increase in inter-regional disparities. Especially, in the absence of a compensatory policy for the government sector.

Our results also have some implications for the European Union's regional policy. As the EU is striving to harmonise more and more decision-making processes in transnational institutions, supporting not countries but rather their poorest regions is the basis for convergence.

6 Summary

Inadequate mechanisms of allocating public funds are an important reason for the low efficiency of expenditure of government sector institutions in the analysed areas. The expenditures consider the size of LGU tax revenues to a small extent, without contributing to the improvement of inter-voivodeship differentiation, either in financial or social terms. As a consequence, fiscal decentralisation does not contribute to the improvement of inter-voivodeship social inequalities in Poland.

Regardless of the ongoing discussions on the amount of public funds that should be allocated to the local government sector (depending on the division of tasks performed) since 1990, Poland's tax revenue system is relatively stable. Despite meeting the basic conditions, however, the local government finance system is far from ideal. The disadvantages of the system in force in Poland are manifested primarily in the low share of LGU own revenues, neglecting justified differences in the costs of performing public tasks when shaping local government revenues, an unclear system of financing excessively complex commissioned tasks, the complicated structure of the general subsidy, limiting the possibilities of effectively equalising financial disproportions or discrepancies between the public tasks assigned to local governments, and the financial capacity to manage independently and effectively the performance of these tasks. The current public finances system is guilty not only of a lack of appropriate mechanisms stimulating comparable quality in public services. It also features regulations that objectively induce behaviour

that, although rational from the point of view of local governments' financial interests, leads to the ineffective use of public funds.

The construction of a correction and equalisation mechanism should be based on the principle of partial compensation of the gap between an entity's fiscal potential and the standard costs of performing public tasks assigned to the LGU. Lower level authorities should be able to cover most of the expenses from local government taxes and other forms of their own income (Blöchliger et al. 2016). This would bring the Polish transfer system closer to the concept of reducing the gap between normatively defined expenditure and income potential, as known from the literature.

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Sustainability of the community-based ecotourism development in the Aksu-Zhabagly nature reserve, Kazakhstan: An evaluation through local residents' perception

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Abstract. The development of community-based ecotourism (CBE) has the potential to preserve biodiversity and protect the environment, as well as play an important role in the socio-cultural, economic and politically sustainable development of the community. This paper assesses the implementation of CBE development and compares the sustainability of ecotourism development between the Zhabagly community and the Abaiyl community. The data is obtained mainly through the household questionnaire survey, field observations, in-depth interviews and focus group discussions. 222 representative families were surveyed with 5-point Likert scale questions in this paper including 166 Zhabagly and 56 Abaiyl participants. The study used 18 indicators based on 4 dimensions: environmental, socio-cultural, economic and political. Results from this analysis indicate that the sustainability of CBE development in two communities is slightly different in all 4 dimensions. Zhabagly community is more successful in achieving sustainable CBE development than the Abaiyl community. The results reveal that the overall evaluation of the two communities on sustainability is moderate. However, both communities demonstrate that, potentially, they are politically unsustainable. As a result, we initially assert that the sustainability of CBE development in the Aksu-Zhabagly nature reserve (NR) is far from perfect. In particular, the positive economic and political impact of tourism development is not obvious. To address this shortcoming, tourism development organizations need to jointly develop a design policy for the sustainable development of CBE.

Key words: Community, Ecotourism, Sustainable development, Nature reserve, Aksu-Zhabagly, Kazakhstan

1 Introduction

The Global Ecovillage Network developed local and community-based planning initiative guidelines to improve sustainability and develop community sustainability assessments (Schäfer et al. 2018). These guidelines act as a tool to compare the status quo of existing environmental, social, cultural and spiritual sustainability goals for existing villagers and rural communities. Indicators have been identified as ideal tools and/or metrics for

assessing and monitoring progress in sustainable development (Tsaur et al. 2006). The has been promoting the use of sustainable tourism indicators to measure sustainable tourism management as an important tool for decision-making (Mearns 2011). In order to improve the sustainability of the community-based ecotourism (CBE) sites, it is determined to use sustainable tourism indicators to test the effectiveness of tourism implementation (Tanguay et al. 2013).

CBE has tools for biodiversity and natural environmental protection, including the protection of cultural heritage, economic development and favorable government policies that empower the local community involvement in sustainable management to build sustainable community development. Environmental sustainability can also get help from sustainable ecotourism, which effectively manages the implementation practice and long-term maintenance of natural resource planning for future generations to use (Theingthae 2017). Ecotourism development will provide an opportunity to local people to support the sustainable use of culture and heritage sites. At the same time, revenues generated from culture and heritage sites will be used for conservation and maintenance (Theingthae 2017). Attracting a large number of tourists to ecotourism destinations while focusing on long-term maintenance of an area's unique environment can create economic benefits for the community development and contribute income to the local people (Gilmore et al. 2007). To achieve long-term success in community ecotourism development, the government must ensure local people's involvement in tourism development's decision-making and planning process. At the same time, the government should also pursue a policy of poverty reduction based on the sharing of benefits from community tourism management (Keovilay 2012).

This paper aims to assess the execution of CBE development in Aksu-Zhabagly nature reserve (NR) by comparing the sustainability of ecotourism development in the neighboring two communities (Zhabagly and Abaiyl settlements). The reason is that sustainable ecotourism development based on the aforementioned four dimensions of sustainable management will help to make it more profitable for the local community of Aksu-Zhabalgy NR.

2 Literature review

2.1 Community-based ecotourism development

It is universally recognized that community-based tourism initiatives reduce poverty by increasing incomes and providing rural communities with tools and education for long-term critical thinking and decision-making. CBE is a type of ecotourism that focuses on the development of local communities and allows local people to significantly control its development, management and participation, at the same time, part of the profit should be allocated to community development (Denman 2001, Wood 2002). CBE essentially helps protect biodiversity and wildlife and supports the idea that people living in natural areas should participate in decision-making about conservation strategies (Reimer, Walter 2013). CBE authorizes the host community to participate in the decision-making of ecotourism planning while considering the positive and negative impacts on the environment, social culture and economy (Kaplan 2015). CBE destinations bring potential benefits to individuals, communities and the entire country in terms of creating employment opportunities, foreign exchange earnings and improving the well-being of local residents (Mbaiwa 2003). Moreover, from a social point of view, nature-based ecotourism employs the local population and promotes the development of the regional economy, as well as assures the quality of life among the local population, preserves environmental values and provides quality services to tourists (Williams, Fennell 2002).

Development organizations see CBE as a potential source of economic development and poverty eradication, especially in rural areas with limited agricultural potential. For example, in the past decade, CBE in East Africa and Southern Africa has seen the strongest growth in the global market because of its positive economic impact on the people of the region, making it an essential industry (UNWTO 2001). CBE has increased local income and built the regional economy by protecting the local ecosystem and culture. However, only when the community sees the benefits of ecotourism development, and when the

development of ecotourism does not harm their environment and affect their main source of livelihood, will ecotourism get support among the local community (Alexander 2000, Walpole, Goodwin 2001, Salafsky et al. 2001). CBE and responsible tourism should be part of a sustainable development strategy. Environmental sustainability includes present generations' preservation of natural heritage and biodiversity, and the preservation of important environmental processes for future generations (Törn 2007). However, the CBE project has become a double-edged sword for realizing natural resource protection and improving the livelihoods of host communities (Spenceley, Snyman 2012). For example, for rural communities that use forests and other natural resources as their main source of livelihood, these natural resources are at risk of overexploitation (Mensah 2017).

2.2 Sustainability of community-based ecotourism development

Sustainable ecotourism is embodied by an approach to explore natural resources and unique cultures and traditions without harming natural and cultural resources. Ecotourism is considered as a tool for nature protection and sustainable development, so how to maintain the sustainable development of ecotourism has become an important issue. Ecotourism is a form of sustainable tourism based on natural resources and it mainly focuses on experiencing and learning about nature, landscape, flora, fauna and their habitats, as well as local cultural handicrafts (Dowling, Fennell 2003). Ecotourism is concentrated on activities such as restoration and conservation, community and sustainable tourism visits (Fennell, Weaver 2005). Sustainable ecotourism requires minimizing the consumption of natural resources and cultural heritage as tourist attractions, and it should aim to bring socio-economic benefits to the community, protect the environment and protect cultural traditions (Ok et al. 2011). The goal of ecotourism is to understand culture and history, not to change or destroy biodiversity and ecosystems (Cheia 2013). When promoting ecotourism to a community that solely depends on the extraction of natural resources, awareness raising and a practical implementation of sustainability is essential to gain community support (Ekwale 2014). In order to protect the environment and preserve biodiversity, it is necessary to involve all stakeholders in the implementation of ecotourism policy based on sustainable development (Kumara 2016). Sustainable community-based ecotourism development aims to understand residents' views on actual implementation based on sustainable practices (Theingthae 2017). In ensuring the sustainability of ecotourism products, it is necessary to pay attention to the safety of visitors, the quality and authenticity of service, while respecting cultural sensitivity and environmental protection (Pomering et al. 2009).

3 Case study description

3.1 Study area overview

Aksu-Zhabagly Reserve is Kazakhstan's second natural world heritage site, and it offers amazing and diverse landscapes from semi-deserts to snow-capped peaks. The Aksu-Zhabagly State Nature Reserve was established in 1926 and it is located in the north-west of Talas Alatau and the south of Karatau in the Western Tien-Shan. Aksu-Zhabagly was listed by UNESCO as a natural world heritage site in accordance with the criteria of (vii–To contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance) and (x–To contain the most important and significant natural habitats for in-situ conservation of biological diversity) on July 17, 2016 (whc.unesco.org, 2016). It is a unique wilderness experience where marmots, wild goats, lynxes, wolves, bears, argali and deer live. The wild tulips, the unique natural apples, and the snow leopards (which roam the high mountains of this area) in the Aksu-Zhabagly reserve spread its name all over the world (Akbar et al. 2021).

It is home to 48% of regional bird species, 72.5% of vertebrates, 221 out of 254 fungi species, 63 out of 80 moss species, 15 out of 64 vegetation types, and 114 out of 180 plant formations found in the Western Tien-Shan. Approximately 2500 insect species have been recorded in the reserve (Akbar, Yang 2021). Aksu-Zhabagly State Nature Reserve consists of three zones, it lies in Tulkibas district of Turkistan region and Jualy district of

Figure 1: Aksu-Zhabagly NR of Kazakhstan in the Western Tian-Shan.

Jambyl region of the Republic of Qazaqstan. The main part of the nature reserve (N42 16 34, E70 40 27) has a 131,704 ha property zone and a 25,800 ha buffer zone. The other two zones are Karabastau Sustainability 2020, 12, 143 5 of 18 paleontological areas (N42 56 24, E69 54 54) and Aulie paleontological area (N42 54 18, E70 00 00) with only property zones, 100 ha and 130 ha, respectively (Akbar et al. 2020). The Aksu-Zhabagly Biosphere Reserve is located in four districts of two oblasts in the most densely populated region of Kazakhstan with a total population of about three million people. Approximately 150,000 people live in the transition area of the Aksu-Zhabagly Biosphere Reserve. The main economic activities of neighboring settlements are agriculture, plant growing, and cattle breeding. In the last 10 years, ecological tourism has become highly popular in the reserve, mainly due to ornithological and botanical foreign tourism, and local recreational tourism (Akbar, Yang 2021). Aksu-Zhabagly NR has many tourist attractions, such as gorges, various landscapes and caves. For the development of ecotourism, 10 tourist routes have been developed which were funded by the Global Environment Facility (GEF) project. Along with natural sites, cultural heritage is also of interest for tourism. Medieval cities (Sharafkent and Isfidzhab), ancient mounds (50-60 km from Zhabagly), the sacred place – Baibarak spring and rock paintings – petroglyphs are part of the history of the region.

All the aforementioned facts underscore the diversity of the flora and fauna across the terrain of Western Tien-Shan. This region contains unique sites of upper Jurassic flora and fauna, which, undoubtedly, improves the value of biological and landscape diversification and strengthens the case for nature conservation.

3.2 Case study background

In our study, two neighboring communities (Zhabagly and Abaiyl) are selected that are considered to be the most affected by the development of ecotourism in Aksu-Zhabagly NR. As these two selected settlements are the closest to the reserve area, and the main roads leading to the reserve territory pass through these areas. Zhabagly and Abaiy settlements are electrified and they have good telephone and internet systems. The roads are mostly asphalted, but need repair.

Zhabagly community

Zhabagly village is an administrative unit of Tulkibas district. It includes the settlement of Zhabagly, Abaiyl, and Russian Railway 117. The total population of the Zhabagly village is 3,048 people, including 2,401 people of Zhabagly settlement, 545 people of

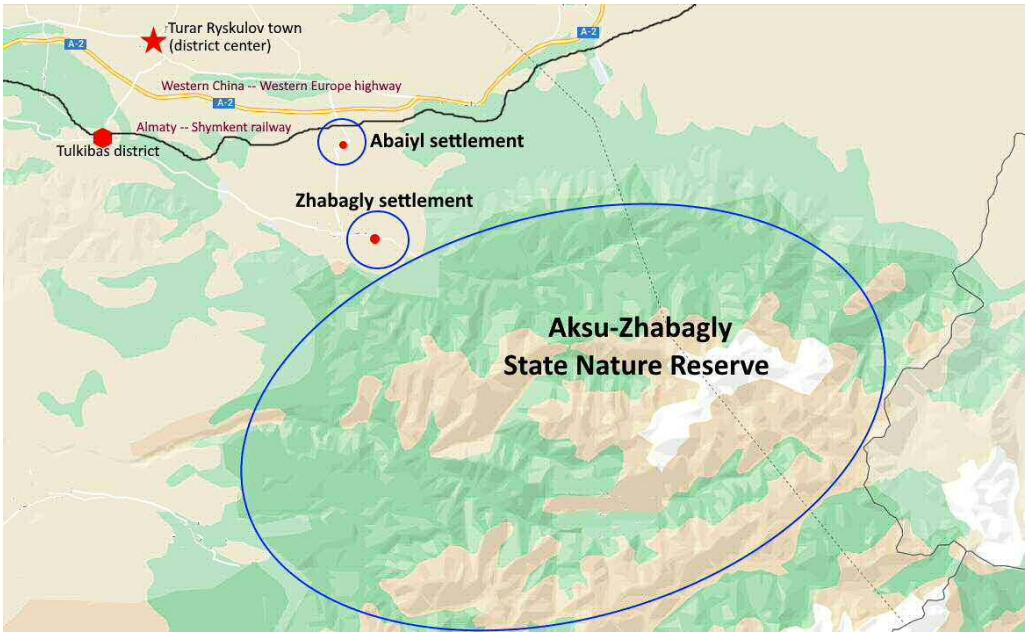

Figure 2: Zhabagly and Abaiyl community location.

Abaiyl settlement, and 102 people of settlement Russian Railway 117 (National Bureau of Statisttics 2019). Zhabagly settlement is 17 km South East of the town Turar Ryskulov (formerly Vannovka), the administrative center of Tulkibas district. Zhabagly settlement has a public transportation connection to the town of Turar Ryskulov and the city of Shymkent. Lying adjacent to the Western Tien-Shan Mountains, Zhabagly settlement is the gateway to Aksu-Zhabagly State Natural Reserve (Figure 2).

Most people from Zhabagly settlement are herders and farmers. The population size is larger compared with the two other nearby settlements, with a total of 2,401 people, of which the economically active population is 1,571 people; nearly all of them Kazakhs. There are 4 Shops, 14 limited liability companies and 4 industrial complexes in the village center. Zhabagly settlement has 4,612.7 ha of agricultural land, 1,755 ha non-irrigation land, 569 ha of irrigation land, 116.7 ha of meadowland and 2,172 ha of pastureland. There are 1,171 cows, 645 horses, 4,151 sheep and goats, and 5,757 poultry birds in the Zhabagly village center (National Bureau of Statisttics 2019). And there are mainly 4 tour operators' offices and guest houses in the village center, two of them are located on the gateway of the Aksu-Zhabagly world heritage site.

Abaiyl community

Abaiyl settlement is located between Zhabagly village center and Akbiik village of the Tulkibas district. Most people from this settlement have a stable job, including many railway workers. The population size is not large, with a total of 545 people, of which 275 are economically active, nearly all of them are Kazakh people. There are no big shops, limited liability companies and industrial complex in this settlement. In total, this settlement has 73 ha of agricultural land, 45 ha of non-irrigation land and 28 ha of irrigation land. The settlement of Abaiyl contains 246 cows, 46 horses, 554 sheep and goats, and 1,122 poultry birds (National Bureau of Statisttics 2019).

4 Data and methodology

4.1 Data collection and methodology

In this study a mainly quantitative research method was employed in data collection and analysis. A questionnaire survey was used to evaluate the sustainability of community-based ecotourism development in the Aksu-Zhabagly NR. The Aksu-Zhabagly NR was

selected because it has been identified as a more CBE developed area among nature reserves in Kazakhstan.

Our advance study area observation helps to effectively perform questionnaire surveys for the primary data analysis. Field research was conducted in a roughly 3 week-long visit to the Aksu-Zhabagly ecotourism destination from the 2nd of March to 22th of March, 2019, with respondents selected from the settlements of Zhabagly (166 people out of an economically active population of 1,571) and Abaiyl (56 people out of an economically active population of 275). Focus respondents were the key CBET stakeholders (local residents) including eco-tour guides, guesthouse owners, cooks, taxi drivers etc., who are representatives from both Zhabagly and Abaiyl settlements.

This study is based on quantitative research, a total 222 respondent participated in this study consisting of 156 local people in Zhabagly community and 56 from Abaiyl community. The questionnaire uses the five points of the Likert scale. The study used 18 indicators to measure progress toward improving the sustainability of CBE development in the case study. This was based on residents' perceptions of the implementation of sustainable ecotourism development: Environment (4 indicators), Socio-cultural (5 indicators), Economic (5 indicators) and Political (4 indicators). The data was analyzed using Microsoft Excel 2016. Descriptive statistics were used to summarize the mean score and weighted average values. The weight of the indicator was calculated by:

$$\text{Indicator weight}(w_{ij}) = \frac{\text{Mean score of each indicator}}{\text{Total indicators mean scores}} \times 100$$

To determine sustainability, weight score of indicators within three relationship aspects are found by:

$$y_{ij} = \frac{r_{ij} - 1}{m} w_{ij}$$

where y_{ij} is the weighted scores of the j-th indicator in the i-th aspect, r_{ij} is the mean score of the j-th indicator in the i-th aspect, and w_{ij} is the weight of j-th indicator in the i-th aspect, m explains the four intervals of sustainability barometer.

$$y_i = \sum_{j=1}^{k} y_{ij}$$

where y_i is the sum of weighted score for the i-th aspect; and k is the number of indicators included in the i-th aspect.

The study used the Barometer of Sustainability to determine gradations of sustainability (Ko 2005). And four interval scales of 1-100 were used, in which 1-25% was classified as "unsustainable (bad)", 26-50% was classified as "potentially unsustainable (poor)", 51-75% was classified as "potentially sustainable (good)" and 76- 100% was classified as "sustainable (excellent)".

Interval scales denoted the indicator mean score between 1 and 5, where 1.0-2.0 denoted unsustainability, 2.1-3.0 denoted potential unsustainability, 3.1-4.0 denoted potential sustainability and 4.1-5.0 denoted sustainability.

To determine the contribution to sustainability from a relationship aspect, the achievement scores were obtained by:

$$D_i = \frac{y_i}{w_i} \times 100\%$$

where w_i is the sum of weighted, y_i is weighted scores, and D_i is the i-th relationship aspect. Theingthae (2017) used this method in his study. His paper assesses the implementation of CBE and compares the sustainability of ecotourism development between the Tha Chat Chai Buddhist (TCCB) community and the Bang Rong Muslim (BRM) community. The results reveal that ecotourism sustainability varied greatly between two communities with empowerment and local community involvement in the implementation of CBE. However, both communities have the poorest possible sustainability rating on the economic dimension.

Table 1: Details of resident sample responses (n = 222)

Characteristics	Zhabagly (n=166) Percentage	Abaiyl (n=56) Percentage
Gender:		
Male	66.3	67.9
Female	33.7	32.1
Age (years):		
Young (18–34)	36.2	39.3
Middle age (35–54)	53	48.2
Elder ($\geq$ 55)	10.8	12.5
Ethnicity:		
Kazakh	91.6	92.8
Russian	4.8	3.6
Other	3.6	3.6
Education:		
Middle (school or college)	85.5	89.3
High (university or above)	14.5	10.7

4.2 Demographic characteristics of respondents

Table 1 shows that out of the 222 respondents, 166 were from the Zhabagly settlement and 56 were from the Abaiyl settlement. Since men generally go out to work in remote villages to earn money while women do housework and raise children, the number of men we interviewed is almost twice as large as that of women, with 66.3% (from Zhabagly) and 67.9% (from Abaiyl) respectively. The highest number of respondents was the middle-age group (35–54) with (53.0%) from Zhabagly and (48.2%) from Abaiyl respectively, followed by the young (18–34), with 36.2% (Zhabagly) and 39.3% (Abaiyl). And the lowest number of respondents was the elder group ($\geq$ 55), with (10.8%) from Zhabagly and (12.5%) from Abaiyl respectively. Nearly all respondents were Kazakhs: 91.6% from Zhabagly and 92.8% from Abaiyl were interviewed, respectively. At the same time, survey questions were answered by 4.8% people of Russian ethnicity and 3.6% other ethnic groups in Zhabagly and 3.6% Russian and 3.6% other ethnic groups in Abaiyl. Most respondents had the middle level (school or college) of education, with 85.5% of Zhabagly and 89.3% of Abaiyl while only 14.5% (Zhabagly) and 10.7% (Abaiyl) had received higher education (university or above).

5 Results

Sustainable tourism enables people to participate and benefit from it. Developing sustainable tourism activities can generate income for local residents and build community facilities. However, it is not only local people who will benefit from sustainable tourism resources, with the private sector also seeing benefits (Polnyotee, Thadaniti 2015). In order to achieve a sustainable development of tourism, tourism development should obtain a higher level of satisfaction or good perception from the local community. To measure the sustainable development of tourism types in a designated area, it is necessary to study how the community as a whole evaluates the area as a tourist destination. Therefore, we consider the following indicators to determine the sustainability of community-based ecotourism development in the Aksu-Jabagy NR. They are the four main components of sustainability principles, including the environmental, socio-cultural, economic and political dimensions. Based on the description and analysis of questionnaires, the results from the total assessment of implementation of sustainable ecotourism management is shown in Table 2.

Environmental dimensions

In the environmental dimensions of CBE development, it is commendable that Zhabagly community is achieving a higher level of compliance. The residents of Zhabagly community recorded the highest mean score on the "existence of flora and faunal biodiversity management plan" (4.52). Since the territory of Aksu-Zhabagly NR is state-owned land which the government controls and holds a monopoly on, including its natural resources, residents and enterprises can engage in activities permitted by law around natural public areas. The residents of Zhabagly community also recorded the highest mean score on "providing and development knowledge of local people in environment conservation" (4.27), reflecting the fact that the people living in Zhabagly settlement have participated in educational activities highlighting the importance of protected natural areas and environmental protection enforced by relevant governmental and non-governmental organizations.

Conversely, the residents of Abaiyl community recorded a medium mean score on the implementation of environmental sustainability dimensions. The lowest mean score recorded from Abaiyl community was on the "trained and development knowledge of local people in ecotourism management" (3.20). This is due to the fact that the majority of the population in this area is railway workers, who are on duty and do not often take part in the tourism development strategies in the reserve.

Socio-cultural dimensions

Overall, on a comparison of basic descriptive analysis, the Zhabagly community have a higher level of perception on the indicators of tourism's positive socio-cultural impact. For the residents of Zhabagly settlement, the perceived highest mean score is on "rehabilitation and conservation of local cultural and historical values" (4.18). At the same time, Zhabagly community also perceived relatively higher compliance with "existence and revival program of traditional clothing, music and dance" (3.89) and "recovery & implementation of local traditional rituals and festivals" (3.71) respectively. It can be seen from the Table 2 that the degree of compliance of the Abaiyl community in indicators of a socio-cultural dimension is moderate. The highest perception from the Abaiyl community is on "existence and revival program of traditional clothing, music and dance" (3.59).

Conversely, both the residents of Zhabagly and Abaiyl community perceived the lowest compliance with "implementation of quality infrastructure development" (Zhabagly=3.21 and Abaiyl=2.57 respectively), which indicated that the state of infrastructure development in Aksu-Zhabagly tourism destination is still at a lower level.

Economic dimensions

In relation to the economic dimensions, results showed that both communities are implementing with a moderate level of compliance. Residents of the two communities perceived the highest mean score for "provide locals with employment opportunities" (Zhabagly=3.68 and Abaiyl=3.51 respectively). And the lowest mean score in this dimension is on "promote the development of other economic sectors" (1.96), recorded by the community of Abaiyl. Because of longer distances from the core zone of the tourism destination, residents of the community of Abaiyl do not perceive a high degree of economic benefits from tourism (Figure 2).

At the same time, the views of both communities that tourism "increases local residents' household income" and "generates foreign exchange" are positive, with a mean score of greater than 3. However, they do not agree with the opinion that "tourism increases government tax revenue", one of the main reasons for this is that most of Kazakhstan's government budget comes just from the oil and gas sector, and tourism is not one of the priorities of economic development.

Political dimensions

Overall, the communities of Zhabagly and Abaiyl have a less positive perception relating to the political dimension. Accordingly, the mean score of "promote investment that

Table 2: Mean scores, weight, weighted score and ranking of indicators for sustainability of the CBE development in the implementation of each dimension accordingly

Dimensions		Indicators	Zhabagly community				Abaiyl community				
			Mean Score	Weight	Score	Rank	Mean Score	Weight	Weighted Score	Rank	p-value
Environmental	EN1	Providing and development knowledge of local people in environment conservation.	4.27	6.93	5.66	3	3.78	7.22	5.02	4	0.000
	EN2	Trained and development knowledge of local people in ecotourism management.	3.78	6.13	4.26	1	3.20	6.11	3.36	1	0.039
	EN3	Existence of management plans for geomorphological formations and soils.	4.05	6.57	5.01	2	3.38	6.46	3.84	2	0.002
	EN4	Existence of flora and faunal biodiversity management plan.	4.52	7.33	6.45	4	3.41	6.51	3.92	3	0.000
Socio-cultural	SO1	Rehabilitation and conservation of local cultural and historical values.	4.18	6.78	5.39	5	3.39	6.48	3.87	3	0.001
	SO2	Recovery & Implementation of local traditional rituals and festivals.	3.71	5.65	3.50	3	3.22	6.15	3.41	2	0.006
	SO3	Implementation of quality infrastructure development.	3.21	5.21	2.88	1	2.57	4.91	1.93	1	0.008
	SO4	Existence and Revival program of traditional clothing, music and dance.	3.89	6.31	4.56	4	3.59	6.86	4.44	5	0.000
	SO5	Convenience of access to tourist attraction and basic tourist facilities.	3.68	5.97	4.00	2	3.48	6.65	4.12	4	0.006
Economic	EC1	Increase local residents' household income.	3.38	5.48	3.26	1	3.27	6.25	3.55	4	0.009
	EC2	Provide locals with employment opportunities.	3.68	5.97	4.00	5	3.51	6.7	4.20	5	0.003
	EC3	Generate foreign exchange.	3.48	6.46	4.81	3	3.02	5.77	2.91	3	0.009
	EC4	Promote investment that support local development.	2.43	3.94	1.41	2	1.96	3.74	0.90	1	0.032
	EC5	Increase government tax revenue.	2.59	4.20	1.67	4	2.13	4.07	1.15	2	0.040
Political	PC1	Promote investment that support local development.	2.23	3.62	1.11	1	1.45	2.77	0.31	1	0.039
	PC2	Safety management for local people and tourist.	2.79	4.53	2.03	3	2.63	5.02	2.05	4	0.045
	PC3	Existence of strategies in promoting education and public awareness.	2.83	4.59	2.10	4	2.57	4.91	1.93	3	0.028
	PC4	Existence of strategies in poverty reduction through tourism development.	2.66	4.32	1.79	2	1.79	3.42	0.68	2	0.041

Notes: Statistically significant at $p < 0.05$.

supports local development from both communities" was low, with 2.23 for Zhabagly and 1.45 for Abaiyl. This reflects a perception that the government does not pay sufficient attention to attracting investment for the management of ecotourism activities. Moreover, residents of Abaiyl community recorded the lowest mean score for "strategies in poverty reduction through tourism development" (1.79), due to limited support for education and public awareness by relevant organizations.

The views of the two communities on "safety management for local people and tourists" are mostly the same, (Zhabagly=2.79 and Abaiyl=2.63 respectively). Although both communities rated the effectiveness negatively, they rated it relatively higher than other political dimensions. When conducting research in the study area, we also found that the authorities did not pay enough attention to providing financial support for the development of local souvenir shops, local gourmet restaurants, homestays and others projects that provide services to attract tourists.

6 Discussion

From the comparison of basic descriptive analysis, we found that there are differences in sustainability in the implementation of CBE development between the two communities (Figure 3). Although the Zhabagly and Abaiyl communities rated CBE development at the same level (potentially sustainable and potentially unsustainable) in two dimensions (socio-cultural and political), their assessments of the other two dimensions (environmental and economic) were different. If we compare the assessment of tourism sustainability of the two selected settlements on 4 indicators, the community of Zhabagly rated all indicators higher than the population of Abaiyl by approximately 10% . One of the main reasons for this is that the village of the Abaiyl settlement is located on the railway bank, far from the nature reserve compared to the Zhabagly settlement (Figure 2), so the people in Abaiyl do not associate themselves with the development of various industries (including tourism) in the reserve. They see themselves as heavily dependent on permanent employment and trade.

Zhabagly residents perceived the highest level of compliance (sustainable) in the environmental dimension with 79.31% while residents of the Abaiyl community believe that the environmental dimension is potentially sustainable with 61.37% (Table 3). This indicates that the development of ecotourism in Aksu-Zhabagly NR has achieved its goal to some extent because residents of Zhabagly settlement gave a comparatively high evaluation on the positive ecological impact of tourism development in the nature reserve.

As far as the assessment of the socio-cultural impact of tourism is concerned, Table 3 shows that the assessment of the residents of the two settlements was at a potentially sustainable level (Zhabagly=67.95 and Abaiyl=57.23 respectively). In a survey of local people, we found that with the development of tourism in the reserve, the local Kazakh people were happy to see the restoration of traditions that had disappeared during the Soviet era. And the demonstration of national traditions to tourists is mostly organized in the Zhabagly settlement.

According to the results of the community assessment of the economic impact of tourism, the village of Zhabagly rated the economic impact of tourism higher than that of Abaiyl. The people of Zhabagly settlement referred to this dimension as a potentially sustainable category with 58.17%, but the residents of Abaiyl classified it as a potentially unsustainable level with 47.91% (Table 3). Although Abaiyl settlement is not far from the nature reserve and the quality of paved roads from this settlement to the Aksu-Zhabagly tourist destination is sufficient, the people in Abaiyl settlement recognize the economic benefits of tourism development to a lesser extent than those in Zhabagly. One of the main reasons for this situation is that the government lacks effective policies to encourage them to participate in tourism. On the other hand, most of the people in Zhabagly are railway employees and seem to be satisfied with their current stable job.

In relation to the political dimension, residents of both settlements gave the lowest score in 4 dimensions. Both community's residents believe that the political dimension of ecotourism development is potentially unsustainable in the Aksu-Zhabagly NR (Table 3). This is because many issues exist in these two communities such as a lack of programs for

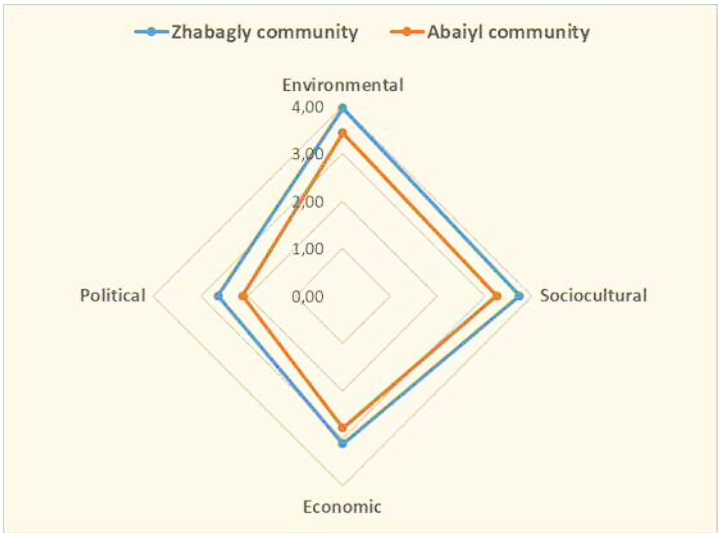

Figure 3: Implementation of CBE development in Aksu-Zhabagly NR.

Table 3: Sustainability achievement of Zhabagly and Abaiyl communities in inter-relationship aspects

Dimensions	Weight (Wi)	Weighted Scores (Yi)	Achievement Percentage (%)	Interpretation
		Zhabagly community		
Environmental	26.97	21.39	79.31	Sustainable (excellent)
Socio-cultural	29.92	20.33	67.95	Potentially sustainable (good)
Economic	26.06	15.16	58.17	Potentially sustainable (good)
Political	17.05	7.03	41.23	Potentially unsustainable (poor)
Total	*100.00*	*63.91*	*63.91*	Potentially sustainable (good)
		Abaiyl community		
Environmental	26.30	16.14	61.37	Potentially sustainable (good)
Socio-cultural	31.05	17.77	57.23	Potentially sustainable (good)
Economic	26.53	12.71	47.91	Potentially unsustainable (poor)
Political	16.12	4.97	30.83	Potentially unsustainable (poor)
Total	*100.00*	*51.59*	*51.59*	Potentially sustainable (good)

sustainable development investment partnership, and a lack of attention by the authority to support investment in local souvenir shops, local food restaurants, homestays and others services for attracting tourists.

Summarizing the above discussion, the assessments of the two main communities directly affected by tourism development in the nature reserve show that two (environmental and socio-cultural) of the four basic dimensions for measuring the sustainability of tourism are sustainable. This means that the development of ecotourism contributed to the protection of the ecology of Aksu-Zhabagly NR and the preservation of national culture and traditions of the local population. The overall result shown by both communities is potentially sustainable (Zhabagly=63.91 and Abaiyl=51.59). Conversely, according to the results in Table 3 we can say that the other two sustainability dimensions (economic and political) are rated as unsustainable. It is clear that the development of tourism in the nature reserve has not had a direct impact on improving the well-being of local people and reducing poverty in the surrounding community.

7 Conclusions

By investigating the views of neighboring communities on the ecological, socio-cultural, economic and political impact of tourism in the nature reserve, we assessed the sustainability

of community-based ecotourism in the Aksu-Zhabaly State Reserve in Kazakhstan. This process helps to conceptualize the socio-economic value of NR together with its positive environmental impact, to demonstrate its usefulness, and to promote knowledge that has practical policy implications in a variety of ways. At the same time, it provides innovative theoretical knowledge by combining relevant areas of NR tourism research and sustainable tourism development, and emphasizes the need to provide more empirical evidence on the issues studied through case studies.

The study concludes that the two main neighboring communities of the Aksu-Zhabagly tourist destination are dissatisfied with two dimensions (economic and political) of sustainable tourism development to some degree, which are the main driving forces for the development of local areas. Currently, few people see the economic benefits of the tourism industry, especially in the village of Abaiyl, which is relatively far from the reserve. At the same time, the government has not developed effective policies for the active involvement of the local population in tourism. In general, this shows that the sustainability of ecotourism in the Aksu-Zhabagly region is still low. In order to ensure best practices and a high level of CBE development, it is important to involve local people in sustainable ecotourism development initiatives. To improve the sustainability of community-based ecotourism in the Aksu-Zhabagly NR, the following recommendations are made: first, the relevant tourism management organizations should promote the positive economic influences of ecotourism development on local communities. The indicators relating to the economic dimension which have the lowest mean score are "promote the development of other economic sectors" and "increase government tax revenue". Marketing strategies, promotion, and collaborative organizations can improve community productivity and support local small businesses in achieving their goals in the process. In order to achieve long-term survival and an economic recovery of both communities, they must ensure a high degree of implementation of economic dimensions. Secondly, in both communities, relevant government units and community leaders should promote the implementation of the strategies involving "attract investments that support local development" and "poverty reduction through tourism development". For example, local communities' tourism relevance, participation rank and empowerment level should be improved.

There are a number of key limitations of this study to evaluate the status of the sustainability of ecotourism development by analyzing and discussing a limited number of indicators, such as ecological, socio-cultural, economic and political dimensions, and survey the local residents through quantitative analysis. Firstly they are not fully representative of the entire population of stakeholders in the Aksu-Zhabagly tourist destination. In addition, the empirical research is biased due to the use of a single case study, the research's duration and budgetary constraints. A single case study could give some new ideas or theoretical propositions, but may not be an effective basis for laying a general theoretical foundation. If a study is conducted by using this method among several communities from the point of view of all major stakeholders in the region, we hope that this method has the potential to serve as a theoretical basis for many other ecotourism development areas.

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Economic security of regions: A methodological approach to assessment, management, and legal regulation

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Abstract. At the present stage of development, one of the major problems of regions is ensuring their economic security. This requires the development of effective methodological approaches to assess economic security at the regional level by governing bodies, and the development of directions for regulating economic security at the local and state levels. The purpose of the article is to form methodological tools for assessing the economic security of regions based on the method of fuzzy modeling, to develop approaches to managing the economic security of a region by public authorities and local governments. The article has proposed and analyzed indicators for assessing the economic security of regions. The scientific novelty of the article is the use of fuzzy modeling to assess the economic security of regions. This method, unlike others, allows you to use fuzzy input data in simulation modeling and obtain output data that can be reduced to crisp values using defuzzification methods. The expediency of using fuzzy logic tools to assess economic security at the meso-level has been substantiated. The effectiveness of the practical application of the proposed approach has been tested based on assessing the economic security of the regions in Ukraine. The integral index of economic security has been modelled, together with its components: investment, innovation, financial, foreign economic, demographic, social security, and security of economic activity. For the demonstration of the practical application of the proposed methodological approach, the data of 10 regions of Ukraine has been analyzed and their economic security has been assessed. The directions of economic and legal regulation of the analyzed regions of Ukraine, which are characterized by crisis and low level of economic security and its components, have been offered.

Key words: economic security, fuzzy logic, legal regulation, management, method of fuzzy modeling, region

1 Introduction

The main goal of managing the economic security of regions is the formation of favorable socio-economic and institutional conditions for the implementation of economic interests of each of their entities and the region, maintaining their functioning and intensive

development, ensuring their economic independence and freedom, competitiveness, and sustainable economic condition in the long run. Economic security management is aimed at timely detection and elimination of threats that arise in the economic system of a region and create unfavorable conditions for the development of socio-economic processes at the micro-, macro- and meso-levels of the national economy (Granberg et al. 2008, Varnaliy et al. 2016, Onyshchenko, Bondarevska 2018). All this, in turn, threatens the well-being of every individual, causes an increase in costs and a decrease in income from the economic activity of enterprises, leads to a reduction in production and sales of products, reduces investment demand, and restricts economic development (Yapatake et al. 2018, Arkhipova, Kulikova 2020, Tiutiunyk et al. 2017).

Furthermore, the management process is aimed at the development of preventive measures and measures to counteract the negative impact of destabilizing factors, at maintaining the sustainability of regions and economic entities under the conditions of uncertainty, and forming a legal framework for economic security of the regions. It is the timely application of effective management mechanisms which ensures prompt adaptation to negative changes, overcoming risks and threats, and manageability of the economic system of the region in the process of further development (Varnaliy et al. 2016, Grigoreva, Garifova 2015). That is why it is important to find the most optimal tools for managing the economic security of regions, as well as opportunities to promptly respond to negative changes in the internal and external environment through economic and administrative measures.

To solve this problem, it is necessary to form new methodological approaches to assess the economic security of regions, which would allow its objective quantitative and qualitative analysis. This will identify weaknesses and strengths of regions in investment, innovation, financial, foreign economic, demographic, social security, as well as economic security. Also, it is necessary to develop managerial measures to counter the risks and threats that arise in the economic system of a region, and on their basis to make more effective management decisions in the field of economic security of regions at the state and local government levels.

2 Literature

Issues of ensuring economic security at the regional level have been the subject of research by many economists. The theoretical foundations of the essence and forms of economic security were laid by representatives of the classical school of political economy and marginalism (Smith 1776, Ricardo 1817, Mill 1848, Pareto 1906, Varnaliy et al. 2016). Western scholars have mainly seen economic security as a component of national security or as a set of favorable economic and institutional conditions in society, which can provide protection from internal and external threats in the economic system, reduction of economic risks, and maintaining standards and quality of life (Luciani 1988, Cable 1995, Marsh 2012). Later, representatives of this school expanded their approach and studied the global aspects of economic security, as well as factors influencing national economic security, problems of regional economic security, and security of companies and individuals (Glaser 1997, Kahler 2004, Makštutis 2006, Rupert 2007, Hacker et al. 2014, Tamošiūnienė, Munteanu 2015, Nam et al. 2016, Koudoumakis et al. 2019).

In post-Soviet economic science, the problems of economic security at the macro-, micro- and meso-levels have been studied in more detail (Granberg et al. 2008, Varnaliy et al. 2016, Kharazishvili 2019, Arkhipova, Kulikova 2020, Grigoreva, Garifova 2015, Iefimova et al. 2020, Chistnikova et al. 2017, Ivanova et al. 2021).

Accordingly, in the process of scientific analysis, the scientists have formed current ideas about the economic security of regions. In particular, the scientists substantiated the theoretical aspects of economic security and its components, and identified the conditions that need to be created in society to maintain it; they analyzed factors that ensure the sustainability of an economic system and its capability to withstand threats (Kharazishvili 2019, Varnaliy et al. 2016, Cable 1995, Wimbush, Tsereteli 2008, Yapatake et al. 2018). The application of a managerial approach to the analysis of these indicators allowed scientists to develop a mechanism of economic security at the meso-level (Chistnikova

et al. 2017), substantiate the institutional aspects of economic security and achieving sustainable economic development (Grigoreva, Garifova 2015), and identify the possibility of regional convergence on this basis to overcome the consequences of the economic crisis (Koudoumakis et al. 2019).

The authors' analysis of scientific achievements in this field shows that researchers have used various indicators that, from their point of view, characterize the economic security of the regions, and proposed various methodological approaches to its evaluation. In the process of analysis, the researchers used nationally approved methodological approaches and indicators to assess the level of economic security (Kharazishvili 2019), and proposed their own approaches to its analysis.

The generalization of the results of the analysis of previously published scientific works devoted to the assessment of the economic security of regions, allowed the authors to establish that these indicators include: the level and quality of life (Karpov et al. 2016); labor and non-labor incomes; the level of income differentiation (Duran 2015); employment and unemployment rates in the region (Kharazishvili 2019, Ovcharenko et al. 2021); the level of government and local government spending on public goods (Batabyal Amitrajeet 2018); domestic and foreign investment in the region (Novikova, Krasnikov 2010); consolidated index of innovative development of the region, which allows to identify areas (regions) with a critical, relatively stable, and medium level of economic security (Arkhipova, Kulikova 2020); socio-economic development (Ivanova 2018); indicators that characterize the environmental situation in the region (Tiutiunyk et al. 2017), and others. The weaknesses of the researchers' approaches are that they use metrics which are indicators of multiple components of economic security, only focus on assessing certain components of economic security and ignore others, and use too many metrics to evaluate.

That is why, at the present stage of the development of economic science, there has not been formed a single approach to the sample of metrics that would reflect the state of economic security. In our opinion, more objective results can only be obtained by generalizing the approaches of the researchers and by applying a systematic approach to the selection of metrics for assessing economic security.

On the other hand, scientists studied the methodology and principles of assessing the economic security of regions and compared the advantages and disadvantages of scientific approaches to its analysis (Granberg et al. 2008).

For instance, Onyshchenko, Bondarevska (2018) proposed to assess the economic security of regions based on monitoring and analyzing the key economic indicators and threats, by determining the threshold, critical, and acceptable values of the level of economic security and its components (Onyshchenko, Bondarevska 2018). The weak point of this method is that the threshold values of metrics are very difficult to determine, in particular, quantitative and critical parameters that would accurately reflect the approach of the metrics to a critical level and that would take into account the interests of the region.

Akberdina et al. (2017) substantiated the approach according to which an assessment of the economic security of the region is carried out based on analysis of production, social, environmental, financial, and innovation-investment indicators of the functioning of the sectors of the region, as well as the level of development of networking industries. The approach determines the level of economic security through the construction of a function that includes the above indicators, and time series characterizing changes in time of certain indicators (Akberdina et al. 2017). This approach requires processing too many metrics at the same time, which in our opinion complicates the analysis, since a large array of data is difficult to formalize and describe.

Chichkanov et al. (2020) applied a qualitative approach to assessing the economic security of a region by analyzing the factors influencing the development of industries in the region, such as historical, cultural, economic, and social factors, based on the method of expert estimates and further ranking of these factors (Chichkanov et al. 2020). However, in our opinion, the results obtained through the application of the expert assessment method are quite subjective and do not reflect a true picture of the region's development.

Chistnikova et al. (2017) proposed to assess economic security based on indicators of

threats, such as socio-demographic, economic, and investment threats, that exist in the region, and further on to identify the condition of the regional system as a normal, crisis, or critical one (Chistnikova et al. 2017). However, we believe that this approach only forms an idea of the negative factors that may affect the socio-economic development of the region, rather than assess the level of its economic security. Moreover, as a methodological basis, the researchers have chosen the threshold method that only answers the question of whether we have reached the threshold level or not, but does not allow for a quantitative assessment of the level of economic security.

Iefimova, Labartkava and Pashchenko assessed economic security through the method of normalized values and analysis of direct and reverse action factors, where the former contributes to an increase in the level of economic security, and the latter, reduces its level (Iefimova et al. 2020). The assessment was based on indicators of economic development and investment status of the regions, as well as demographic indicators. The weak point of this approach is that it does not consider such indicators as the income of regional entities, the level of their financial security, or the region's participation in foreign economic activity. Yet, it is these indicators that allow characterizing the level of security of each individual, enterprise, and region, to form an idea of the security of all participants in economic activity in the region.

Despite the achievements of the researchers in the field of methodology for assessing the economic security of regions, the proposed approaches have a number of weak points. This identifies the problem under study, i.e., the search for a more flexible, realistic, and therefore, more effective method of assessing the economic security of regions, which would avoid the above shortcomings.

The scientists have proven, and we agree, that economic-mathematical modeling is a productive methodological approach to assessing economic security (Cable 1995, Granberg et al. 2008, Kharazishvili 2019, Iefimova et al. 2020, Chichkanov et al. 2020, Onyshchenko, Bondarevska 2018). Thus, significant advances in assessing the level of economic security of regions were achieved by using the clustering method (Ivanova et al. 2020, 2021, Ovcharenko et al. 2021) and the nonlinear approach and the method of fuzzy logic, whose current methodological foundations were substantiated by Piegat (2001), Zelentsov, Korotka (2018). In view of this, the authors of this article in their previous research used the method of clustering to assess the economic security of regions. Based on the results obtained, we proposed an approach to identifying the cluster groups of regions as outsiders, leaders in the level of economic security, or having an average level of economic security (Ovcharenko et al. 2021). In our opinion, the previously obtained results can be enriched and become the basis for further research in this area, this time using the method of fuzzy logic.

For example, using the latter method, the researchers have proven that income differentiation produces a significant impact on the economic security of regions and on their labor potential (Duran 2015, Harmider et al. 2019), developed a methodology for integral analysis of the level of security of sustainable development in Ukraine (Kharazishvili 2019), built a model of an economic security management system (Feofilova et al. 2015), formed a model of sustainable development of the national economy due to an increase in the level of economic security (Nilashi et al. 2018), analyzed the conditions of uncertainty and their impact on the economic security of the country (Guseva et al. 2017), and the possibility of potential economic situations in these conditions (Voynarenko et al. 2021). However, scientists have not assessed the level of economic security using the fuzzy logic method. Therefore, the novelty of this article is the application of a new methodological approach to assessing economic security – fuzzy modeling.

The fuzzy modeling method has significant advantages over deterministic approaches in assessing the economic security of regions. First, this method allows fuzzy input data to be used in simulation and formalized through the mathematical apparatus of fuzzy set theory (Piegat 2001). In addition, fuzzy inference makes it possible to obtain output data that can be reduced to clear values using defuzzification methods.

The fuzzy logic method, compared to other methods, opens up opportunities to obtain fuzzy models that are closer to the real processes they describe, as well as more accurate and objective results in the process of assessing the level of economic security.

Table 1: Stages of assessing the level of economic security of regions

Stage	Description
1	Formation of a set of indicators that characterize the economic security of the region, their distribution by groups (input data of the system)
2	Formalization of fuzzy data using linguistic variables
3	Construction of a fuzzy rule base: description of linguistic variables using membership functions; formation of the rule base; determination of the required number of rules for an adequate description of the model; the choice of the defuzzification method for obtaining the value of the integral index of the economic security of a region (the output variable of the system)

Source: authors approach

This, in turn, is the basis for the formation of effective approaches to decision-making and economic security management by public authorities and local governments at the meso-level of the economy. Therefore, we consider the method of fuzzy logic to be the most promising for scientific analysis.

The purpose of the article is to form methodological tools for assessing the economic security of regions based on the method of fuzzy modeling, and to develop approaches for managing the economic security of a region by public authorities and local governments.

3 Data and methods

The fuzzy logic approach is proposed to assess the economic security of the regions. The application of the mathematical apparatus of fuzzy set theory (fuzzy logic, fuzzy inference, fuzzy modeling, etc.) allows solving problems, whose solution by traditional methods is ineffective or completely impossible due to limited information about the system or object of research (Piegat 2001). These systems operate under conditions of uncertainty, but describe the object of modeling more closely to the real one and require the use of fuzzy economic and mathematical models.

Given that the assessment of economic security of regions is based on the analysis of factors that affect it and which are often unclear and need to be formalized, in our opinion, the use of traditional approaches is not appropriate here. That is why, to assess the economic security of regions, we propose a methodological approach which is based on the fuzzy logic method and allows the research in statics and dynamics, analysis of quantitative and qualitative indicators, assessment of the overall level of economic security and of its individual components, and taking effective managerial decisions.

The algorithm for assessing the level of economic security of regions includes three stages (Table 1).

At the first stage, a set of indicators of economic security of a region is formed to be further used for the construction of an integral index as a basis for assessing the level of economic security.

The analysis of scientific publications on this issue, carried out by the authors, made it possible to establish that the major components of economic security of a region are the investment, innovation, financial, foreign trade, demographic, social security, and security of economic activity (Sukhorukov, Kharazishvili 2012, Denezhkina, Suzdaleva 2011, Chistnikova et al. 2017, Akberdina et al. 2017, and other authors). Based on the results of these studies, the authors of the article have worked out a set of indicators that characterize the economic security of the region, as well as its components. These indicators are further used by the authors to build an integral index as a basis for assessing the level of economic security (stage 1).

The indicators for assessing the components of economic security of the regions and their limiting values are presented by the authors in Tables 2 and 3. The limit values for the indicators in Table 3 are indicated according to the results of the studies and previous recommendations of the scientists (Sukhorukov, Kharazishvili 2012, Kalina, Savelyeva 2014, Karpov et al. 2016, Novikova, Krasnikov 2010, Illarionov 1998, Denezhkina, Suzdaleva

2011, Karpov, Korablevoy 2017, Makhanko et al. 2017, Ferova, Krot 2016, Kharazishvili, Liashenko 2019).

Table 2: Indicators (aggregated influencing factors) for assessing the economic security of a region

Name of indicator	symbol
Investment security	X_1
Innovation security	X_2
Financial security	X_3
Foreign trade security	X_4
Social security	X_5
Demographic security	X_6
Security of economic activity	X_7

Source: authors' approach

Table 3: Indicators (specific factors) for assessing the economic security of a region

Name of Indicator	Symbol	Limit value
Capital investment to GRP ratio for the relevant period	x_1	$25-30$
Indicator of innovation activity	x_2	≥ 2
Indicator of the region's financial security	x_3	≥ 50
Indicator of the region's exports to imports ratio	x_4	$2-5$
Share of imports in GRP	x_5	≥ 0.3
Unemployment rate	x_6	≥ 4
Share of the population with incomes below the subsistence level	x_7	≥ 7
Overall crime rate	x_8	≥ 0.016
Population income level	x_9	$5-6$
Depopulation rate	x_{10}	> 1
Population reproduction rate	x_{11}	> 2.3
Industrial production index	x_{12}	> 105
Agricultural production index	x_{13}	> 105
GRP volume ratio	x_{14}	$> 103-104$
GRP per capita by region to GRP per capita by country ratio	x_{15}	> 100
Level of the region's economy shadowing	x_{16}	< 50

Source: authors' approach

Investment security is a state of the investments being protected from internal and external threats, which allows preventing a decrease in their volume in conditions of an acceptable level of risk (Bobrovska et al. 2021). The share of capital investments in Gross Regional Product (GRP) is used to assess investment security. The level of investment security should be such as to ensure the growth of production of tangible and intangible goods in accordance with market needs and an efficient use of investment resources in the region, considering its natural, economic, socio-demographic, as well as scientific and technological factors (Hordiienko, Boiarko 2013).

The security of innovative development is determined by the region's capabilities for the production and introduction of innovations in all spheres of management, as well as for maintaining and developing its scientific and technical potential (Arkhipova, Kulikova 2020). To analyze the innovation component, the indicator of innovation activity is used, which is calculated as the ratio of scientific and technological development financing from all financing sources to GRP.

The financial security of the region is characterized by the capability to meet the region's needs with the revenues received and by the degree of dependence of the regional budget on the state one. The coefficient of the region's financial security is used for its assessment. This indicator is measured as the ratio of the amount of reverse subsidies to the regional budget to the amount of basic subsidies to the regional budget (Ovcharenko et al. 2021). Reverse subsidies are funds that the region transfers to the state budget

for the horizontal equalization of the tax potential of the territories. Basic subsidies are financial resources that are allocated from the general fund of the state budget to increase the fiscal capacity of local budgets (Ovcharenko et al. 2021). Basic subsidies cover the regional expenditures, primarily with tax revenues, which the local budget cannot provide at the expense of its own revenues.

The foreign trade security of the region shows the degree of openness of the region's economy, the capability of the regional enterprises to produce and sell competitive products in the international market (Grigoreva, Garifova 2015). This contributes to the socio-economic development of the region and raising the living standards of its population. The foreign trade security of the region is assessed using, first, the region's exports to imports ratio.

Social security is a component of economic security and is at the intersection of interests of an individual and the region (Karpov, Korablevoy 2017). This indicator characterizes the level of the population income, social instability and social unrest in the region, social attitudes and behaviour of the region's population, and includes the following indicators: unemployment rate, the share of the population with incomes below the subsistence level, the total crime rate, and the population income level – per capita income to the subsistence level ratio.

Demographic security characterizes the level of provision of the region with labor resources which is the most important type of economic resources and creates the basis for its economic development (Kharazishvili 2019, Ovcharenko et al. 2021). This indicator is formed, firstly, based on the depopulation rate, i.e., the ratio of the number of births to the number of deaths over a period, and secondly, the reproduction rate, i.e., the ratio of the number of children born per year to the average annual number of women in the region.

Security of economic activity in the region reflects the general state of socioeconomic development of the region (Sukhorukov, Kharazishvili 2012) and is characterized by the following indices: industrial production index, agricultural production index, GRP volume ratio, and the ratio of the region's GRP per capita to the country's GRP per capita. The latter index reflects the state of region's development relative to other regions in Ukraine, and characterizes the level of the economy shadowing.

Indicators $x_1, \dots x_{16}$ (private factors) were taken from the national (regional) statistical database. For the calculation of indicators of investment, innovation, financial, foreign trade, social, demographic security, and the safety of economic activity ($X_1, \dots X_7$), the fuzzy rule base was used, which was compiled according to the methodological approach described below by the authors.

In this article, statistical data from the regions of Ukraine, which have been calculated by the State Statistics Service of Ukraine, are used as input data for assessing the economic security of the region. To demonstrate the practical application of the proposed methodological approach, 2017 data from 10 of the 24 regions in Ukraine have been analyzed (in Ukraine, statistical information on regions is generated with a significant delay). In particular, R_1 – Vinnytsia region, R_2 – Dnipropetrovsk region, R_3 – Zhytomyr region, R_4 – Zaporizhia region, R_5 – Kyiv region, R_6 – Lviv region, R_7 – Odessa region, R_8 – Poltava region, R_9 – Kharkiv region, R_{10} – Chernihiv region. The input data used to analyze these regions are shown in the Table 4.

Analysis of the methodology for calculating the indicators selected by the authors for the study (Table 4) showed that in terms of statistics, these indicators are of fuzzy, blurred, or interval nature, as they fluctuate within certain limits. For example, the methodology for calculating the industrial production index is based on the use of data on changes in the production of certain types of industrial products (set of industrial goods) in the dynamics using the appropriate individual indices for each product. Accordingly, this indicator can be set by interval values. Thus, it is obvious that the other indicators selected by the authors for the analysis are vague and cannot be considered as point values. In this case, for modeling it is necessary to choose mathematical methods that can be used to analyze fuzzy sets, i.e., quantities that can vary within certain limits and which are not point, but fuzzy quantities. Therefore, when solving this class of problems, it is advisable to abandon the use of deterministic approaches and methods, because they

Table 4: Input data for assessing the economic security of regions

	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}
x_1	12.66	13.67	12.53	12.20	21.97	16.35	14.91	10.54	10.35	13.06
x_2	0.05	0.71	0.05	0.66	0.18	0.23	0.18	0.04	1.16	0.08
x_3	0.28	9.8	0.24	2.38	7.15	0.53	0.8	5.09	1.28	0.2
x_4	2.99	1.53	1.31	2.24	0.51	0.73	1.27	1.62	0.74	1.40
x_5	0.12	0.40	0.20	0.28	0.59	0.40	0.26	0.21	0.23	0.21
x_6	10.7	8.5	10.8	10.7	6.5	7.5	7.3	12	6.1	11.2
x_7	7.7	6.9	18.1	4.9	7.4	6.2	4.0	2.2	4.5	7.4
x_8	0.009	0.014	0.012	0.019	0.015	0.011	0.014	0.016	0.013	0.015
x_9	2.1	2.7	2.0	2.6	2.5	2.2	2.4	2.3	2.3	2.0
x_{10}	0.59	0.54	0.58	0.51	0.61	0.78	0.76	0.47	0.53	0.40
x_{11}	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.02	0.01
x_{12}	108	100	110	106	110	106	112	99	106	97
x_{13}	96	101	106	97	96	106	99	83	90	105
x_{14}	103	103	103	105	105	102	107	96	100	100
x_{15}	0.92	1.54	0.79	1.19	0.92	1.43	0.99	1.68	1.10	0.87
x_{16}	44.9	44.3	50.2	44.3	50.2	43.5	44.3	44.9	44.3	50.2

Source: State Statistics Service of Ukraine (Derzhavna sluzhba statystyky Ukrainy)

will not fully describe the process being modeled. In this case, we must work with fuzzy economic models (Diligenskij et al. 2004), which require methods of the mathematical apparatus of fuzzy set theory. Fuzzy modeling involves working with fuzzy quantities and their membership functions (Piegat 2001, Shtovba 2009, Zelentsov, Korotka 2018). The application of this method will allow working with fuzzy or blurred data, to perform simulation which is closest to the real described systems, and to avoid the shortcomings of deterministic approaches. That is why we consider the method of fuzzy modeling the most acceptable for the analysis of the output data of this kind.

In this study, fuzzy information is formalized through fuzzification operations. Mamdani-algorithm is used for fuzzy inference, which is based on the fuzzy knowledge base built in the work (Zheng-Hua 2006, Piegat 2001, Zelentsov, Korotka 2018, Harmider et al. 2019). The process of its implementation is described below.

Since the input factors are blurred, the output data on the assessment of the level of economic security of the region will also be characterized by fuzziness. Therefore, it is necessary to formalize all the information about the input and output data using the mathematical apparatus of fuzzy logic (second stage).

The output variable – the integral index of economic security of the region (I_b) – is calculated based on the values of the input indicators as (1):

$$I_b = R(X_1, X_2, X_3, X_4, X_5, X_6, X_7) \tag{1}$$

where I_b is a functional for assessing the economic security of the region, which depends on seven functions. On (2):

$$X_i = r_i(\bar{x}) \tag{2}$$

where X_i are aggregated influencing factors (in the graphical representation: the arcs of the graph, which come from non-terminal vertices) ($i = 1, \dots 7$); $r_i(\bar{x})$ are convolutions of factors; $\bar{x}$ are vectors of specific factors. The variables x_j are given in Table 3.

The above functions of the convolution of factors have the form: $X_1 = r_1(x_1)$ – investment security; $X_2 = r_2(x_2)$ – innovation security; $X_3 = r_3(x_3)$ – financial security; $X_4 = r_4(x_4, x_5)$ – foreign trade security; $X_5 = r_5(x_6, x_7, x_8, x_9)$ – social security; $X_6 = r_6(x_{10}, x_{11})$ – demographic security; $X_7 = r_7(x_{12}, x_{13}, x_{14}, x_{15}, x_{16})$ – security of economic activity.

Variables $x_j = [x_j^-; x_j^+]$, $j = 1, \dots 16$ are fuzzy values. Each of them varies in its respective range $[x_i^-; x_i^+]$. Obviously, the influential factors X_i will also be fuzzy sets, whose ranges of definition depend on specific factors. The functions r_i have no analytical task ($i = 1, \dots 7$), but it is possible to use expert estimates to construct them.

Formally fuzzy mathematical model for assessing the economic security of the region can be represented as (3):

$$\left.\begin{array}{l} X_1 = \{[x_1^-; x_1^+]\} \xrightarrow{r_1} \tilde{X}_1 \\ X_2 = \{[x_2^-; x_2^+]\} \xrightarrow{r_2} \tilde{X}_2 \\ X_3 = \{[x_3^-; x_3^+]\} \xrightarrow{r_3} \tilde{X}_3 \\ X_4 = \{[x_4^-; x_4^+]; [x_5^-; x_5^+]\} \xrightarrow{r_4} \tilde{X}_4 \\ X_5 = \{[x_6^-; x_6^+]; [x_7^-; x_7^+]; [x_8^-; x_8^+]; [x_9^-; x_9^+]; \} \xrightarrow{r_5} \tilde{X}_5 \\ X_6 = \{[x_{10}^-; x_{10}^+]; [x_{111}^-; x_{11}^+]\} \xrightarrow{r_6} \tilde{X}_6 \\ X_7 = \{[x_{12}^-; x_{12}^+]; [x_{13}^-; x_{13}^+]; [x_{14}^-; x_{14}^+]; [x_{15}^-; x_{15}^+]; [x_{16}^-; x_{16}^+]; \} \xrightarrow{r_7} \tilde{X}_7 \end{array}\right\} \xrightarrow{R} \tilde{I}, \quad (3)$$

where X_j $j = 1, \ldots 7$ are input fuzzy vectors of groups of coefficients; r_i are unknown laws that transform fuzzy sets of input vectors into sets of groups of fuzzy indicators ($\tilde{X}_j$); R is an unknown law that transforms sets of groups of fuzzy indicators into a fuzzy set for assessing the economic security of the region $\tilde{I}$.

At the third stage, it is necessary to quantitatively reproduce linguistic variables and their membership functions. To do this, we build a fuzzy knowledge base considering direct expert estimates, and choose an algorithm for fuzzy inference (Zheng-Hua 2006, Piegat 2001). After that, we carry on as follows: select the operation of blurring (fuzzification) of fuzzy sets; construct a fuzzy knowledge base that satisfies the conditions of completeness and / or linguistic and / or numerical completeness; select the relevant operation of fuzzy inference; select operations of defuzzification to reduce the variables, which have been received as a result of fuzzy derivation, into a crisp set; obtain the value of the membership function for a crisp result for the economic security of the region.

Since limits of variation of input data are known, it is proposed to formalize the fuzzy information about them using membership functions (MF). It is known that there are indirect (using statistics, pairwise comparisons, rankings, etc.) and direct approaches to their construction. When choosing a method, one should consider the difficulty obtaining expert information, its reliability, and the complexity of the algorithm for processing the information. The use of the direct method using expert data is relevant, since this method significantly reduces computational costs (Shtovba 2009, Piegat 2001). The number of term sets for the description of linguistic variables is also given, considering direct expert estimates.

In order to assess the linguistic indicators that characterize the economic security of the region, the authors propose the following scale for evaluation of indicators and their subsequent classification for the input data: C – crisis level; L – low level; M – medium level; AM – above medium level; H – high level.

Based on this, the following scale is used to assess the possible values of the output variable I_b: CS – crisis level of economic security of the region; LS – low level of economic security of the region; MS – the medium level of economic security of the region; AMS – above medium level of economic security of the region; HS – a high level of economic security of the region. Table 5 shows the quantitative characteristics of the limits of the terms of linguistic variables proposed by the authors.

To adequately describe the object of modeling, it is necessary to decide on a sufficient number of logical rules of a fuzzy knowledge base (FKB) (Zheng-Hua 2006, Piegat 2001). The quality of the fuzzy rule base (RB) determines how fully and adequately the modeling process will be carried out. When constructing the FKB, we take into account that: the properties of the rules can be of a local nature; the total number of rules is important; completeness of the model is important; consistency of the rule base, and RB connectivity are important.

If we leave five terms for each private variable x_1, $(i = 1, \ldots 16)$, it is obviously quite difficult (in fact impossible) to describe a fuzzy base $5^{16} = 1.5259 * 10^{11}$ and add terms for the output variable I_b. The situation looks much better when there is a grouping of factors (i.e., some hierarchy of rules), and the functional I_b is considered from a mathematical point of view. This will significantly reduce the number of rules, which can range from 72 to 75.

Table 5: Limits of terms for linguistic variables

	Input data				
	C	L	M	AM	H
X_1	0-12	8-21	18-32	28-42	38-50
X_2	0-3	1-5	3-9	7-16	14-25
X_3	0-0.58	0.42-0.83	0.67-1.08	1.17-1.58	1.42-2.0
X_4	0-1.2	0.8-2.3	1.8-3.2	2.8-4.2	3.8-5
X_5	0-2.2	1.6-4.7	3.8-6.2	5.8-8.2	7.8-10
X_6	0-2.2	1.6-4.7	3.8-6.2	5.8-8.2	7.8-10
X_7	0-55	45-105	100-125	115-165	160-200
	Output variable				
	CS	LS	MS	AMS	HS
Ib	0-2.2	1.8-4.2	3.8-6.2	5.8-8.2	7.8-10

Source: authors' approach

Table 6: Fragment of the fuzzy inference system for indicators

IF (x_4 = H & x_5 = M),	THEN X_4 = H
IF (x_6 = M & x_7 = H & x_8 = H & x_9 = M),	THEN X_5 = H
IF (x_{10} = M & x_{11} = M),	THEN X_6 = M
IF (x_{12} = M & x_{13} = H & x_{14} = H & x_{15} = H & x_{16} = AM),	THEN X_7 = H
IF (x_1 = H & x_2 = H & x_3 = H & X_4 = H & X_5 = H & X_6 = H & X_7 = H),	THEN R = AMS

The authors propose to consider not a linguistically complete but a numerically complete base of rules, when each crisp input state $(X_1^*, X_2^*, X_3^*, X_4^*, X_5^*, X_6^*, X_7^*)$ corresponds to the activation of at least one rule R^*. The latter approach allows a further reduction in the size of the rule base and adequate description of the modeled object.

The knowledge base was configured using expert a priori knowledge. For some variables, the number of terms has been reduced; various membership functions (trapezoidal or bell-shaped) and their parameters were selected.

Given that RB has about 100 rules, it is possible to make a mistake in their formation. The measurement of input and output data of the system was checked for unambiguity, when one input state $(X_1^*, X_2^*, X_3^*, X_4^*, X_5^*, X_6^*, X_7^*)$ can correspond to different output values of economic security of the region. The rules were tested for incompatibility and any of such happenings were excluded.

Mamdani-type inference was used as a fuzzy inference algorithm. To formalize fuzzy input information, membership functions of different types were used depending on expert estimates and the problem to be solved.

As a result, the fragment of the fuzzy inference system for indicators (private factors) that characterize the aggregated influencing factors (shown in Table 3) has the form shown in Table 6.

In fact, we have a hierarchical system of fuzzy inference, and accordingly, it is necessary to write a fuzzy knowledge base for aggregated factors, a fragment of which is given in Table 7.

Since the Mamdani fuzzy inference algorithm has been chosen, the logical minimum operation is taken as the implication, and the logical maximum operation is taken as the composition operation (Piegat 2001, Zelentsov, Korotka 2018, Korotka 2021). To obtain a crisp value from a fuzzy set, the centroid method (4) was used:

$$\mu(r) = \frac{\int_{\underline{u}}^{\overline{u}} u\mu_{\Sigma}(u)du}{\int_{\underline{u}}^{\overline{u}} \mu_{\Sigma}(u)du} \tag{4}$$

where μ_{Σ} is the membership function of the obtained fuzzy set as a result of implication

Table 7: Fragment of a fuzzy knowledge base for aggregated factors

Rule(1):	IF X_1="L" and X_2="C" and X_3="C" and X_4="M" and X_5="L" and X_6="C" and X_7="L",	THEN y="LS"
Rule(2):	IF X_1="L" and X_2="C" and X_3="C" and X_4="L" and X_5="C" and X_6="C" and X_7="C",	THEN y="CS"
Rule(3):	IF X_1="L" and X_2="C" and X_3="H" and X_4="L" and X_5="L" and X_6="C" and X_7="M",	THEN y="LS"
Rule(4):	IF X_1="AM" and X_2="AM" and X_3="AM" and X_4="AM" and X_5="AM" and X_6="AM" and X_7="AM",	THEN y="AMS"
Rule(5):	IF X_1="AM" and X_2="AM" and X_3="H" and X_4="H" and X_5="H" and X_6="H" and X_7="H",	THEN y="HS"
Rule(6):	IF X_1="H" and X_2="H" and X_3="H" and X_4="H" and X_5="H" and X_6="H" and X_7="M",	THEN y="HS"
Rule(7):	IF X_1="H" and X_2="H" and X_3="H" and X_4="H" and X_5="H" and X_6="M" and X_7="M",	THEN y="AMS"
Rule(8):	IF X_1="H" and X_2="H" and X_3="H" and X_4="M" and X_5="M" and X_6="M" and X_7="M",	THEN y="MS"
Rule(9):	IF X_1="H" and X_2="H" and X_3="M" and X_4="M" and X_5="M" and X_6="M" and X_7="M",	THEN y="MS"
...	...	...

and composition operations; $\underline{u}$ and $\overline{u}$ are, respectively, the left and right boundaries of this fuzzy set.

Software developed by one of the authors of this article (Korotka 2021) was used for fuzzy modeling and conducting numerical experiments with simulation models. The software implements the Mamdani fuzzy inference algorithm. The C++ programming language and the Visual Studio Community development environment were used (Korotka 2021).

4 Results and Analysis

The proposed methodological approach was used to assess the level of economic security of the regions in Ukraine. Table 8 presents the values of the output variables and the results of modeling the system for the selected ten regions.

The obtained results assert that the fuzzy information has been formalized, and the constructed knowledge base adequately describes the modeled process. The values of membership functions are close to 1 in almost all the experiments, which indicates a sufficient number of values of the linguistic variable of the functional for assessing the economic security of the region.

Graphical interpretation of the results of the study is presented in Figures 1 and 2. The results of the calculations show that the integral indices of economic security (I_b) correspond to the terms LS and CS, and thus to low (in regions R_1, R_2, R_4, R_5, R_6, R_7, R_8, R_9, R_{10}) and crisis (R_3) levels of economic security of the regions. The lowest indicators of I_b are in Zhytomyr (I_b R_3 = 1.8), Vinnytsia (I_b R_1 = 2.15) and Lviv (I_b R_6 = 2.56) regions (Table 8, Figure 1). Among the 10 regions of Ukraine under study, there are no regions that correspond to high and medium levels of economic security (Table 8, Figure 1). The results of calculations show that the obtained integral indices of economic security of the regions are low, though with varying degrees of differentiation: Dnipropetrovsk region – 3.6; Odessa region – 3.43; Chernihiv region 3.39.

The results of the analysis of the regions' economic security by its components (X_1, X_2, X_3, X_4, X_5, X_6, X_7) indicate that in all the regions under consideration, demographic security (X_6) is at a crisis level (Table 8, Figure 2). This situation is because Ukraine has a high level of depopulation (x_{10}) and a low level of labor reproduction (x_{11}). The population does not receive enough income to reproduce the labor force and new generations, the number of women of childbearing age is decreasing, and the mortality rate exceeds the birth rate. In addition, there is a tendency of outflow of labor abroad and declining birth rates.

Table 8: Results of economic security assessment

	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}
					Input data					
X_1	L	L	L	L	M	L	L	C	C	L
X_1	(13)	(14)	(13)	(12)	(22)	(16)	(15)	(11)	(10)	(13)
X_2	C	C	C	C	C	C	C	C	C	C
X_2	(0.05)	(0.72)	(0.05)	(0.66)	(0.18)	(0.23)	(0.18)	(0.04)	(1.16)	(0.08)
X_3	C	H	C	H	H	L	M	H	H	C
X_3	(0.28)	(2.0)	(0.24)	(2.0)	(2.00)	(0.53)	(0.80)	(2.00)	(2.0)	(0.20)
X_4	M	L	L	L	C	C	L	L	L	L
X_4	(2.6)	(1.53)	(1.3)	(2.1)	(0.9)	(1)	(1.28)	(1.4)	(2.2)	(1.4)
X_5	L	L	C	L	L	L	L	M	M	L
X_5	(2.2)	(2.7)	(1.9)	(3.7)	(2.6)	(2.6)	(2.7)	(4.1)	(4.3)	(2)
X_6	C	C	C	C	C	C	C	C	C	C
X_6	(0.6)	(0.54)	(0.58)	(0.51)	(0.61)	(0.78)	(0.76)	(0.47)	(0.53)	(0.4)
X_7	M	M	L	M	M	M	M	M	M	M
X_7	(100)	(105.1)	(87.2)	(108.4)	(106.2)	(110.1)	(106.6)	(105.1)	(107.3)	(99.7)
					Defuzzificated value (output variable):					
I_b	LS	LS	CS	LS	LS	LS	LS	LS	LS	LS
I_b	(2.15)	(3.6)	(1.8)	(3.84)	(3.66)	(2.56)	(3.43)	(3.55)	(3.69)	(3.39)

Source: authors' calculations

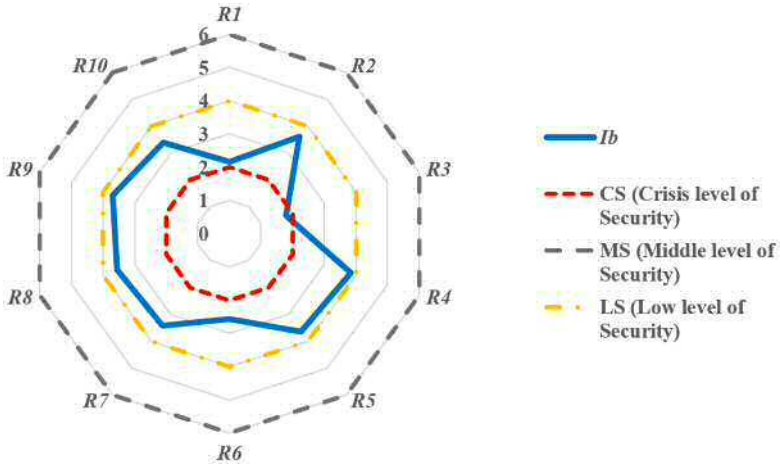
In our opinion, these negative tendencies directly affect the security of the social sphere of the regions (X_5). In the regions under study, there is a high level of unemployment (x_6) and crime (x_8), low income (x_9), and a high share of the population with income below the subsistence level (x_7). Only regions R_8 and R_9 show an average level of social security.

Furthermore, a similar situation is typical for indicator X_2: all regions, without exception, are characterized by a crisis level of innovation security (Table 8, Figure 2). In our opinion, this trend is due to low (in R_1, R_2, R_3, R_4) and crisis (in R_6, R_7, R_8, R_9, R_{10}) levels of investment security (X_1) in these regions. It was our analysis that showed that these regions are characterized by a low level of investment, which is associated with high risks for investing in Ukraine's economy under the economic and political crisis, unfavorable institutional conditions, and unstable regulatory framework in the field of investment and taxation. This causes low investment attractiveness of the regions and directly affects the level of innovation, which is insufficient to ensure the production of science-intensive and competitive products and modernization of fixed assets, as well as ensuring the proper functioning of enterprises in the regions.

Most regions are characterized by a high (R_2, R_4, R_5, R_8, R_9) and medium (R_7) level of financial security (X_3). Only the regions R_1, R_3, R_{10} show the crisis level of this indicator (Table 8, Figure 2). At the same time, there is a significant gap between the regions in terms of financial security. For example, the gap in x_3 is 10 times between Dnipropetrovsk and Chernihiv regions. This is due to the underdeveloped industrial potential in the regions R_{10}, R_1, R_3, R_7. Dnipropetrovsk region is the leader in terms of financial security (x_3), and Chernihiv region – an outsider in this regard.

At the same time, for all regions, except R_3, the level of economic security (X_7) is at the average level (Table 8, Figure 2). This tendency is due to the low level of x_{15} and the high level of x_{16} indicators in the R_3 region. In general, for the regions under study, the indicators of the industrial production index (x_{12}), the coefficient of GRP physical volume (x_{13}), and the ratio of per capita GRP by region to per capita GRP by country (x_{13}) correspond to the term M.

On the other hand, the studied regions are characterized by crisis (for R_5 and R_6) and low (for R_2, R_3, R_4, R_7, R_8, R_9, R_{10}) indicators of foreign trade security (X_4) (Table 8, Figure 2). The high level of the ratio of exports to imports (x_4), the share of imports in GRP (x_5) cause significant import dependence and negatively affect the level of economic



Source: authors' calculations

Figure 1: The level of economic security of the regions of Ukraine

security (X_7). This situation is associated with unfavorable economic and institutional conditions for economic activity in the regions, and low competitiveness of enterprises in the regions. This leads to a decrease in the industrial potential of the regions, reducing the share of small and medium-sized businesses, and insufficient level of development of the service sector and others. This contributes to the increase of x_5 and, accordingly, the import dependence of the regions, and, consequently, to the reduction of the level of foreign trade security of the regions.

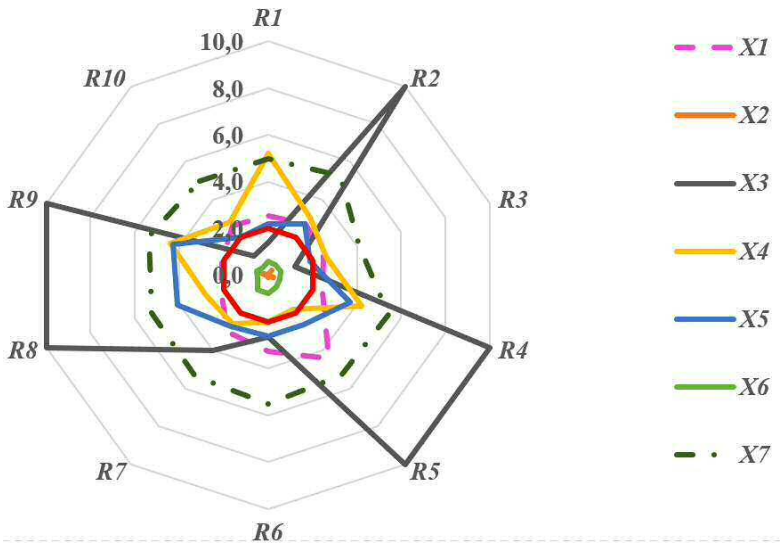
5 Conclusions

The results of numerical experiments allow us to draw the following conclusions. Firstly, fuzzy modeling is a powerful tool for describing complex nonlinear economic processes, such as the level of economic security. Secondly, this method makes it possible to operate with fuzzy / incomplete / blurred data which are difficult to formalize and which cannot be applied in accurate quantitative analysis and, as a result, their use is problematic in the implementation of deterministic approaches. Thirdly, the proposed fuzzy linguistic model of economic security describes the processes being modeled more transparently and closer to real situations.

The fuzzy model proposed by the authors is based on a Hierarchical Fuzzy Logic of Mamdani-type Fuzzy Inference System. This approach allows formalizing of all private factors and further working with aggregated influencing factors. In this work, a compact base of fuzzy rules has been formed, which is part of a numerically complete knowledge base.

The use of the level scale developed by the authors (Table 5), as well as the results obtained during the research, allowed the authors to conclude that the studied regions in Ukraine are characterized by uneven socio-economic development. According to this scale, these regions show high depopulation and unemployment, low investment and innovation activity, which has led to a critical state of demographic and innovation security in all regions, as well as low levels of investment and social protection in most regions. In addition, negative trends are observed in the area of foreign trade security. At the same time, five out of ten considered regions of Ukraine are characterized by a fairly high financial security.

The methodological approach proposed by the authors is quite flexible. However, a change in the number of input indicators, in our opinion, calls for the skills of a fuzzy system designer. During modeling, private indicators used in the formation of aggregated indicators can be redistributed by groups. This, however, will not significantly affect the process of obtaining the final results of the study, according to the authors, and will not reduce the significance of the proposed methodological approach.



Source: authors' calculations

Figure 2: Polygon of economic security of the regions of Ukraine

The results of the calculations indicate the need for taking managerial decisions by state and local governments in the regions that show crisis and low levels of economic security, and for measures to improve the situation. The capability of the region to ensure sustainable economic development, rational use of available economic resources, production of competitive goods, formation and use of innovation and investment opportunities, advance in research and technology, and maintaining the level and quality of life of the population lies not only in the plane of interests of the region itself, but also the interests of each person and society as a whole.

That is why economic security of each individual region and of the national economy as a whole will depend on the quality of managerial decisions at the level of state authorities and local self-governments. Given the current situation, in regions with crisis and low levels of investment, innovation, social, demographic, foreign trade, and economic security, there is a need to implement effective investment projects, which has to be done through public and private funding, introduce targeted programs of state support for these regions, form innovation clusters of regions to ensure the implementation of their economic potential, and create new workplaces and conditions for the development of services and entrepreneurship in these regions.

In addition, it is important to form a legal framework to support the development of the regions, which includes amendments to the legislation on decentralization, revision of the norms in the field of taxation and state regional policy, cooperation and association of territorial communities, delegation of powers to local governments, formation of effective models of financial support of the regions, and support of regional development.

This work is a contribution to the methodology of analysis and monitoring of economic security of regions, which consists of the application of a new methodological approach to its evaluation, namely, the method of fuzzy modeling. The use of the proposed approach will allow making more effective management decisions in the field of economic security of regions at the state and local government levels, identifying weaknesses and strengths of regions in the spheres of investment, innovation, financial, foreign economic, demographic, social security, and economic security. The results of the assessment of economic security of the regions in Ukraine, which were obtained by the authors, indicate the need for measures in the regions with crisis and low levels of economic security to reduce income shadowing, depopulation, unemployment, and crime, and to increase income and ensure its reproduction, stimulate investment, export orientation, and development of industrial production.

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Municipal amalgamations and local housing prices

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Abstract. In this paper, we examine the relationship between housing prices and municipal amalgamations. Due to consumer preference for access over amenity value, there is a spatial disparity of housing prices, reflecting the value of land in specific locations. According to Tiebout (1956) local amenity values will increase if the services of a municipality improve without a comparable rise in taxes or service fees, or if taxes or service fees decrease while the service level remains the same. The bid-rent curve is a framework frequently used to capture a presence of goods or bads such as amenities, disamenities, and externalities. Accordingly, the present study will be used to detect a possible social benefit or loss following amalgamations of municipalities. Macro panel data from Iceland will be used, representing several essential variables of the house market for 79 municipalities in Iceland during the period from 1992 through 2006. The research shows a significant positive relationship, ceteris paribus, between regional municipal amalgamations and local real prices of apartments.

Key words: Housing prices, amalgamation of municipalities, Hedonic price model, local government reforms, Fixed effect model

1 Introduction

Theoretically, municipal amalgamations should return lower average cost per capita due to economies of scale, but empirically the evidence is somewhat mixed. It is possible, however, that the return of a reform such as municipal amalgamation was either used to reduce local taxes, municipal service fees, or to improve municipal services. In all cases this should benefit the inhabitants and attract new residents from other regions that did not amalgamate simultaneously or carry out any reforms, according to Tiebout (1956). A recent study suggested, however, that this has not been the case in Iceland (Karlsson, Eythórsson 2019). An older study, based on Icelandic data, detected relatively weak evidence for lower average operational cost of municipalities following amalgamations (Karlsson 2015). Nevertheless, another study concerning Iceland concluded that the amalgamations have led to an improved service level in the relevant municipalities – at least in the most central urban community of a newly amalgamated municipality (Eythórsson, Karlsson 2018). But this study had some minor methodological drawbacks. It was based on a survey among the inhabitants of relatively few municipalities while Karlsson, Eythórsson (2019) included close to 40 amalgamations during a period of 20 years. Thus, the results are mixed for Iceland as well. Therefore, an alternative general

approach to investigate the social return of municipalities amalgamations to test the theory was one of the major objectives of the present study.

One way to address this problem is to investigate whether housing prices change following municipal amalgamations. One could use a spatial data sample of housing prices, and the analytical framework and theory of the bid-rent curve based on the theory by Johann Heinrich von Thünen to test the suggested relationship. Then, all relevant explanatory variables must be included in the model along with a variable or variables for amalgamations. This is the intention of the present paper and the objective is to test whether local housing prices correlate with municipal amalgamations.

This approach, which is sometimes called "method of revealed preferences" (Tietenberg, Lewis 2012), is methodologically robust since the model has been used in comparable terms; that is, to estimate potential externalities. If the answer is "yes", it suggests that municipal amalgamations have been successful and returned a detectable benefit such as better municipal services or lower local taxes or service fees. This method reveals costs as well since it is a hedonic price model. It is not, however, the purpose of the paper to define the benefit any further or divide it between those three possible channels. Here, the investigation will only focus on whether there is significant evidence for any benefits derived from previous municipal amalgamations in Iceland since the results of all earlier research has been mixed.

The paper is constructed in the following sequence: first, the research-question is addressed and the paper's topic introduced and rationale presented. The following section briefly analyses the background and structural environment of municipalities in Iceland. A literature review is then provided, with the model and data outlined in Section 3. The estimating results are presented in the Section 4 along with the discussion. Finally, the last section comprises the summary and concluding remarks.

2 Governmental structure in Iceland and the development of local government

The governmental structure in Iceland is a two-tier system, divided into a central government (the state) and local governments (the municipalities). Counties exist but not as administrative units; they serve as jurisdictions for Iceland's courts and police. Municipalities in Iceland have, however, established eight different regional federations, most of which were founded in the late 1960s. Even though almost all municipalities in Iceland participate in such federations, membership is voluntary and they serve as free organisations. The federations have no legal liabilities with regards to either municipalities or inhabitants, apart from their own regulations. This is why they do not have an identical structure, objectives or programmes – even though they have many factors in common such as the operation of regional development centres, running or supporting adult learning, marketing offices, and managing a regional development fund (i. uppbyggingarsjóður).

The main historical pattern structure indicates that the number of municipalities at just over 200 at the beginning of the 20th century, gradually increased until the middle of the century, reaching a peak of 229 municipalities, when agriculture began to lose its dominance to fisheries and the main flow of interregional migration was from farming to coastal communities. Accordingly, new hamlets, villages and towns developed, and in some cases the need arose for new municipalities. Their number decreased slowly after this, until after 1990 when the trend changed significantly. The rapid changes since 1990 were directly and indirectly facilitated by two referenda on municipal amalgamations – the first in 1993 and the second in 2005 – and their implications. Since 2018 the number of municipalities has been 69.

The number of municipalities never exceeded the 229 that existed in 1952. One municipality disappeared the following year when all the inhabitants moved away, reducing the number of municipalities from 229 to 228 (Figure 1). In 85 amalgamations, where 243 municipalities joined and some of them repeatedly, the number of municipalities fell to 69 in 2020 (Figure 1). There are 160 fewer in 2020 than in 1952. Amalgamations in Iceland have always been voluntary even though the central governments have sometimes

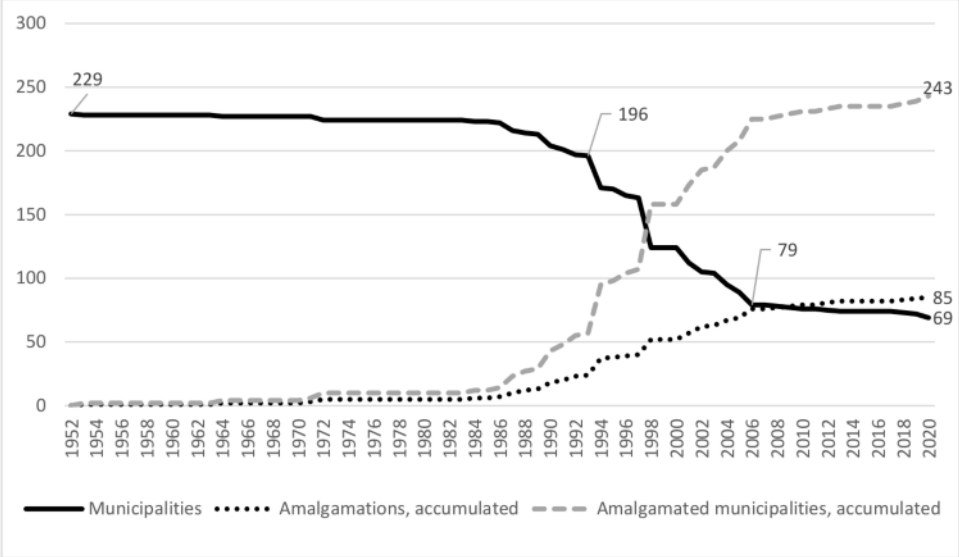

Figure 1: Number of municipalities in Iceland, amalgamations and amalgamated municipalities 1952-2020

offered motivation to amalgamate. Some minor restrictions have been set in law like a minimum of 50 municipal inhabitants in. These restrictions were abolished with the Local Government Act in 2011. According to the Act, no municipality can be amalgamated with another municipality until after a local referendum, whereby a majority of the participating voters vote for amalgamation. The current government policy is, however, to set the minimum number of municipal inhabitants at 250 by the elections in 2022 and at 1,000 by the elections in 2026. This particular issue was not completed due to massive resistance from especially the smaller municipalities.

From Figure 1, it becomes apparent that the most successful years of municipal amalgamations were 1994 and 1998 and the period from 2000-2006 when the number of municipalities dropped from 196 to 76. Fortunately, the present paper includes data from this period.

3 Literature review

3.1 Studies regarding the impact of municipal amalgamations

Earlier research and experience on the impact of municipal amalgamations, has focused on various aspects. When the economic consequences of costs and efficiency are investigated, the results point in different directions. The same applies to the impact on services. Tavares (2018) has collated such studies in a literature review in a recent article.

Looking specifically at the impact on economies of scale and costs as well as economic efficiency in this context, Tavares mentions several studies that have failed to find a significant lowering of expenditures as a result of municipal amalgamations in Denmark, Germany, Japan, and Canada (Blesse, Baskaran 2016, Blom-Hansen et al. 2014, Cobban 2017, Miyazaki 2018). Even Blesse, Roesel (2018) fail to find any evidence of cost saving or staff reductions in their studies of county amalgamations in Austria and Germany. In an Icelandic study, Karlsson (2015) did not find any clear evidence of cost savings connected to amalgamations. The results from Blom-Hansen et al. (2016) doing research on 9 policy areas are more mixed. They found that cost savings in some areas were offset by increases in others. In a study of 11 European countries by Steiner et al. (2016), however, the most important economic effect of amalgamations turned out to be cost savings. Blesse, Baskaran (2013) studied the impact of municipalities' amalgamations on their overhead cost, with the analysis divided between compulsory and voluntary amalga-

mations, and found less of an impact in the cases of voluntary compared to compulsory in the short run. In the long run the overhead costs increased in the cases of voluntary and kept on decreasing in cases of compulsory. This might create in readers an expectation regarding the results in the present study, since there have been only voluntary mergers in Iceland. Finally, a study by Reingewertz (2012) on municipalities in Israel is assessed, where there is evidence that municipal amalgamations have achieved economies of scale.

When the impact of amalgamations on services and service quality is reviewed, the evidence seems to be generally more positive. Tavares (2018) mentions both aspects. A study from the Netherlands by Allers, Geertsema (2016) shows no change in the quality of public services as a result of amalgamations. In a study from Denmark, the results from Krøtel et al. (2017) suggest that public management related to daily operations is not affected by size. Studies from Switzerland by Steiner (2003) and Steiner, Kaiser (2017) both conclude that performance quality of municipalities generally improves with amalgamations. In an Icelandic study by Eythórsson, Jóhannesson (2002), an improvement of municipal services was detected, however, only social services and primary schools were evaluated. In Eythórsson, Karlsson (2018), Icelandic local leaders generally evaluate the impact of amalgamations on services as being rather positive, but it turned out that service quality did not seem to be equal in different parts of the amalgamated municipalities. The centre-periphery divergence was apparent.

3.2 Studies regarding the bid-rent curve on local amenities

Local amenities affect the attractiveness of communities and thus generate interregional migration when they change. This was first pointed out by Tiebout (1956) when he focused on the services of local government as an example. Later, the concept of amenities was extended and now covers a wide variety of phenomena such as climate and beautiful nature (Graves 1979, Roback 1982) or pollution and crimes (Blomquist et al. 1988). Interregional migration affects housing prices so the value of amenities can be detected through the housing market.

A large number of studies have utilized housing prices to detect some local amenities or dis-amenities, a method called revealed preferences (Tietenberg, Lewis 2012) as noted earlier. There are examples of estimating the value of a new transportation network, or access to similar additional transportation possibilities (Bae et al. 2003, Bowes, Ihlanfeldt 2001, Gibbons, Machin 2005, Wen et al. 2018). Another study focused on assessing school quality, recreational opportunities, and crime rate (Haurin, Brasington 1996) and yet others suggested that geographical disparity in housing prices reflects, inter alia, differences in demographic variables, new constructions, proximity to downtown, manufacturing employment, and aggregate school enrollment (Case, Mayer 1996).

Kiel, Zabel (1996) used the model to detect any potential racial effects, or, as they say themselves "housing market discrimination and prejudice". The study included three cities in the USA. Evidence for increasing discrimination in Philadelphia and Denver was among the results, while this appeared to be decreasing in Chicago. The data sample was the American Housing Survey in the period 1978-1991.

Examples of other negative amenities (or dis-amenities) such as the impact of the presence of an incinerator, or of natural disasters (Cobián Álvarez, Resosudarmo 2019), on housing prices was analysed by a hedonic price method (Kiel, McClain 1995a,b). Another was used for positive amenities such as an urban forest (Tyrvainen, Miettinen 2000), or the presence of nature in general terms (Gibbons et al. 2014). This can be linked to the concept of capitalization – a capitalization of public services into apartment prices. One of the essential conditions for full capitalization of this kind is the homogeneous preferences of households regarding amenities (Hilber 2011). The demand for amenities appears to be heterogeneous across municipalities in Iceland, but there is no evidence aross households within municipalities. On the contrary, there is some evidence for Tiebout's hypothesis (Tiebout 1956) regarding natural resource amenities, tranquility, and many types of public services (Karlsson 2021). Accordingly, consumer mobility has generated a heterogeneous external mixture of communities with a relatively homogeneous mixture of consumers within each community. According to Oates (1999) local fiscal differences should therefore be capitalized into apartment prices.

Several examples of the implementation of a hedonic price model in the case of local amenities or dis-amenities have been assessed. If an amalgamation of municipalities is successful it would generate flexibility in their operations; either by lowering taxes or increasing or improving services. Since the latter relates to amenities and the former real household income, both must increase local housing prices. Therefore, a hedonic price model is the appropriate method for the present analysis. It would capture any social benefit following a municipal amalgamation, detected by the local population, regardless of how its returns are spent.

4 The model

The standard model for analysing the spatial disparity of housing prices is based on the theory of Johann Heinrich von Thünen, often called the bid-rent curve, where the housing price, ψ, is a function of household income, Y, travel cost, $T(r)$, distance or travel time, r, to the nearest central business district (CBD), consumption of land, s, and other goods, z (Fujita 1989, pp. 14-16).

$$\psi(r,u) = \max_{z,s} \left\{ \frac{Y - T(r) - z}{s} \;\middle|\; U(z,s) = u \right\} \tag{1}$$

Many extensions of the model have been developed and the hedonic price model is one of them, being the most frequent approach in analysing the spatial disparity of housing prices within the economic literature (Archer et al. 1996, Cobián Álvarez, Resosudarmo 2019, Cunningham 2006, Gibbons, Machin 2005, Gibbons et al. 2014, Haurin, Brasington 1996, Kiel, Zabel 1996, McMillen 2003, Plaut, Plaut 1998, Tyrvainen, Miettinen 2000, Wen et al. 2018). The standard hedonic price model includes housing and lot characteristics (Cunningham 2006, Tyrvainen, Miettinen 2000). Accordingly, special explanatory variables are added to the standard model which captures the house or apartment characteristics, such as house age, size of garden, number of rooms, building material, and the location's amenity values. Other alternative approaches are the standard repeat sales (McMillen 2003, p. 290) approach and the Fourier repeat sales approach (McMillen 2003, p. 291). The standard repeat sales approach is similar to the hedonic model, but includes only the data of houses which have been sold more than once in the relevant period (Kiel, McClain 1995a, McMillen 2003) and the difference is calculated for each house in order to capture the appreciation in its price. According to McMillen (2003) the repeat sales approach was developed to avoid missing variable biases which tend to fluctuate over time, but it has disadvantages too, since it reduces the available data sample and can create a sample selection bias, as argued by Kiel, McClain (1995a). There are studies of pure hedonic price approaches, such as Cunningham (2006), Eshet et al. (2007), Kong et al. (2007), Haurin, Brasington (1996), Kiel, Zabel (1996), and others of the pure repeat sales model, such as Archer et al. (1996). There are also studies of mixed hedonic and repeat sales model approaches, such as Gibbons, Machin (2005), McMillen (2003), and Kiel, McClain (1995a). The approach of this paper will be that of a pure hedonic model.

The empirical model is based on von Thünen's theory of land rent, extended by Alonso (1964), Mills, Hamilton (1972), Muth (1969), and Evans (1973) to the house market, as noted earlier. Since distance between localities is the essence of this theory, its model becomes an appropriate tool in this paper since one of the explanatory variables of spatial disparity of local real price of apartments is investigated. A theoretical derivation of this model is included in the Appendix of an earlier study (Karlsson 2011). According to Fujita (1989) and Kiel, McClain (1995b), the general context from the basic model can be derived through a log linear utility function into an equation of the following form:

$$h(r) = Ae^{-br} \tag{2}$$

where h is the land value, r is the distance between the land location and the CBD, and A and b are positive constants. Since the present paper follows the work of Karlsson (2011) the empirical model becomes:

$$\ln(h_{it}) = \alpha_i + r_{it}\beta_1 + x'_{it}\beta_2 + d'_{it}\beta_3 + \epsilon_{it} \quad (3)$$

where the natural logarithm of housing price, h, is dependent on the distance, r, to the capital area, or CBD, several other explanatory variables, x', dummy variables, d', and relevant residuals, ϵ, of every municipality, i, in every single period, t. Age, size, some other design characteristics of the relevant house buildings, and municipal amalgamations are other explanatory variables. Household income is not needed as suggested by Yinger (2015) where he argued that income-related amenities, amongst others, are not appropriate in an envelope function such as the hedonic price function. The variables for municipal amalgamations are count variables. Unfortunately, limitations of the data prevented any possible estimation of the compensated good, z, lot size, s, and mortgage interest rates.

The current model is based on earlier work by Karlsson (2011) and his data sample, designed for estimating the impact of transportation improvements on housing prices. A polycentric version of the bid-rent model was then constructed, suggesting that there were two levels of CBDs in Iceland. This is why four variables for travel time are included: Two to Reykjavík, one to Akureyri, and one dummy variable (see Table 2). Akureyri is defined as a second level CBD and therefore the travel times between Akureyri and all municipalities closer to Akureyri than Reykjavík were calculated and constructed as an explanatory variable, s. In order to preserve the observations all municipalities closer to Reykjavík than Akureyri were allocated zero as a value in s. Another explanatory variable, u, was constructed for all other municipalities which captured their travel time to Reykjavík. The third explanatory variable, v, was constructed for all municipalities closer to Akureyri than Reykjavík. This contained the additional travel time for them to Reykjavík because Reykjavík is the top level CBD. Finally, a dummy variable was constructed; that is, 1 for all municipalities closer to Reykjavík than Akureyri. It was only for practical, technical and statistical purposes that zero values were cancelled out as irrelevant in the other three travel time variables. Further discussion regarding the matter is provided by Karlsson (2011, p. 231).

Year dummies, y, were included in the model to capture any macroeconomic impacts on housing prices, such as economic growth, interest rates and other possible macroeconomic variables.

$$\ln(h_{it}) = \alpha_i + s_{it}\beta_1 + s^2_{it}\beta_2 + u_{it}\beta_3 + u^2_{it}\beta_4 + v_{it}\beta_5 + x'_{it}\beta_6 + d_{it}\beta_7 + m_{it}\beta_8 + y_{it}\beta_9 + \epsilon_{it} \quad (4)$$

A vector of hedonic variables is denoted as x'_{it}; these are housing age, apartment size, number of apartments in each house, the floor number, number of rooms per apartment, building material (out-walls), balconies, and parking spots and garages. The approach of the present paper, as suggested earlier, is to estimate a hedonic price model against housing price, where the most significant explanatory variables are included alongside an explanatory variable for municipality merger, m, and to investigate its impact on housing prices. If it is significant and positive this suggests that a municipal amalgamation is returning a local social benefit. All mergers in the relevant period were included apart from the smallest example because of the inefficiency of its housing market.

5 Data

The main independent variables of the present study reflect the amalgamation of municipalities. These are count variables for the amalgamation of municipalities, based on information gathered from the Icelandic Association of Local Authorities. Count variables were chosen to address amalgamations instead of a dummy variable because some of our present municipalities have experienced several amalgamations.

In one version of the model the amalgamations were classified with respect to the number of amalgamated municipalities in one merger and whether the municipalities in each merger were similar or different in terms of population. If the population of the municipalities that joined a merger counted both hundreds and thousands of inhabitants,

Table 1: Varying number of municipal amalgamations

	number of amalgamations								
	similar				different				
Year	2	3	4	> 5	2	3	4	> 5	Total
1992	2								2
1993	1								1
1994					5	3	2	1	11
1995									0
1996								1	1
1997						1			1
1998					2	2	2	3	9
1999									0
2000									0
2001			1	1	1				3
2002	1	1			2	1			5
2003	1								1
2004			1		1	1			3
2005							1		1
2006	1				3		1		5
Total	6	1	2	1	14	8	6	5	43

this was assumed to be an amalgamation of different municipalities. The most common amalgamations were among two and three different municipalities (Table 1).

In order to improve the data sample, all municipalities smaller than 500 inhabitants were discarded. This is because the housing market is least efficient in the smallest communities. Moreover, most of the smallest communities do not include urban centers. This reduced the number of amalgamations from the database. Accordingly, the number of amalgamations was reduced from 39 in the period 1995-2006 and 52 in 1992-2006 (Karlsson, Eythórsson 2019, p. 52) to 29 and 43 respectively (Table 1).

Other data of the present study comes from Iceland, a relatively large European country with a small population. Iceland is divided into 79 municipalities in this paper for the entire period; the number of municipalities in 2006. Accordingly, the data for all years was constructed as annual sums or averages for all the amalgamated municipalities as they were formed after all amalgamations in the year 2006[1]. The explanatory variables included in Equation (3) are drawn from various sources, including the Commissioner of Inland Revenue, Statistics Iceland, and the Icelandic Road Administration. Information on housing price, age and other relevant particulars was obtained from the Iceland Property Registry.

Data on travel time is based on road distance and share of paved roads against gravel roads from a particular municipality to Reykjavík and/or Akureyri. Road distances came from Fjölvís Publishing Company, originally collected by the Icelandic Road Administration. Numbers on paved roads came from Eymundur Runólfsson at the Icelandic Road Administration. Maximum speed varied from 70 kilometres per hour to 90 when gravel roads were paved and affected the average speed accordingly. The transportation network has been improved since 1980 when less than 10% of the network was paved (Karlsson 2012, pp. 19-20) and 39% in 2014 (Karlsson 2016, p. 16).

Time dummies were also constructed to the dataset for each year apart from the last one. The dummies take the value of one for every observation of the relevant year and zero otherwise. The mean value of all dummy variables is 0.04.

[1] During the period 1992-2006 there have been several amalgamations. Some municipalities disappeared because of the amalgamations. Instead of letting them be present in the dataset when they existed and discarding them when amalgamated, they are always constructed as amalgamated (as according to the year 2006). Amalgamations are then identified by a count variable; zero before and one after the first amalgamation, two if the same municipalities went through another amalgamation in the relevant period, three if third, etc.

Table 2: Variable description and sample statistics

Variable (acronym)	Description	Mean	Std. dev.
House price (hopr)	Real price of apartments, in Icelandic krónur	9,748,400	4,522,221
Travel time to Reykjavík (ttre)	Average travel time between Reykjavík and municipalities closer to Reykjavík than Akureyri.	71.79	103.17
Travel time to Akureyri (ttak)	Average travel time between Akureyri and municipalities closer to Akureyri than Reykjavík.	32.43	64.35
Marginal travel time to Reykjavík (ttrm)	Average travel time between Reykjavík and municipalities closer to Akureyri than Reykjavík.	62.37	111.57
Dummy variable (dmr1)	Dummy variable for splitting municipalities into two groups, 1 for being closer to Reykjavík than Akureyri.	0.69	0.46
House age (hage)	Average age of houses sold, in absolute terms	28.70	15.42
House size (hsiz)	Average size of houses sold, in square meters	137.31	52.60
Number of apartments (honr)	Average number of apartments in each house	1.02	0.09
Apartment's floor (hofl)	Average number of floors, reflecting the apartments position in height from the ground	1.75	0.66
Rooms per apartment (horo)	Average number of rooms per apartment	3.26	0.85
Timber house (hom6)	Share of apartments where wood is outer walls' building material	0.18	0.20
Balcony size (hoba)	Average size of balcony, in square meters	2.64	3.38
Parking/Garage (hopa)	Share of apartments where either parking place or any type of garage is included	0.47	0.25
Amalgamation (amal)	A count variable for the amalgamation of all municipalities. 1 for the first amalgamation of the relevant municipality, 2 for the second and etc.	0.47	0.90
Amalgamation 2S (amlk2b)	A count variable for the amalgamation of two similar municipalities. 1 for the first amalgamation of the relevant municipality, 2 for the second and etc.	0.004	0.063
Amalgamation 2D (amol2b)	A count variable for the amalgamation of two different municipalities. 1 for the first amalgamation of the relevant municipality, 2 for the second and etc.	0.032	0.186
Amalgamation >2S (amlk7b)	A count variable for the amalgamation of more than two similar municipalities. 1 for the first amalgamation of the relevant municipality, 2 for the second and etc.	0.014	0.117
Amalgamation >2D (amol7b)	A count variable for the amalgamation of more than two different municipalities. 1 for the first amalgamation of the relevant municipality, 2 for the second and etc.	0.085	0.327

Note: The data in this table, i.e., mean and standard deviation, is based on annual averages transformed by means of Equation (4).

The data series were annual averages for each municipality. This means that the list of hedonic variables is made up of: average age and size of apartments, numbers of apartments in each house, rooms per apartment, number of apartments made of wood, including balcony, a garage or a parking spot. Housing prices were annual averages as well, while the variables for population and road distance were static. Data on population is based on the figure on 1 December every year and the data on road distance is based on data from 1 January every year. The data series were originally classified spatially by municipalities, except for the data on road distance, which was classified by towns or localities. They were transformed from localities into municipalities. All variables that include values in Krónur are in real terms and thus corrected for possible skewness that could be traced to inflation of the Króna.

The averages and the standard deviation of the explanatory variables as well as of the dependent variable show considerable variation (Table 2). The standard deviation of housing prices is approximately 1/2 of the mean and, of road distance, more than 3/4 of the mean. This is evidence of large differences which demonstrates the potential for robust explanations. However, this panel data sample is an unbalanced one since observations for several variables are missing.

6 Estimating the result

6.1 The model results, interpretation, and discussion

The empirical model was set forth in Section 3 (Equation 4). All insignificant explanatory variables, apart from time dummies, closer to Reykjavík than Akureyri, and amalgamations, were discarded from the models to make the analysis more focused. This included number of apartments (honr), apartment's floor (hofl), timber house (hom6), and travel time to Akureyri square (ttak2) (Table 2).

A significant positive change in housing prices was detected following an amalgamation in the case of one variable for all amalgamations (Model 1 in Table 3). When the amalgamations were classified into four different types all of them returned positive coefficients. Two of them were also significant. This was in the case in more than two municipalities, especially similar ones (Model 2 in Table 3). Note that there were only four cases of the amalgamation of more than two similar municipalities, whereas there were 19 cases of more than two different ones (Table 1).

6.2 The reliability of the results

The overall results are in line with the previous analysis (Karlsson 2011) of this data sample, only more significant and robust. Those results were compared with many other related studies and found to be in line with the vast majority of them.

The analysis output contains the coefficients' t-values, number of observations, n, and R squares. For addressing a potential multicollinearity problem, the correlation coefficients were calculated as well. If no absolute values were higher than 0.6 this was marked as a "no" in the table as an indication of absence of multicollinearity.

Serial correlation and heteroscedasticity were also present in the models. The presence of serial correlation was tested by running a simple regression analysis between the residuals and lagged residuals as suggested by Wooldridge (2002, pp. 176-177), and it returned a significant coefficient in the model or a t-value of 10.36. A modified Wald test for testing groupwise heteroskedasticity in fixed-effect regression models was also used, and it returned a probability of Chi2 lower than 0.01 (or close to zero). The proper response was to implement a cluster-robust inference as suggested by Cameron, Miller (2015). Endogeneity was not seen as a threat in the current model.

Confidence intervals were calculated for logarithm of housing prices to detect any possible stability of the implicit prices over time. The results suggest a negligible instability of the price variable when the data sample was divided into three even five year periods (Table 4). This became notable when the standard error was shown to be somewhere between 0.1-0.2% of the mean.

Table 3: Relationship between housing prices and amalgamation – A polycentric model in semi logarithm of a quadratic distance version; data sample 1992-2006

Variable	Model 1 One variable for amalgamation	Model 2 Eight variables for amalgamation
Travel time to Reykjavík (ttre)	-0.00934 (-3.97)***	-0.0101 (-4.73)***
Travel time to Reykjavík sq. (ttre2)	0.00002 (5.37)***	0.00002 (6.28)***
Travel time to Akureyri (ttak)	-0.0077 (-4.11)***	-0.0080 (-4.61)***
Marginal travel time to Reykjavík (ttrm)	0.0031 (1.96)*	0.0032 (2.23)**
Closer to Reykjavík than Akureyri (dmr1)	-0.0631 (-0.58)	-0.0606 (-0.57)
House age (hage)	-0.0098 (-4.45)***	-0.0094 (-4.45)***
House size (hsiz)	0.0014 (2.15)**	0.0014 (2.20)**
Rooms per apartment (horo)	0.0783 (2.43)**	0.0723 (2.29)**
Balcony size (hoba)	0.0107 (2.15)**	0.0102 (2.15)**
Parking/Garage (hopa)	0.1726 (3.43)***	0.1787 (3.52)***
Amalgamation (amal)	0.0816 (2.50)**	
Amalgamation 2S (amlk2b)		0.0221 (0.19)
Amalgamation 2D (amol2b)		0.0096 (0.11)
Amalgamation >2S (amlk7b)		0.3344 (6.05)***
Amalgamation >2D (amol7b)		0.1380 (3.54)***
Time dummy 1992 (tdum12)	-0.1352 (-4.03)***	-0.1293 (-3.78)***
Time dummy 1993 (tdum13)	-0.1253 (-4.32)***	-0.1215 (-4.09)***
Time dummy 1994 (tdum14)	-0.0259 (-0.79)	-0.0035 (-0.10)
Time dummy 1995 (tdum15)	-0.0700 (-2.12)**	-0.0480 (-1.36)
Time dummy 1996 (tdum16)	-0.0849 (-2.33)**	-0.0642 (-1.64)
Time dummy 1997 (tdum17)	-0.0634 (-1.75)*	-0.0431 (-1.23)
Time dummy 1998 (tdum18)	-0.0544 (-1.43)	-0.0471 (-1.31)
Time dummy 1999 (tdum19)	0.0106 (0.37)	0.0182 (0.63)
Time dummy 2000 (tdum20)	0.0120 (0.46)	0.0187 (0.71)
Time dummy 2001 (tdum21)	-0.0314 (-1.04)	-0.0311 (-1.08)
Time dummy 2002 (tdum22)	0.0041 (0.14)	-0.0026 (-0.09)
Time dummy 2003 (tdum23)	0.0997 (2.89)**	0.0948 (2.77)**
Time dummy 2004 (tdum24)	0.1661 (4.24)***	0.1613 (4.05)***
Time dummy 2005 (tdum25)	0.3065 (7.92)***	0.3000 (7.59)***
Constant	16.1964 (63.85)***	16.2748 (71.69)***
Number of observations, n	772	772
R-sq within	0.405	0.4256
R-sq between	0.2141	0.2417
R-sq overall	0.2396	0.2568

Notes: Dependent Variable: LOG (hopr). * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level. Methods: Fixed effect panel data model. Statistical program: STATA. Values in parentheses are t-statistics.

Table 4: Confidence interval of the dependent variable LOG (House price), mean, and standard error

Period	Obs	Mean	Std. Err	Confidence interval (95%) lower limit	 upper limit
1992-1996	223	15.969	0.021	15.927	16.011
1997-2001	234	16.032	0.026	15.982	16.083
2002-2006	233	16.229	0.032	16.165	16.292

According to the discussion above, the results appear robust and reliable. The final results were not disturbed by any potential heteroscedasticity, multicollinearity, serial correlation, or endogeneity.

7 Conclusion

The purpose of this study was to detect any possible impact municipal amalgamations could have had on local housing prices. The idea here was to reveal the expected impact of the amalgamations because many previous studies concerning Iceland on the success of amalgamations have not detected any, or only negligible, impact. Previous studies have mainly focused on investigating the relationship between amalgamations and the operating cost of municipalities, with the most recent one examining the relationship between amalgamations and interregional migration (Karlsson, Eythórsson 2019). The study that came closest to the expected outcome was one on the impact of amalgamation on the municipalities' service level (Eythórsson, Karlsson 2018). Thus, the present study should be a valuable contribution as to whether the amalgamations have been successful in Iceland or not.

Two models were used for the estimation. The first included one variable for all amalgamations and the second used four variables for amalgamations.

The present results suggest that municipal amalgamations have been partly successful. Model 1 suggests that amalgamations of municipalities in Iceland have been successful when correlations between the variables for all amalgamations in the period 1992-2006 and housing prices turned out to be positive and significant. Model 2 revealed amalgamation as having a significant impact on local housing prices when there were amalgamations of more than two municipalities. No significant positive correlation was detected in the case of an amalgamation of two municipalities.

The main research objective was to investigate a potential correlation between local housing prices and municipal amalgamation. The result was partly positive and it suggested that municipal amalgamations in Iceland have been successful with regards to increasing social benefit when more than two municipalities were involved. Such amalgamations have led to an improved service level, lowered local taxes and the service fees of local government. Those developments are reflected in housing prices.

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Adapting the Singapore Model to Nigeria's Urban Management – Possibilities and Challenges

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Abstract. Nigeria and Singapore are two countries that bear both historical similarities and differences. Singapore has emerged as a poster child for sustainable urban development while Nigeria lags very far behind in this area. This paper analyses which lessons can be drawn from Singapore to inform and improve Nigeria's urban planning and management. Improving Nigeria's urban planning sector is especially important considering its projected additional urban growth of 226 million by 2050. Drawing from published academic work and document analysis, this work finds that relevant lessons could be drawn from Singapore's approach to urban planning to encourage sustainable urban planning in Nigeria. The contextual similarities between the countries and the current planning system in place make the chances of success high. This paper advocates planning reforms focused on adequately implementing plans, strengthening its planning institutions and appropriate development control, and putting in place strong disincentives for corruption to promote sustainable urban planning and improve urban conditions and sustainability.

Key words: Sustainable Urban Development, Sustainable Urban Planning, Development, Sustainability, Urban Environment

1 Introduction

Nigeria is deemed the giant of Africa because of its large population of over 208 million people (Echendu, Georgeou 2021). Its economy is currently the largest in Africa and was ranked 26th in the world as of 2014 (Awe et al. 2019). It is one of the fastest urbanizing countries with over 50% of this population residing in urban areas (Abubakar, Aina 2019). The urban population is set to rise by an additional 226 million by 2050 (Farrell 2018). Alongside India and China, Nigeria is projected to contribute up to 35% of the world's population by 2050 (Avis 2019). By 2025, more than 60% of Nigerians will be living in urban areas (Taiwo, Gbolabo 2020). With this projected urban growth, Nigeria's urban planning and management urgently deserve attention given the present state of its urban environment which cannot sustainably support this astronomical projected growth (Echendu 2022, Taiwo, Gbolabo 2020). It is a fact that most Nigerian cities are characterized by various forms of urban decay and unsustainability (Alumona, Onwuanabile 2019, Echendu 2021b). Urban sprawl is on the rise (Yiran et al. 2020). Flooding, building collapse, and informal settlements are prevalent symptoms of decades-long poor planning practices (Echendu 2020a,b). Singapore on the other hand is a city-

Table 1: Selected socio-economic indicators

Indicator	Nigeria	Singapore
Population in 2021	208,000,000	5,600,000
Urbanization rate	52%	100%
Urbanization growth rate	2.8-3%	n/a
GDP per capita (USD)[1)]	2 097,09	59 797,75
Population density[2)]	226	8358

Notes: [1)] Source: World Bank; [2)] Population per square kilometre

state renowned for urban excellence that has consecutively emerged over the years as an archetype of urban management excellence (Tan 2020). It is a city-state with a population of 5.6 million people and a land mass of about 722 square kilometers, having increased its original landmass of 580 square kilometers at independence in 1965 through land reclamation efforts (Ho et al. 2020, Tan 2017). Its economic development took place in tandem with the urban development of the city-state (Curien 2017).

Nigeria and Singapore are both former British colonies. At independence, they were underdeveloped and had to struggle to survive the coming decades. The two nations adopted different development trajectories that would determine their future. Today, Singapore has progressed from being a third-world country to a first-world, high-income country. It plays a major role in the politics and economics of Southeast Asia and beyond with a model that has become renowned as the 'Singapore model' (Brenya et al. 2017). Nigeria, on its part, has remained a third-world country with a poor living environment. Singapore's committed leadership and urban management and planning model has been central to this highly lauded transformation (Shatkin 2014).

Planning, as used in this paper, refers to urban planning, spatial planning, or regional planning and refers to the design and development of the built/physical environment to cater to human needs. This paper first discusses the concept of sustainable urban development and planning which forms the theoretical framework of this study (Section 2). It then goes on to discuss Singapore's planning model and features. Nigeria's planning model/system is discussed and analyzed in Section 5, followed by Section 7 on the replicability of the Singapore model in Nigeria. It goes on to make recommendations on how Nigeria's planning sector could be improved drawing on lessons from Singapore (Section 8). In Section 9 it concludes by summarizing the key factors that ensured Singapore's success which other nations can emulate to achieve success in their urban planning. Table 1 highlights selected socio-economic indicators for Nigeria and Singapore.

2 Sustainable urban development and planning

The concept of sustainable urban planning has emerged as an important discourse because achieving sustainable development itself is largely dependent on having sustainable cities. This dependence exists because urbanization degrades and alters the natural ecosystem, impacts biodiversity, and denies humans encounters and experiences with nature (Colléony, Shwartz 2019). Also, more than half of the world's population lives in cities, consuming a significant proportion of the earth's resources (Currie, Musango 2017, Larijani 2016). While cities are centers of economic production, their high resource consumption (over one-third of natural resources) also makes them hotbeds of issues impacting sustainable development. This is due to the correlated environmental impact and pollution. Cities emit up to 70% of global greenhouse gases (Currie, Musango 2017, Sofeska 2016, UN-Habitat 2011). However, the dense population of cities can portend positive benefits for the larger environment by limiting environmental distortion and landscape change due to urban sprawl. Urban sprawl is associated with negative environmental and socioeconomic consequences with impacts on quality of life, public health, pollution, and environmental degradation (Environmental Defence 2013, Jarah et al. 2019). Cities will therefore make or mar the vision towards sustainable development.

Sustainable development is the ability of the present generation to fulfill their own development needs while assuring chances of the same for future generations (Brundtland 1987).

Contemporary sustainable urban development and planning tilts towards compact cities. Compact cities and densification could be tools for positive urban transformation when led by strong planning (Akbar et al. 2020, Horn 2020). The positive benefits of a denser population could be harnessed by sustainable urban planning. Because cities amalgamate economic assets, potentials, and denser populations, the impact on the environment is extensive, consistent, persistent, and focused. This necessitates more tailored environmental planning approaches as a key strategy for ensuring sustainability (Tang, Lee 2016). Careful planning of urban settlements and the physical environment is a crucial step to securing the future of humanity (Meyer, Auriacombe 2019, Sodiq et al. 2019). Urban planning as a field is concerned with sustainable urban development and connects all three aspects of sustainability - the social, economic, and environmental aspects (Tang, Lee 2016).

Urban development being a multi-faceted issue could be deemed a 'wicked problem' thereby requiring a careful and integrated approach whereby different factors need to be considered alongside good coordination and collaboration (Gohar 2016, Medina, Huete García 2020). Wicked problems are problems with different symptoms that are inherently difficult to solve because there is no one solution and emerging dynamics are not evident from the outset. Urban development then becomes a wicked problem because despite the fact that sustainable urban development portends numerous potentials, cities are also fraught with emerging and constantly changing issues that are difficult to predict.

Sustainable urban planning and development are aimed at reducing and mitigating urban problems and achieving sustainable development by applying the concept of the sustainable city and its principles in the development of urban centers (Larijani 2016). The importance of land-use planning as an integral process of achieving sustainability is well documented in the literature (Echendu 2020b, Musa et al. 2018, Wei et al. 2018). Agenda 21, a comprehensive action plan to be taken globally, nationally, and locally underscores that land-use planning is a tool to be utilized in preventing urban sprawl, most especially in important farming land and sensitive regions. It calls for countries to undertake reviews of the urbanization policies and processes for a better understanding of the impact of urban growth on the environment. This will also facilitate the application of unique planning styles and approaches, tailor-made to local needs, that also consider the features of the growing cities and the available resources (Birch 2016, Caprotti et al. 2017). Chapter 7 of Agenda 21 specifically focuses on fostering sustainable human communities. It calls for improving human settlements management; providing appropriate shelter for all; enhancing sustainable spatial planning and management; promoting integrated environmental facilities like sanitation, water, solid waste management, and drainage; providing sustainable transport and energy system in communities; improving the planning of human settlements and management in disaster-susceptible areas; fostering sustainable construction industry schemes and ventures; bolstering human resource capacity building and development for developing human settlements (UNCED 1992). These all fall in the domain of urban planning. The Sustainable Development Goals (SDGs) also recognize the importance of urban planning to achieving sustainable development. Goal 11 is specifically geared towards making cities inclusive, resilient, and sustainable. A target of this goal focuses on enhancing the capacity of urban planning institutions.

The New Urban Agenda (NUA) also highlights the problems of urban and regional planning and management, how urban areas can fulfill their role as engines of sustainable development, and how they can shape the execution of the SDGs. The NUA functions as a catalyst for the SDGs, specifically SDG 11, and recognizes that 95 percent of the urban growth will be in the developing world. The NUA re-emphasizes the now well-known position of international sustainable development agendas that well-planned and managed urbanization can be a potent tool for sustainable development for both developed and developing countries. Urban planning and management is, therefore, a

tool for achieving these important goals. Indeed, the importance of developing sustainable urban communities cannot be overemphasized especially in an era the battle for sustainability will be won or lost in urban areas.

3 The Singapore Planning Model and features

Singapore is the epitome of good urban management, governance, and development. Strong leadership, centralized urban management and governance were key to these achievements. After its independence, it was led for three decades by Lee Kuan Yew of the People's Action Party (PAP) who championed its transformation (Leggett 2007). Singapore has since enjoyed good leadership by leaders with strong political will with the PAP in power to date. Post-independence, its government adopted a direct interventionist stance to urban development, by marrying its political, economic, social, and land use vision through the planning process and gaining the people's support through good performance and delivery of public service (Yuen 2009).

As a former British colony, it started with a British planning canvas. It was the practice then for Britain to export their planning regulations which were considered the most advanced at the time to their colonies (Watson 2009). The British 1947 Town and Country Planning Act formed the bedrock of colonial Singapore's planning and informed the 1959 Planning Act. The passage of the Planning Ordinance officially legislated town planning. A central planning body was charged with physical planning, long-term development, and development control (Chew 2009, Lee 2015). Developers thereafter became mandated to secure approval before any development.

Development plan and development control were features of the British planning system which also formed the core of Singapore's urban planning. According to Yuen (2009), control over land allotment was particularly important to maintain law and order given the different ethnic mix, religions, and languages of the predominantly immigrant population. The limited land areas also necessitated tight controls to effectively allocate land to satisfy competing purposes. Singapore has the compulsory Land Acquisition Act whereby land can be acquired from landowners who are compensated for the market value. The government owns up to 85% of the land in Singapore and has tightly managed this scarce resource to ensure better integration among its diverse ethnic groups (Shatkin 2014).

The central planning authority in charge of all planning tasks is the Urban Redevelopment Authority (URA). The Minister for national development is in charge as the final authority in matters of planning and development control (Henderson 2012). The URA controls land use and development, prepares and revises development plans, implements conservation, ensures and provides good urban conditions, implements conservation measures, and coordinates private and public sector development schemes (Lee 2015).

Singapore's long-term planning is guided by the Concept Plan and Master Plan. The Concept Plan was first adopted in 1971. It serves to direct Singapore's development over the next four to five decades and encompasses strategic land use and transport framework, ensuring there is enough land to satisfy the needs of future population, economic needs, and a high-quality environment. The Concept Plan is renewed every 10 years and aims to be responsive and flexible to the changing needs of stakeholders (Meng et al. 2016). The current Concept Plan was revised in 2011-2013 and birthed the Ministry of National Development (MND) Land Use Plan 2030. The Plan is in congruence with the population projections by the National Population and Talent Division (NTPD) for 2030 and outlines the blueprint to support the projected economic and population growth while also ensuring a good living environment. The outlined strategies include the provision of well-serviced affordable homes, integration of greenery into the living environment, ensuring greater mobility through an improved transport network, maintaining a vigorous economy with good employment, and assuring growth and a good environment into the future. The dictates of the Concept Plan are then translated into the Master Plan (Ng 2018). The Master Plan on its part translates the long-term goals and strategies laid out in the Concept Plan into more elaborate plans for execution. It is revised every 5 years

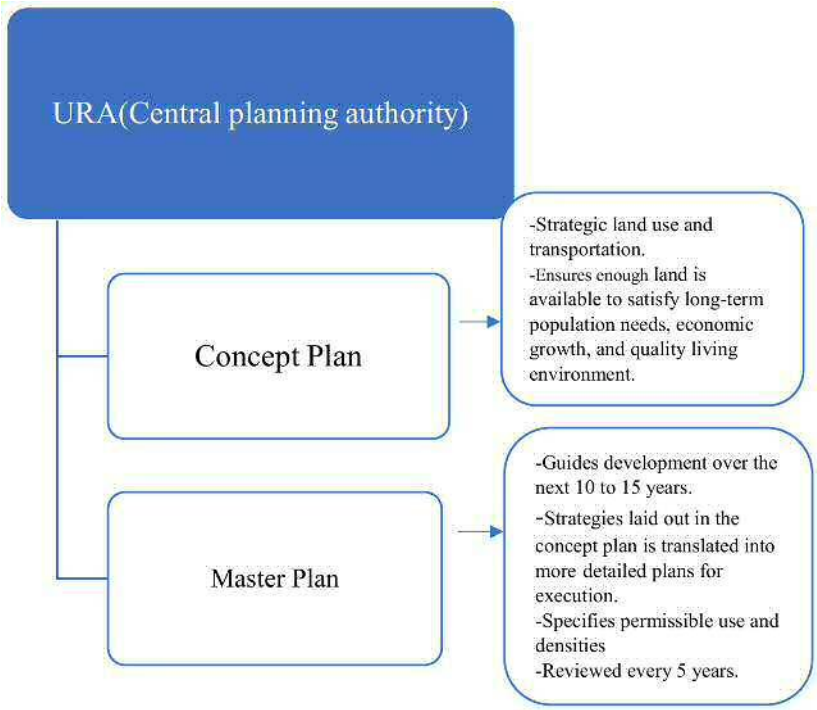


Figure 1: Singapore's Planning Model

and guides development over the next 10 to 15 years. Before any changes to the Plan can be made, however, the URA must run it by the Master Planning Authority which is constituted of members from different government units. Planning regulations and Plans are clearly laid out in writing and available in the public domain ensuring transparency. Infrastructure like water, transport, and drainage are given the priority they deserve. The Master Plan incorporates planning for public utilities and the allocation of land for various functions. Planning and development take a disciplined, logical, and careful approach and nothing is wasted given the scant resources available.

Singapore's Plans are constantly reviewed to respond to changing needs, aspirations, trends, and the general environment. Singapore is seen as practicing a top-down planning approach which may seem like a paradox. This is because it also incorporates place-based planning whereby the community is engaged in the planning process to construe place identity and conservation spaces at the local level to promote a higher sense of community (Lee 2015, Yuen 2009). Singapore has only one Master Plan and corruption is near zero in the public service because of the strong disincentive and stiff punishment in place for offenders. Givers and receivers of bribes are both guilty of corruption and liable to prison terms of up to seven years or fine (up to USD 100,000) or both. The sanctions for public servants are even more severe. Development of land without appropriate permission is a criminal offense with the developer fined up to $200,000 USD or imprisoned on conviction. Continuing offenders are subject to a further fine of not more than $10,000 daily for every day the offense subsists after conviction and with inflation and rising salaries, this amount has progressively risen (Yuen 2009). The many years of conscientious planning, political will, and focus have seen Singapore emerge as the model it is today. The direct interventionist stance to urban development and the synchronization of its political, economic, social, and land use vision through the planning process has been a successful formula. The centralized URA control of the land use and development process ensures a more harmonious management. The oversight function of Master Planning Authority which is constituted of members from different government units provides the necessary check and balance during Master Plan revisions. Figure 1 showcases Singapore's planning model.

4 Some Indicators of Singapore's Successful Planning Model

Singapore's urban planning and management is recognized as cutting edge. The various aspects of sustainability are incorporated into the guiding Concept and Master Plans (Chan et al. 2018, Tan 2006). The indicators of Singapore's urban planning and management are physical properties including but not limited to transportation, public health, air pollution, energy management, water management, and housing. 90% of Singaporeans own their homes (Deng et al. 2013, Wee et al. 2019), a feat that has been attributed to its original Prime Minister Lee Kuan Yew's belief that the best way to foster a sense of identity and build wealth was homeownership as it grounded people, making them stay and raise their families and build long-lasting community ties. Singapore promotes public transport as the most effective and environmentally-friendly way to get around. It is a pioneer in integrated sustainable transport policy and a leader in mobility management (Lee, Palliyani 2017). Technology has been effectively deployed to solve traffic problems and provide travel information in real-time. Integrated land use and transportation planning with effective policies as well as a constant improvement over the years, ensured this good transport system. Walking is actively encouraged with its attendant positive environmental and health benefits (Wang, Wong 2020). Residents are favorably disposed towards active mobility and report satisfaction with the walking infrastructure in place (López, Wong 2017). Homes and amenities are built around major transport hubs to facilitate easier access without needing cars. Singapore's population to landmass ratio and limited natural water sources makes it a water-stressed country. Yet, its water and wastewater management is one of the global best practices (Sanlath, Masila 2020). 30% of the country's water demand is met through the recycling of water. Today, it is a pioneer hydro hub, a status built off the success of its NEWater program (Lefebvre 2018). The Active, Beautiful, Clean (ABC) Waters program launched in 2006 integrates reservoirs and waterways with the surrounding environment achieving multi-purposes of aesthetics, water quality improvement, and runoff management (Goh et al. 2017). The government is also implementing a range of policies to achieve energy independence. Energy use is not subsidized and fuel and electricity prices are regulated by market forces. Stiff penalties apply for inefficient or excessive use of energy (Bhati et al. 2017). Singapore ranked second in the 2017 and 2019 safe cities index (Economist 2019b, Meixler 2017). The report studied the areas of health security, personal safety, digital security, and infrastructure safety. It ranked highest in personal safety which looked at how safe people are from violence and theft. It also ranked first in healthcare quality and accessibility. Digital technologies are infused in many aspects of life in Singapore. Residents can use digital technologies without fear of identity theft or privacy violations because of the security measures in place. The government adopts a holistic and proactive stance to cybersecurity, regularly reviewing and improving measures to improve the resiliency of the smart technologies in use (Luk 2019). Singapore has an excellent healthcare system that has been feted as the best in the world both in terms of service delivery and outcomes (Echendu, Okafor 2021, Lim 2017). However, concerns over rising costs in recent years have led to new measures by the government geared at reducing individual out-of-pocket expenses, expanding coverage, and providing advice on necessary tests and procedures (Lim 2017, Ong, Tan 2019). There is a high life expectancy of 83 years and low infant mortality of 2.4 per 1000 live births (Lim et al. 2017). Singapore has a robust mix of public and private healthcare systems whereby private physicians handle up to 80% of primary care and 80% of in-patient care is provided by public hospitals which provide subsidized care (Cheah 2001, Echendu 2021a). Governance is an elusive concept to measure as its components are subjective. However, Participation and Institutions are two acknowledged aspects of good governance (Johnston 2006). Singapore boasts strong institutions and incorporates citizen participation in planning (Soh 2006). Good governance components are taken here to be accountability, transparency (no corruption or zero tolerance), participation, efficiency and effectiveness, stability and the rule of law, planning, and predictability (Johnston 2006). These aspects are all areas Singapore ranks highly in. Singapore has been consistently ranked as Asia's greenest metropolis in the Asian Green City Index – a study commissioned by Siemens and conducted by

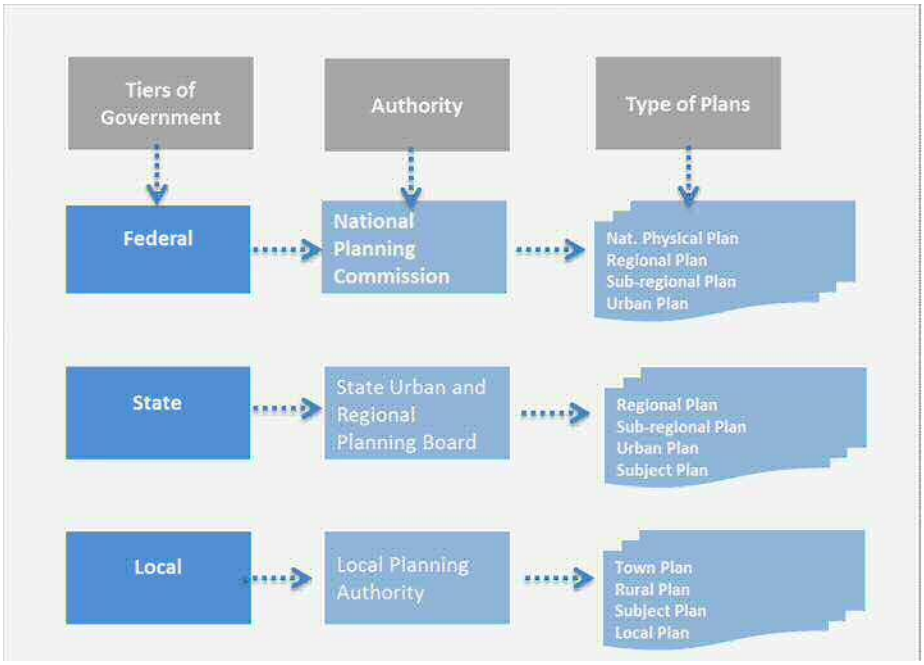
the independent Economist Intelligence Unit. The high performance of Singapore in the urban planning sphere has made it a global leader in urban planning and development.

5 Nigeria's planning model/system

Nigeria's planning model is also rooted in the British system. Most colonized countries simply adopted the planning system of their colonists. Formal urban development policies and strategies have been in existence in Nigeria since the colonial period (Lamond et al. 2015). Nigeria has had the 1863 town improvement ordinance, the Cantonment Proclamation of 1904, 1917 Township Ordinance, 1946 Town and Country Planning Ordinance all meant to guide physical planning and control the issuance of permits for buildings (Fatusin 2015, Omole, Akinbamijo 2012). The Urban and Regional Planning Act serves to specify and distinguish the roles of the three tiers of government on policy issues like land zoning, physical planning, etc. The three tiers of government in Nigeria (federal, state, and local) are involved in urban planning in different capacities (Figure 2 is a graphical illustration of the planning process in Nigeria). The planning law in all the states in Nigeria is the Nigerian Urban and Regional Planning Act (Decree 88 1992). A later amendment was effected, the Urban and Regional Planning (Amendment) Decree No. 18 of 1992 (Dan-Jumbo et al. 2018). This replaced the previous British colonial government's 1946 Town Planning Ordinance that was in use prior (Dung-Gwom 2011). The federal level is tasked with roles such as: formulating national policies relating to urban and regional development and planning; devising and implementing the National Physical Development and Regional Plans; providing financial and technical assistance to states in devising and implementing plans; as well as promoting the training and education of planners. The state government is tasked with formulating its state policy for planning within the stipulations of the national policy. The state also prepares and implements its Regional, Sub-regional, and Urban Plans as well as Subject Plans. They also provide technical support and assistance to the local government on the implementation of Local, Rural, and Subject plans. The local level oversees the Town Plan, Rural Plan, Local Plan, and Subject Plan. Decree 88 1992 requires that a National Urban and Regional Planning Commission, made up of members who are professionals in different fields of urban planning with relevant years of experience, is constituted at the federal level. The various government parastatals and ministries involved in planning in different capacities each have representatives on the national commission. The commission is in charge of carrying out planning functions at the national level. At the state level, a board is also constituted and charged with state planning activities. The local planning authority is tasked with planning at the local level. The members must all be planning professionals.

Before the preparation of the National Plans, the National Commission is mandated to call for inputs from all concerned government and non-governmental establishments and the public whose contributions are to be considered in the draft preparation. This is to achieve integration between all levels of the Physical Development Plans and promote community participation. The draft plan is presented to the public and objections are welcomed and addressed before the final plan is presented to the legislature, which may either approve it in whole or in part or ask for amendments. The approved plan becomes the operative National Physical Development Plan, to be reviewed every five years in sync with changing needs and times. The review process follows the same process and stages as the original plan.

In making the Regional, Sub-regional and Urban/Master Plans, this same procedure is adopted at the state level. The same goes for the making of a Town Plan, Rural Plan, Local Plan, and Subject Plan which must also be in synchrony with the state plan. A Development Control Board in charge of all developments within their jurisdiction is established at each level of government. Every developer both government and private must submit plans (comprising all relevant information like drawings, designs, plans) for approval from the relevant control board before any physical constructions or development. There are various grounds for rejecting plans, including if the proposed development will have a major impact on the environment, inhabitants, or existing facilities.



Source: Lamond et al. (2015)

Figure 2: The planning system in Nigeria

A detailed Environmental Impact Assessment must be submitted by any developer wishing to develop land sizes from three hectares and above, and also for recreational and commercial buildings of stipulated sizes. The Land Use Act 1990 empowers the government to acquire any privately held land for development purposes (Ige et al. 2016).

Decree 88 1992 on paper, is comparable to global standards, but its adoption in practice at all levels of government leaves a lot to be desired. Non-compliance to laws and policies has been identified as a problem of the Nigerian urban built environment, one which has led to many environmental problems (Olugbenga, Adekemi 2014). Even though citizens are encouraged to contribute, participation culture is not deep (Chado et al. 2016), and the government does not obey its laws. Some citizens believe that their contributions would have no impact on the scheme of things (Badiora, Ojo 2021). There are cases where Governors themselves decide where to site facilities without recourse to due processes provided by the law (Dung-Gwom 2011, Osuocha, Njoku 2012). Figure 2 highlights Nigeria's planning system.

6 Challenges and Strengths of Nigeria's Planning system

Nigeria's planning sphere is syncretic. It comprises a combination of customary and colonial practices, made up of mostly outdated policies and plans (Lamond et al. 2015). The historical development and evolution of land administration, governance, and planning regimes in Nigeria from two distinct paradigms is part of the failure being witnessed in the planning system (Gyau 2018). The result is confusion and weak engagement with formal systems. This limits the capacity for well-conceived national and state urban development goals of being realized. The colonial segregation and exclusionary planning policies have largely been replaced by various policies that recognize, but cannot enforce, participation, equity, and urban sustainability. A positive trend in Nigeria's urban planning is the various attempts to change planning and development patterns. For instance, there is a National Urban Development Policy (NUDP) which is the national framework designed to guide sustainable urban development. The presence of such policies signifies an overall acknowledgment of the importance of planning directives.

However, many weaknesses abound. The preferred choice of various state governments

to consult foreign planning companies in the drafting of local Master Plans presents a weakness due to the failure to incorporate local first-hand knowledge. This leads to a disconnect with realities on the ground. Also, the government's inability to set up the requisite bodies as mandated by the decrees continues to be one of the implementation challenges. Only one state out of 36 has been able to set up an Urban and Regional Planning Board and the requisite Planning Authorities (Lamond et al. 2015).

Onokerhoraye (1977) pointed out the symptoms of the improper land-use patterns in the majority of Nigeria's urban centers citing the deteriorated physical environment, poor transport systems, inexistent community facilities. Sadly, this has only worsened four decades later. Long-term planning for the development of cities and rural areas remains inadequate. The lack of continuity in the planning, implementation, and governance process presents challenges in Nigeria's planning field (Momoh et al. 2018). The various regulations and plans in place are incomprehensive and piecemeal. They do not sufficiently cover land use, housing, transportation, conservation, and safety (Eme 2013).

By contrast, the integration of these various key sectors in urban planning is a central aspect of model comprehensive plans like in Singapore. Building codes and zoning where available, are not enforced. Urban regulations and policies aim to control and guide urbanization to prevent problems associated with the growth of cities, and to harness the benefits that come from expansion (UN-Habitat 2016). Unfortunately, this is not the case in Nigeria where the government often fails or is slow to uphold the law and environmental concerns (Eneh 2011). Of particular concern are new housing developments, city infrastructure, and land-use decisions that do not incorporate the tenets of sustainable development (Echendu 2020b). Development in everyday sectors like housing and infrastructure continues to be taken seriously in developed countries, as well as some other developing countries, that have a clear growth and development pathway (Gurara et al. 2018). In Nigeria however, these sectors have been almost totally ignored. Nigeria has been riddled with political instability since its independence in 1960 and is only 21 years into an uninterrupted democracy which also saw a change in leadership with a different party at the helm of affairs from 2015. While good leadership and governance are key for urban development, this essential ingredient has been lacking in the Nigerian polity (Aluko 2011a). There has been a significant surge in its population since independence leading to increased urbanization and further expansion of slums. The existence of planning authorities is not felt, and open spaces in the urban areas are a rarity. Nigeria's poor governance which manifests in the current poor state of every sector of the country's economy has seen secession calls by its various ethnic groups grow much louder than in the past. This has been aided by the fact that different tribes and ethnic groups dominantly occupy different parts with tribalism rife in the country. The government has also been very high handed and brutal in quieting these dissenting voices, but the dissenting voices are rising louder and louder. Planning patterns and governance have been known to serve a strategic purpose of fostering unity among diverse groups (Shatkin 2014, Yeoh 2004).

The state of Nigeria's urban planning is poor. Thought has been given to planning as evidenced by various laws and policies on the ground and one would expect a different reality. What is obtainable is a place rich with laws and policies but deficient in implementation which speaks of poor urban governance. There is a proliferation of independent planning bodies in charge of different aspects of planning and there is no coordination and integration of approach among these planning bodies (Ogu 1999). Corruption is endemic in all Nigeria's agencies including the planning sector (Gyau 2018, Oladosu et al. 2015). This has resulted in government planners seeking personal gratification and approving non-compliant plans for money without following existing rules and the Master Plan (Kingsly, Johnson-Rokosu 2015). The majority of the ongoing development in Nigeria to meet housing needs is either owner-built or developer-built (Lamond et al. 2015). There is, therefore, a lack of infrastructure and services in the new developments because of the huge costs associated with providing infrastructure, something individuals cannot fund.

The political nature of planning cannot be overemphasized as planning itself is a political exercise (Levy 2016). This is even more evident and pronounced in Nigeria where planning is easily deployed as a handy tool for the political and economic elites to

gain and perpetuate power, profit, and deal with opponents through the intermittent enforcement/non-enforcement of planning regulations (Aluko 2011a, Chiweshe 2021). The planning system has been known to promote vested interests as seen in the allocations of prime real estate to the elites connected to those in power (Gyau 2018). Illegal conversion of reserved areas to industrial or commercial areas by governments in power is prevalent (Galadima et al. 2018).

Non-compliance with Master Plans is the norm and practice in Nigeria even in its capital city Abuja (Gumel et al. 2020, Obiadi et al. 2019). While various instruments of planning law and policies provide for periodic review of the Master Plan, the reality is far from practice (Echendu 2021b). There are also instances whereby Master Plans have been altered arbitrarily without observing due process (Jack et al. 2017).

For economic and social sustainability, people need to inhabit an environment that will enable them to thrive and be in good health to realize other sustainability goals (Hawkins 2010). The built environment needs to come to the forefront of urban planning, as it is the activities of the built environment that have the most impact on the environment.

7 Replicability of the Singapore model in Nigeria

Singapore's status as a city-state gives it the unique advantage of having policies from the central government implemented much more easily. Its success in urban planning has ensured it continues to rank highly in various global liveability rankings (Allam, Allam 2020, Krzywda, Majewska 2019). Cities are different but best practices exist in urban management and governance that can inform practice elsewhere (Shell 2014). Singapore is thus, a good example of a best practice in urban management and governance with a model worthy of emulation by developing countries. Singapore's planning success has also seen other countries implement lessons from Singapore in their city planning. For example, a London group improved management of its inner-city traffic using Singapore's example and Tianjin city in China was also birthed from collaboration with Singapore (Henderson 2012). Replication is thus not impossible.

Nigeria on its part is renowned for its poorly planned and blighted cities (Fabiyi 2017). Nigerian cities generally, do not compare with global cities and lack administrative effectiveness. Lagos, one of Nigeria's megacities, for instance, ranked as the 3rd least liveable place in 2018 and 2nd least liveable place in 2019 (Economist 2019a, Kiunguyu 2018). This commercial center is plagued by various forms of urban problems that negatively impact liveability (Dano et al. 2019). Shatkin (2014) alludes that developing countries are especially drawn to the Singapore model because they aspire to dominate planning control and use it for political gains. However, urban planning is already being used as a tool of political gain in Nigeria by the government even without the adoption of the Singapore model.

The historical similarities between the two countries signify that positive transformation is not a far-fetched ideal in Nigeria's urban planning sphere. Some of these similarities include both nations being former British colonies that gained their independence only a few years apart. Both countries were also previously classified as third-world countries. They are also polyglot, multi-ethnic, and multi-religious countries. Differences include size (population and landmass) and natural resources endowment. Singapore is a tiny island country not rich in natural resources (Portes 2020), while Nigeria is much bigger and is blessed with an enviable array of natural resources. Despite Singapore's lack of endowment in natural resources, it has transformed itself into a first-world country in one generation with a model numerous countries desperately try to replicate. Nigeria, on its part, is still languishing at the bottom rung of development. Replicability is possible due to these common characteristics of both countries who favor Master Planning models. Nigeria will thus not be veering into unknown territory. Even though Master Planning is deemed 'old style' in some quarters and is facing growing critique with its opponents arguing it should be replaced with the more flexibly structured strategic urban management plans (Watson 2009). Strategic urban planning is deemed a more progressive planning method because it can respond to changes as they happen and aligns better with the interests and needs of various stakeholders (Muminović et al. 2020). Despite

its critics, Master Planning is still the preferred planning approach in many parts of the world including Singapore and Nigeria, and has proven particularly effective in Singapore. Planning is not a one glove fits all approach. Countries need to adopt planning styles that suit their local situation. In Nigeria particularly, given its size and political dynamics, Master planning is better suited in contrast to Strategic Planning. The flexibility of Strategic planning makes it more subject to the whims and caprices of the ruling class and government in power. Given Nigeria's antecedents on the abuse of planning laws by governments in power, Strategic Plans are much more likely to be abused and arbitrarily modified to suit personal and political gains. Such constant politically motivated changes would impede progress in the urban sphere. A tweaked form of Master Planning which can even go by a different name that fully considers our unique local environment, the traditional planning system and full public participation can help improve Nigeria's urban development.

There is no perfect system on earth, but patches of excellence abound in different places that can be tweaked to suit the local environment. The Singapore model also faces criticism for its style of governance despite its proven excellence in the urban management sphere. Singapore has faced criticisms and expressed regrets for some of its actions. For example, the demolition of heritage buildings in the process of its building of a new modern city which it has sought to remedy by conserving existing heritage buildings. It is important to note that Singapore has only one level of government in a single city-state urban area and has not had the option or need to separate urban planning and management activities. The state is responsible for services including parks and housing which are delivered elsewhere by lower levels of government. This means it is easier for Singapore to better achieve coordination with its planning institutions. Nigeria, in contrast, has three levels of government with different roles.

Given Nigeria's system of government and size, it only needs to emulate those core principles that have led to Singapore's success story for its cities to occupy the pride of place they deserve. Streamlining land use planning authorities to handle every aspect from long-term strategic plans to everyday development control just like Singapore will eliminate the conflict of interest among the various planning agencies in Nigeria. Singapore's success can be broken down into a systematic framework that leaders can adapt to their environment (Singapore Ministry of the Environment and Water Resources 2015). The Singapore model's replicability lies in how it is achieved, the spirit, and hard work that can be adapted to every environment no matter the uniqueness. Nigeria can adapt these factors to suit its environment and make gains in urban development. Nigeria has in the Singapore model, a good and workable example to modify to suit its environment. There has been a long history of imposing planning styles from the global North in the global Southern countries some of which were unsuited to the local environment and which had little concern for promoting sustainability (Watson 2009). Replicating aspects of Singapore's urban planning and governance success will be a change to the European colonial-influenced planning practice and bring a breath of fresh air. While Singapore's planning also has colonial influences, it has succeeded in achieving its own unique 'Singapore model' of planning that even their colonists seek to replicate. The fact that it is not a global north country will be a shift to an extent from Nigeria's colonial planning legacy which has not exactly been a success.

8 Recommendations for Policymakers

Successful planning styles in a part of the globe can potentially influence planning elsewhere (Watson 2009). Understanding context, differences, and similarities adapting, and factoring them into the local context during adoption is key to success. Given the preference for the master planning system expressed by the two study countries, a shift by Nigeria from its current system to adopt some of Singapore's core elements which have made it the great success it is today will not be a major disruptive move. To facilitate positive change in Nigeria's planning sphere drawing lessons from the Singapore model, the following is recommended:

1. *Drawing up Concept Plans (or similar long term plans) in full cognizance of the traditional planning system and adequate implementation of Plans*: Just as the Concept Plan guides Singapore's long-term planning, Nigeria can have a similar plan to guide the overall national development and outline goals which will then be translated into relevant custom Plans at the state and local government levels. Urban Plans are important planning tools and have proven effective in many climes. They are a detailed guide to achieving a purpose. Plans exist for a reason and are meant to guide development and thus need to be properly implemented. Some Nigerian cities already have Master Plans although the implementation is poor. It is important to ensure appropriate implementation and monitoring of existing Master Plans in states and cities that have one. Preparation and implementation of new Plans where they are non-existent or out of date are advocated. Moreover, out-of-date Master Plans need to be reviewed to ensure they are responsive to present realities. Such reviews must involve active public participation to build support and acceptance.

2. *Consistency in policy development, integration, and cooperation*: Adopting a long-term planning approach needs strong policy support. The precarious nature of Nigeria's political system makes long-term planning a challenge but this can be overcome by ensuring the independence of the planning institutions charged with executing the long-term planning Plans. The overarching land use policy must consider the various local contexts, similarities, and differences in the relevant planning policy documents. Where there are different agencies involved in executing laws and policies, a framework should be in place to enhance cooperation and avoid duplication of tasks, efforts, roles and eliminate in-fighting. This framework should also include the private sector and general citizen participation. The lack of integration of colonial planning legacy and customary land use practices creates tension between government planning authorities and traditional authorities. This also necessitates policy-level attention. Given the current and projected population growth, it is key for urban expansion policy to adopt a cohesive, holistic, and strategic stance instead of the current piecemeal approach, for a better planning outcome.

3. *Retain current three-tier planning system but strengthen planning institutions at all levels*: The problem of weak institutions including institutions charged with urban development like the ministries of urban development is a development barrier. Planning institutions should be strengthened and made independent to be able to hold their ground in the face of political interventions from powerful individuals who circumvent the system for their benefit. The local governments also need to be strengthened to be able to efficiently perform their roles in urban development as mandated by Decree no 88 1992. National-level plans should specify national planning guidelines while state-level Plans work with these guidelines to formulate state goals and planning projects that will deliver the outlined goals. The same needs to happen at the local level. There is a need for state and local level urban planning to map out land use regulations to align with constituents' aspirations. The state and local level plans need to be in accordance and according to national guidelines to ensure congruence. A timeline backed by law with relevant sanctions should guide planning administration activities to eliminate bureaucracy and time wastage associated with government activities in Nigeria.

4. *Putting in place strong disincentives for corruption*: Effective systems of control are supported by stiff and firm sanctions to deal with contravention if it is to be effective as intended. Enforcement of Development Control is an important aspect of planning but largely fails due to factors including corruption and political interference. To change the paradigm, adopting stiff sanctions along the lines of what is practiced in Singapore is highly recommended to serve as a deterrent to offenders and ensure better compliance. Receivers and givers of bribes both deserve punishment and erring government planners who go against the rules should also be relieved of their duties to sanitize the system.

9 Conclusion

While countries are unique, there are opportunities to learn from each other and adapt best practices to local situations. Singapore is one country that has achieved immense success because of its purposeful approach to national outcomes. Environmental, social, and economic sustainability is Singapore's national goal which has been fostered by progressive urban planning and development. Nigeria can emulate the key factors of focused leadership, discipline, and clear goals, planning, and execution that made Singapore a resounding global success. Given that Nigeria has the compulsory land acquisition act like Singapore, there is an opportunity to use this Act to foster integration among its diverse peoples just as Singapore has achieved. Even though Nigeria is more ethnically and culturally diverse than Singapore, adequate urban planning can help it achieve its goals of unity along the lines of Singapore's unification strategy. Ensuring cohesion and taking a central and integrated approach to planning and changing land ownership rules and working to integrate the various tribes and ethnic groups in the manner that Singapore has done will go a long way in achieving cohesion and unity. Governments in power are encouraged to shelve political and selfish ambitions in the application of the Planning Act and needed reforms in Nigeria. Singapore's successful outcomes are built on the twin foundations of sustainable urban planning and development and good urban governance. Singapore adopts a long-term planning approach, sometimes as far as a century ahead, but retains the flexibility to review plans as needs change. This is certainly an approach Nigeria can emulate to achieve environmental, economic, and social development. Adopting a tweaked form of the Singapore model could be the panacea to the woe that is the state of Nigeria's Urban planning. Singapore's success did not happen by chance but is a result of inspirational leadership, hard work, and vision. The Singapore model is unique and not replicable in its entirety in Nigeria, but the core success factors can be drawn upon which is regarded in this paper as visionary leadership, discipline, focus, and understanding where the country's strength lies and capitalizing on it to achieve sustainable development.

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Territorial cohesion, the COVID-19 crisis and the urban paradox: Future challenges in urbanization and economic agglomeration

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Abstract. The recent COVID-19 pandemic and the subsequent economic downturn due to the lockdown of economic activities have spurred a lively debate concerning their effects across locations in the EU and the resulting challenges to territorial cohesion policy. The COVID-19 emergency not only has provoked EU cohesion policy responses but also may change some of the basic principles on which these policies have been built. This paper briefly casts light on some present and future implications of the COVID-19 pandemic for two fundamental aspects of territorial cohesion policy, namely urbanization and economic agglomeration. Both aspects are linked to territorial cohesion's significant dimension of polycentricity (as balanced and harmonious development), and together they constitute a challenge to established norms of urban agglomeration. Finally, the paper discusses some policy ideas that have recently (re)appeared on the European policy landscape. Such policy options bring together urban development and regional policy agendas with the aim of promoting territorial cohesion by attempting to solve the 'urban paradox' – the coexisting positive and negative effects of urban agglomeration and its established geography.

Key words: territorial cohesion, COVID-19, urbanization, economic agglomeration, urban paradox, regional policy

1 Introduction

The recent COVID-19 pandemic and the subsequent economic downturn due to the lockdown of economic activities have greatly affected the economic well-being of Europeans, putting the European Union (EU) member states under severe stress. The recession had not only economic but also social effects, as relative indicators reveal (Grasso et al. 2021). Furthermore, the effects of the crisis appear anything but spatially uniform, affecting different EU locations in very different ways (Bailey et al. 2020, Kapitsinis 2020). These new developments have triggered a growing and heated debate concerning the uneven impact of the pandemic on different locations in the EU and the resulting challenges to territorial cohesion and territorial cohesion policy (Capello, Caragliu 2021).

Territorial cohesion is a shared competence distributed between the European Commission and the various EU member states/governments. It is an ambiguous and multifaceted concept with many interpretations. It has been the subject of numerous efforts to (re)construct its character and meaning (Artelaris, Mavrommatis 2020). Among other

interpretations, Mirwaldt et al. (2008) have argued that territorial cohesion is comprised of the following dimensions: 1) a form of polycentricity that can promote economic competitiveness and innovation; 2) balanced development that reduces socioeconomic disparities; 3) access to services, facilities and knowledge irrespective of where one lives; 4) networking and the creation of physical and interactive connections between centres and other areas. For Medeiros (2019), the most characteristic dimension of territorial cohesion is polycentricity as it promotes balanced and harmonious development.

The emergence of the European policy discourse on territorial cohesion has also led to the re-conceptualization of regional policy by supplementing it with the notion of spatial justice (Davoudi 2005). This notion considers justice as a matter of geography (Heynen et al. 2018) associated with 'both processes (income distribution mechanisms) and outcomes (level of imbalances) prevailing in different territories' (Petrakos et al. 2021, p. 2). Great strides have been made in academia during recent years toward the application of the concept of spatial justice in relation to EU cohesion policy concerns (Kearns et al. 2014, Jones et al. 2020), and some European policymakers have explored whether the concept of spatial justice can be used as an effective alternative to territorial cohesion (Jones et al. 2019, p. 99).

This paper sheds light on the possible effects of the COVID-19 pandemic on a few critical aspects of EU territorial cohesion and territorial cohesion policy. It can be argued that the COVID-19 emergency has provoked EU cohesion policy responses by possibly increasing territorial inequality and necessitating recovery across EU territories. It can also be suggested that the COVID-19 emergency might lead to changes in some of the basic foundations on which territorial cohesion policies have been built. More to the point, the paper envisages some present and future implications of the COVID-19 pandemic for two fundamental aspects of territorial cohesion, namely urbanization and economic agglomeration (which, in combination, are called urban agglomeration). Although territorial cohesion policy has many dimensions, extending from social cohesion to environmental sustainability and from physical and digital networking to regions that are lagging behind, this paper's emphasis on urbanization (urban agglomeration) stems from the following two considerations. Firstly, although urbanization is a highly differentiated process across EU space, almost 75% of EU residents are based in cities and towns, with that share estimated to reach almost 85% by 2050 (Bachtler et al. 2020). In other words, the EU is clearly an urbanized and urbanizing space. Secondly, territorial cohesion has a clearly marked urban dimension (Medeiros 2019) as it is related to polycentricity, which promotes harmonious and balanced development across regions; cities are the centres of economic growth and have the potential to lead regions toward economic development. Accordingly, as we shall see, urban development and regional policy agendas can be interconnected and interrelated.

2 Territorial cohesion, spatial inequalities and the COVID-19 pandemic

During the last two decades, the EU has experienced rising levels of territorial inequality as a result of important socioeconomic and political changes (Artelaris, Tsirbas 2018, Iammarino et al. 2019, Bailey et al. 2020, Dijkstra et al. 2020). The increase in, and need to limit, spatial inequalities among EU localities have lately been highlighted in several official EU documents, such as the Territorial Agenda 2030 (Ministers 2020). Furthermore, it has been argued that spatial disparities might not only endanger what is perceived as the European Model of Society and EU economic, social and territorial cohesion (Faludi 2007a,b, Zaucha, Böhme 2020) but also hamper European integration and even threaten democracy.

Territorial cohesion is the opposite of territorial inequality; when the aims and goals of territorial cohesion are met, spatial inequalities and disparities between and within places gradually diminish. However, the COVID-19 pandemic encountered an environment of increased territorial inequality across EU space. Only a few years after the end of the 2008 crisis, the COVID-19 crisis once again poses great challenges for several EU countries and the EU as a whole; this is probably the most serious test of the EU in terms of crisis management since the end of World War II (Russack, Blockmans 2020), calling

many past certainties into question. Beyond its effects on health, COVID-19 has triggered an economic and social crisis. However, the 'footprint' of the crisis is expected to be spatially uneven rather than homogeneous. Although the literature on geographies of crisis is scarce and underdeveloped, and rigorous explanations for the respective responses of different regions to shocks are lacking (Eraydin 2016, Martin et al. 2016, Artelaris 2017),[1] a clear message from studies of the 2008 economic crisis in the EU was that some regions were more affected than others (Committee of the Regions 2010, Martin 2010, Kitson et al. 2011, Brakman et al. 2015, Capello et al. 2015).

Although more and better data is needed to understand and evaluate the economic and social effects of COVID-19 at the spatial level, a few recent studies, mainly focusing on GDP per capita, reveal that the pandemic crisis has left an uneven spatial footprint and show evidence of increasing levels of territorial inequality (OECD 2020). For instance, Capello, Caragliu (2021), using the latest generation of the Macroeconomic, Sectoral, Social, Territorial (MASST4) model, show evidence of increasing regional inequality in the EU, mainly arising from the heterogeneous effects of the crisis at the country level. In a similar vein, Brada et al. (2021) also offer evidence of growing regional inequalities in their examination of 199 NUTS-3 regions in Central and Eastern Europe (CEE). In short, the COVID-19 crisis appears to have reinforced and even deepened spatial disparities, posing new challenges to EU territorial cohesion.

From a policy point of view, the existing (preliminary) empirical evidence encourages the implementation of a sound territorial policy and the adoption of spatially selective interventions to ameliorate the effects of the pandemic crisis on the areas most affected. Moreover, (past) experience suggests that there is a need for appropriate and focused policy efforts to actively protect social outcomes rather than trying to recover losses in the aftermath of crises, as economic recoveries do not necessarily and inevitably lead to recoveries for human and social indicators; very often, the damage is permanent or highly persistent because some of these losses are simply not recoverable (Martin 2010, Mohseni-Cheraghlou 2016, Artelaris 2017). As stated in the Territorial Agenda 2030:

> While revising the Territorial Agenda, the COVID-19 pandemic has changed policy making and future development outlooks. As implications and policy responses vary across territories due to different conditions, the pandemic shows that territories matter and are highly interdependent. Territorial cohesion should play an important role in the recovery process. (Ministers 2020, p. 2)

3 European Union Policy Responses to the COVID-19 Pandemic

In this challenging environment, some questions naturally arise in terms of EU policy: What were the immediate EU policy responses to the pandemic? What changes did the COVID-19 pandemic bring to EU cohesion policies and territorial cohesion policy in particular? To start with, the EU adjusted its budget to cope with the negative socioeconomic consequences of the pandemic. In July 2020, the Special European Council decided on a massive European Recovery Plan increasing the budget of the post-2020 period. The main aim was to support a 'sustainable and resilient recovery' while promoting the already-intended green and digital transitions (Bachtler et al. 2020). The most significant measures were the launching of the 'Next Generation EU' initiative (2021-2024) and a new, revamped budget for the current programming period (2021-2027) exceeding one billion euros. Other significant measures included the creation of a financial

[1] It is worth noting that the literature focusing on this issue has two main strands. The first strand relates the spatial concentration of economic activities to cycles, suggesting that regional disparities exhibit a pro-cyclical behavior, increasing in periods of expansion and decreasing in periods of recession (Berry 1988). The second strand, known as regional resilience and triggered by the 2008 crisis, refers to the manner in which spatial entities or systems react to and recover from adverse disruptions, such as recessionary downturns and economic shocks (Martin 2012, Martin et al. 2016, Sensier et al. 2016). Although there is no consensus, potential critical determinants of the crisis have been considered to include geography, economic structures, policies, the openness of trade and instability of exports of goods, infrastructure and regional innovation systems (Artelaris 2017).

instrument providing (temporary) support to mitigate unemployment risks in a crisis-ridden environment (SURE), amendments to the EU budget to address urgent issues, redirection of EU funds to help the member states most in need and support to the sectors most affected[2]. Apart from these emergency measures, the main priorities remained the facilitation of a transition to a 'smarter' and 'greener' Europe. For the European Commission, the advent of the pandemic was not only a challenge but also an opportunity to bring closer the much-needed digital and green revolutions. As stated by the European Commission: 'Our generational challenges – the green and digital revolutions – are even more important now than before the [COVID-19] crisis started. Through the recovery, we will press fast-forward on the twin green and digital revolutions' (EC 2020b).

Cohesion policy has proven to be an effective and efficient policy tool in mitigating economic crises, such as the 2008 economic crisis and the 2014-15 refugee crisis. The current pandemic is no exception as cohesion policy has been one of the cornerstones of the European response to the COVID-19 crisis. For example, a new initiative, REACT-EU, was established to increase the 2014-2020 budget for cohesion policies by 55 billion euros. The REACT-EU initiative stands for Recovery Assistance for Cohesion and Territories of Europe. The extra funding was distributed between the European Regional Development Fund (ERDF), the European Social Fund (ESF) and the European Fund for Aid to the Most Deprived (EC 2020a). The new instrument was launched in 2020 and continues in 2021-2022 through funds from the 'Next Generation EU' initiative. It aims to provide financial support for the recovery of significant sectors of the economy while decisions for the allocation of funds take place at the national level. All these initiatives offer great help in all EU countries, but those hit hardest benefit the most (Sapir 2020).

4 Looking into the future: Changes in urbanization?

All across Europe, economic development concentrates in cities and their adjacent metropolitan (functional) areas. These are the places where the bulk of innovation, digitization and rapid economic growth are concentrated; these are the hotspots of our established economic system. The concentration of people, activity and resources in a small number of big cities advances economic growth and innovation and even drags surrounding regions into development through a number of positive externalities (Annez, Buckley 2009). European societies are based on the concentration of population and human activity in cities and thus are highly urbanized in nature. Apart from being significant economic growth machines, cities are also the social, cultural and political pinnacles of our urban civilization. In short, urbanization and city life constitute the mainstream of our way of life (Quigley 2009). However, this state of affairs is not without problems. For instance, the concentration of people and wealth in a few urban areas creates traffic congestion, pollution, inflated housing prices and spatial inequality not only within cities but also between developed cities and other, less developed areas. This is the 'urban paradox' that characterizes established forms of urbanization in the EU and beyond (Eurostat 2016, p. 34).

As far as the COVID-19 crisis is concerned, it is widely accepted that the spread of the pandemic has been positively correlated with levels of urbanization and population density (Connolly et al. 2020). For instance, city centres and inner-city areas with high population density have proved to be the prime victims of the pandemic, leading, in several cases (such as New York), to the collapse of their healthcare systems. In this context, demand has greatly increased, at least during the early stage of the pandemic, for housing away from neighbourhoods with high population density; the main cause of this trend is related to the decreased need to live near jobs (Liu, Su 2021). Furthermore, the pandemic appears to have intensified socio-spatial inequalities as infection rates were much higher in deprived neighbourhoods and among ethnic minorities (Biglieri et al. 2020).

The positive relation between urbanization and levels of infection raises questions about the future of our crowded cities. The current pandemic has changed city life

[2]For a thorough presentation, see https://www.consilium.europa.eu/en/policies/coronavirus/covid-19-economy.

and, even more importantly, the ways we think about urban density. During successive lockdowns and acute restrictions on mobility, cities and city centres lost much of their liveliness and economic activity (Lee, Huang 2022). Gradually, a small but growing literature has begun to emerge documenting the ways that cities have coped and are still coping with the evolving pandemic crisis. An uncertainty about the future of cities has come to the fore (Gill et al. 2020).

More to the point, the COVID-19 crisis and its urban effects have created dual scenarios for the future of cities. One line of thought (for instance, Graziano 2021) envisions de-urbanization and a 'back to the villages, towns and rural areas' movement. In this scenario, technology is deemed to play a paramount role in facilitating forms of remote work and providing other technology-driven services. Closely related to this notion of de-urbanization is the concept of the 'distanced city' (Gill et al. 2020), where people work from home, engage in electronic shopping and adopt various measures of physical detachment to protect themselves from the crowdedness of city life. For instance, Lee, Huang (2022) showed the existence of strong support for 'urban' flight within metropolitan areas in the United States during the pandemic. In sharp contrast to this, the second scenario envisions the emergence of the city of 'proximity' (Cerasoli et al. 2022). According to this scenario, COVID-19-related mobility restrictions have made proximity extremely important. Some other writers have even argued for the need to create 'an economy of proximity' (Tricarico, De Vidovich 2021); all these ideas bring to the fore the notion of a new 'hyper-local' urbanism. According to such narratives, there is a need to reconfigure the role of proximity in city life by eradicating travel time and thus creating more compact and coherent neighbourhoods where residents can work, shop, be entertained and receive health-related services close to their homes. Many cities around the world, from Seoul to Paris, appear to have adopted this philosophy by working towards the creation of the 10- or 15-minute city. On this model, travel on foot or by cycling should be sufficient to meet all one's needs. To cut a long story short, the COVID-19 pandemic appears to have produced dual future urban scenarios, based either on de-urbanization and distanced living or on urban living characterized by proximity, neighbourhood self-sufficiency and 'hyper-localism'.

Furthermore, the post-pandemic city has been envisaged as greener and sustainable (Ferrini, Gori 2020). A new urban planning philosophy and even architectural paradigm have been deemed necessary (Sharifi, Kharavian-Garmsir 2020). Through the prism of the 'distanced city', it has been argued that a dominance of suburbs over city centres might characterize post-pandemic times. E-commerce and remote work might become permanent features of our lives and lead to the decentralization of activities and forms of dwelling (Pisano 2020). As a result, urban centres might lose a large part of their vitality and even experience a gradual economic and cultural decline. However, we should not forget that since Louis Mumford's 'Culture of Cities' (Mumford 1970), cities and urban centres have been regarded as manifesting life in its highest form. Jane Jacobs (1961) and Richard Sennett (1970) perceived face-to-face interaction and urban encounters as the very essence of city life. Economic geography contributed a perception of spatial clustering as responsible for producing innovation and economic growth. Richard Florida spoke of the creativity of cities (Florida 2002). All these ideas are, in one way or another, close to the notion of 'proximity'. One is left wondering whether the pandemic might bring some of these aspects of city life close to an end, changing our urban lives and the ways we think about cities and city centres.

For some authors, the expected effect of the pandemic on cities depends on its duration. If the pandemic lasts for years, they believe, cities will change to a significant extent; if its duration is shorter, changes to cities might not be of great concern (Florida et al. 2021). Currently, we are in the midst of an economic recovery, compromised by rising inflation, near the end of a pandemic and facing the risk that COVID-19 might become endemic. Consumption has increased, and many city centres are open to customers and workers alike. Several reports anticipate that cities and urban centres will prosper as people are eager for face-to-face contact (Giorgi et al. 2022). However, some cities are still empty as people continue to work from home. For Mumford (1970), as long as people desire face-to-face contact, cities and city centres will exist in one form or another. Again, only

the passage of time will make clear whether the pandemic eventually changes urbanization or cities continue as they have been.

5 Looking into the future: A more dispersed economic agglomeration?

The COVID-19 pandemic has the potential not only to transform cities and urbanization but also, more importantly, to challenge the territorial logic on which our economic system is based. As argued above, polycentric development is one of the most important aspects of territorial cohesion. The idea of polycentricity is close to the notions of economic competitiveness, smart growth and digital connectivity (Artelaris, Mavrommatis 2020). For territorial cohesion policy, the concentration of people, activity and prosperity in a few specific urban areas both increases costs (land values, quality of life, commuting time, etc.) and creates obstacles to spatial justice (concentration of economic opportunity, facilities, infrastructure, etc.). These are the negative aspects of the urban paradox. Nevertheless, territorial cohesion policy accepts the positive side of the urban paradox, namely that cities are the main engines of economic growth and innovation. In a way, one of the goals of territorial cohesion policy is to take advantage of the positive side (urban growth) while counteracting the negative aspects of the urban paradox. The aim of territorial cohesion can further be described as facilitating harmonious and balanced development through the creation of a polycentric urban system able to produce significant economic growth and development. The creation of such a system can increase the economic competitiveness of different regions and break the monopolistic conditions attendant on the European global city model.

Leaving aside for a moment the idea of the polycentric system, the reality is that cohesion policies in general and territorial cohesion policy in particular are based on the notion of economic agglomeration. Since the 1990s, the agglomeration of economic activity has been the model on which cohesion policies were built. To put it differently, cohesion and territorial cohesion policies have followed, or simply accepted, an agglomeration-centric approach by adopting neoliberal economic principles: the free economy boosts economic growth while finding, in parallel, ways for it to trickle down (Davoudi 2020). In short, the agglomeration model has been the economic cornerstone of cohesion policy (Cotella, Vitale Brovarone 2021). Agglomeration is even the basis for the idea of creating a polycentric European urban system, albeit a more dispersed one with more cities (polycentric development) creating growth, advancing economic development and bringing along surrounding regions.

However, the COVID-19 pandemic appears to create barriers to the efficiency of the economic agglomeration or urban agglomeration model. As the pandemic has spread widely in cities, those are the places under the greatest threat (Connolly et al. 2020). In this sense, the vulnerability of (crowded) cities to the pandemic calls into question the future viability of the agglomeration-centric approach according to which economic activity and human skills concentrate in urban densely populated areas. Accordingly, in the light of the COVID-19 pandemic, some pertinent (although theoretical) questions arise: What is the future of economic agglomeration or urban agglomeration? What alternative types of spatial models could emerge to create economic growth in a post-pandemic world that takes seriously the possibility of new pandemic outbreaks? Could these new spatial models be closer to the aims of territorial cohesion?

The reality is that the European economic model cannot really abandon its urban agglomeration logic; practically, it cannot leave cities behind and extensively relocate economic activities to the countryside and beyond. This is not feasible under current circumstances as the economic system is clearly urban in nature. Nevertheless, for some scholars, massive investment could render rural areas more livable and functional as a complement to the urban dimension (Cotella, Vitale Brovarone 2021). In such a scenario, agglomeration would spread from cities to the surrounding rural areas, creating more opportunities for people and economic activities. However, the 'new' rural would not substitute for the urban; instead, the rural and the urban would work together to create a new, more 'spread-out' form of the agglomeration model (Cotella, Vitale Brovarone 2021). This is probably similar to Lefebvre's (2003) idea of the creation of an urban capitalist

economic system that is found not only in cities but also in areas that lie between them – a more dispersed agglomeration that encompasses both urban and rural spaces. Will the pandemic bring Lefebvre's urban 'capitalist revolution' closer to reality than before? This is debatable. However, it is time to shift our focus to some policy ideas and options that have recently appeared on the European policy landscape.

6 Policy options: From the urban paradox to territorial cohesion policy for post-pandemic recovery

By situating the idea of the urban paradox within the context of this paper, we seek to put forward some policy thinking and options that, while not new, have lately experienced a boost. In very simple terms, the urban paradox can be summarized as follows: the growth of cities and urban areas promotes economic development and innovation. However, such urban growth also creates problems, including inequality within urban centres and disparities between them and less developed areas. Paradoxes are logical contradictions, which are not exactly meant to be solved. A paradox is inherently unsolvable; solving it would prove it was not a true paradox. From Zeno of Elea to Bertrand Russell, paradoxes have been central to philosophical thinking by challenging us and provoking fresh thought. According to the Cambridge Dictionary, a paradox is 'a situation or statement that seems impossible or difficult to understand because it contains two opposite facts or characteristics'. A paradox presents a contradiction and shows the limitations of reason.

Bringing these ideas closer to the subject of this paper, we could argue that the urban paradox can be rephrased by saying that urban agglomeration is 'good' and urban agglomeration is 'bad' (for the aforementioned reasons). These contradictory statements both characterize our European urban system and its geographical economic logic. Nevertheless, the COVID-19 crisis poses a test for the present and future of our crowded cities, for the established economic system as well as its territorial logic; the pandemic constitutes a challenge to the regime of urban agglomeration in the EU (and elsewhere). Consequently, its effects seem to influence the salience of the urban paradox. As argued, de-urbanization and the creation of a 'distanced city' have the potential to change cities and urban areas. At the same time, the possibility of a more spread-out regime of economic agglomeration might influence the territoriality of our economic system. These developments render the future existence of the urban paradox less certain, partly jeopardizing the 'truth' of the two contradictory statements it contains. Time will tell.

The existence of the urban paradox is a significant reason for the creation of territorial cohesion policy as that policy attempts to ameliorate the negative effects of urban agglomeration without compromising its positive ones. How does it do that? By promoting polycentricity within the European urban system, and through that, a harmonious and balanced development across EU space. In more concrete policy terms, the urban paradox can be seen as the relationship between regional policy, urbanization and economic agglomeration (Ferry, den Hoed 2020). Bringing regional policy to the forefront, the urban paradox can be recast as following: urban agglomeration is 'good' for regional economic growth but 'bad' in terms of regional inequality (at the national level). Regional policy deserves foregrounding here because the harmonious, balanced development that is its very essence makes it part and parcel of territorial cohesion policy.

In this context, the key question is what regional policy can do in relation to the urban paradox, specifically how it can take advantage of the positive while ameliorating the negative effects. It should be highlighted that, in general terms, regional and urban policy are distinct and autonomous fields at the national policy level. Nevertheless, regional policy attempts to promote and facilitate urban growth and development as it accepts that regional growth is (mostly) dependent on the economic performance of urban centres that economically strengthen surrounding areas through spillover effects and positive externalities. At the same time, it attempts to ameliorate the negative effects of urban agglomeration on the equity of inter-regional growth. How can this be done? By bringing urban development and regional policy agendas closer together. As a matter of fact, during the pandemic in the last two years, regional policies in a number

of EU member states have addressed urban issues; there has been an ongoing effort to combine urban and regional agendas by acknowledging the contribution of urban areas to regional development. This has taken place mostly through policy governance measures and strategic frameworks that integrate urban and regional concerns (Ferry, den Hoed 2020).

One such approach is the promotion of urban-rural linkages that acknowledge the complex dependencies between urban and rural areas. As Cotella, Vitale Brovarone (2020) argue, the COVID-19 pandemic is 'a specific moment in time where contextual conditions allow to push forward conditions that would not take root in normal times as for instance those insisting on the valorization of inner areas [inner rural areas in Italy] and the potential synergies that could be established with denser urban regions' (Cotella, Vitale Brovarone 2020, p. 115). Furthermore, the role of medium-sized cities increases in prominence as a means of promoting regional development and moving towards the always sought-after, yet never attained, goal of regional equity. In close relevance to this, Medeiros, Rauhut (2020), within the context of territorial cohesion policy, have highlighted the importance of strengthening medium-sized towns through targeted public and private investment as a way of achieving territorial cohesion within countries and across EU space. Their rationale is based on the hypothesis that the growth of medium-sized cities, or 'Territorial Cohesion cities', will lead to the growth of undeveloped areas and thus contribute to territorial cohesion or regional equity. It is interesting and deserving of further research how the effects of the COVID-19 pandemic may transform these policy ideas (rural-urban relationships and the role of medium-sized cities) in relation to the urban paradox.

7 Conclusions

The recent pandemic, probably resulting in the most dramatic economic crisis in the history of the EU, constitutes a major challenge for the EU's economic, social and territorial cohesion. Although more and better data is needed, there is reason to think that the effects of this multifaceted crisis are not geographically homogeneous across Europe; instead, new forms and increasing levels of inequality have emerged across and within EU countries, regions and localities, undermining the European objectives of economic, social and territorial cohesion. From this perspective, European territorial cohesion policy might be a sound and effective policy tool for bringing about a post-pandemic economic, social and territorial revival. There is also reason to think that the COVID-19 emergency might lead to changes in some of the basic foundations on which territorial cohesion policies have been built.

This paper has shed some light on the possible effects of the COVID-19 crisis on two fundamental aspects of territorial cohesion, namely urbanization and economic agglomeration (urban agglomeration). As city centers and inner-city areas with high population density emerged as the prime victims of the pandemic, the positive relation between urbanization and levels of infection raised questions about the future of our crowded cities. The current pandemic has both transformed city life and, even more significantly, brought changes to the ways we think about urbanization and urban density. As a result, an ambiguity about the future of cities has come to the fore as cities face the choice between a distanced model and a model that prioritizes proximity. Partly as a result of this ambiguity, the pandemic has the potential not only to change cities and urbanization patterns but also, more importantly, to challenge the territorial logic on which our economic system is based. The COVID-19 crisis creates barriers to the efficiency of the economic agglomeration or urban agglomeration model. The vulnerability of (crowded) cities exposed by the pandemic calls into question the future viability of the urban-agglomeration-centric approach. In consequence, we are left to wonder not only about the future of our cities but also about the prospects of the established urban agglomeration model.

In most circumstances, regional and urban policies are distinct and autonomous fields. However, during the last two years, the regional policies of many EU member states have attempted to address urban issues; there have been significant efforts to integrate

urban and regional agendas. One such effort works through the promotion of urban-rural linkages. Additionally, a more prominent role is emerging for medium-sized cities as means of promoting regional development and regional equity. For the urban paradox to be addressed, European territorial cohesion and regional policy should work together to strengthen the merits of urban agglomeration and counteract its negative aspects. However, we do not expect the urban paradox to be solved; if it were solvable, it would not be a true paradox. As a matter of fact, in philosophy, logic and mathematics, paradoxes are not there to be solved; instead, they urge us to think afresh and change our perspective. In the light of the COVID-19 pandemic and the changes it has brought to the established regime of urban agglomeration in and across the EU, our policy perspectives on territorial cohesion and regional policy might well be in need of some novelty and fresh thinking.

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Investment in digital infrastructure: Why and for whom?

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Abstract. This study investigates the variation in attitudes across stakeholders towards investments in the digital economy. Using semi-structured interviews to identify attitudes about the spatially evolving socioeconomic importance of the digital economy in New Zealand, we identified seven distinct yet partially overlapping concerns that prioritise preferences for digital investment. A key finding is that there are important asymmetries in stakeholders' narratives and epistemological foundations that currently align to collectively strengthen resolve to invest in digital infrastructure and training, but this alignment may splinter in future. Some stakeholders saw internet access as coalescing social economy, and there were concerns that some people and some places would get left behind if access is not rolled out uniformly and as a priority. There were disagreements about who will prosper, who will get left behind, who should pay for upgrading digital skills, the extent that investments were connected with wellbeing and identity, whether fake news was significant, and the longevity of the impact of digital economy investments. This study contributes to theory by demonstrating that practically-relevant, socially-informed policy decisions can be underpinned by collective efforts that draw on heterogeneous narratives and multidimensional understandings.

JEL classification: D83; L86; L96; O18; R58

Key words: Internet, Infrastructure, Wellbeing, Left behind, Places, People, Epistemology

1 Introduction

Policymakers residing over different jurisdictions gather and share knowledge, experience, and policy insights with fellow policymakers, stakeholders, and academics to try to augment the influence and impact of their policies. Policymakers' own experiences and current contexts influence their understandings of the strength and effect of available policy options. In some cases, contrasting stakeholder pressures create inertia in the system reducing the likelihood of achieving agreement across the political spectrum. In other cases, conflicting epistemological foundations can coalesce to steamroll the development process, which is the case when stakeholders, academics, and policymakers agree on a policy outcome but for disparate reasons.

The digital economy (DE) represents the convergence of computing, fixed and mobile telecommunications, commerce, and entertainment (Tapscott 1994); the architecture of the DE includes applications, platforms, and infrastructures (Hanseth, Lyytinen 2016). New DE business models have created enormous wealth, concentrated in a small number of countries, companies, and individuals. Countries face policy challenges to realise the potential of the DE such that the benefits are realised by many and not just the few.

The purpose of this paper is to assess the extent to which DE development policies are underpinned by diverse understandings of the costs and benefits of DE investments. This is important because if influential stakeholders, academics, and/or policymakers begin to perceive that the net benefits of DE investments are waning, then inertia may set in and potentially enhance the spatial inequalities in online accessibility.

The aim of this research is to understand the different narratives underpinning DE policy. We created a semi-structured interview schedule centred around DE issues relating to engagement, wellbeing, and opportunities in an attempt to uncover perceptions, processes, needs, and priorities associated with DE investment policies. We then interviewed a structured sample of key informed stakeholders, academics, and policymakers across New Zealand. New Zealand is a particularly interesting and relevant case study as their government is leading the world by altering their budgetary focus to strive to ensure a holistic approach to wellbeing and wealth, with some policy initiatives focusing on the DE.

We identified seven distinct though partially overlapping concerns relating to the socioeconomic importance of investments. The analysis reveals distinct differences in epistemology underpinning attitudes and perceptions towards the DE. This study contributes to understanding by demonstrating that policy decisions can be underpinned by collective efforts that draw on heterogeneous narratives and multidimensional understandings, but it also warns of potential future challenges to DE investment policies when attitudes wane.

This paper is structured as follows. Section 2 reviews the literature on the importance of narrative, attitudes, pressure groups, and other stakeholders in the formation of resource allocation policies and highlights existing gaps in this literature. Section 3 presents the research methodology. Section 4 presents the identified themes and synthesises the findings. Section 5 discusses these results and draws conclusions.

2 Literature review

Shiller's seminal contribution (Shiller 2017) contends that discursive narratives, factual or otherwise, effect the occurrence, spreading, and possible control of all aspects of the economy. Shiller argues that spoken and written accounts instinctively and subliminally stir emotions and motivate human actions that affect effort levels, spending patterns, and investments, and thereby shape the evolution of the economy. It is plausible therefore that the presence and evolution of DE policies can be influenced by diverse narratives underpinned by epistemologically informed beliefs and priorities. Contrasting narratives may strengthen the ideological divide between policymakers, stakeholders, and academics, and make majority agreements over policy formation a matter of pragmatism. Given these complex issues, it is surprising when a diverse set of policymakers, stakeholders, and academics agree on the importance of a policy, as appears to be the case for policies relating to DE investments.

2.1 Consensus

The usual stance for advocating the development of the DE is grounded on the assertion that the internet provides superior access to information, greater opportunities to share information, and greater access to a more diverse set of goods, services, and markets. Economic growth then results from increases in productivity, jobs, and firm births (Duvivier et al. 2021, Canzian et al. 2019, Vial 2019). The internet augments social contact and access to healthcare and education, thereby supporting wellbeing (Early, Hernandez 2021, Benda et al. 2020) and strengthening the fabric of society.

The literature tends to view the advocation of DE investments as unquestionable with the proviso that alongside ICT infrastructural investments come investments in digital skills training that enables individuals and firms to benefit. Broadband provision and digital skills are not equally distributed within or between countries leading to a range of digital divides. Three digital divides are identified in the literature (Aissaoui 2021). The first is the access divide between those who do and do not have access to the internet. The second is the use divide between those who do and do not have the digital skills and knowledge to use ICTs. The third level is the performance divide between those who can and cannot mobilise digital resources to achieve their aims and gain offline outcomes (Aissaoui 2021). While much of the digital divide literature focuses on the second and third levels, the first divide persists; for example, 21 million people lack broadband access in the US (Rodriguez, Bates 2020). Support for DE investments is called for across the literature even through arguments explaining why it is needed are heterogenous.

2.2 Economy vs. people

From an economic growth perspective, it is argued that DE investments support an entrepreneurial environment (Gorelova et al. 2021, Tiwasing 2021), encourage firm births (Conroy, Low 2022), and stimulate entrepreneurial behaviours by lowering barriers to entry and creating new markets (Duvivier et al. 2021, Mei, Lu 2020). Early adoption of ICT infrastructures benefit a locality by attracting knowledge intensive firms (Tranos, Mack 2016) that increase the productivity and profitability of resident firms (Kharlamov, Parry 2021, Canzian et al. 2019, Vial 2019). Digitally connected firms benefit from access to online business networks (Tiwasing 2021) and a greater range of suppliers with improved knowledge sharing (Gallardo et al. 2021, Leuven et al. 2018). Access to the internet therefore supports firm growth, innovation, reputation, and competitive advantage (Vial 2019) whereas digital exclusion negatively affects productivity (Gallardo et al. 2021). Firms are known to benefit from engaging in social media due to the growth effects of greater direct connections with customers (Aronica et al. 2021, Tiwasing 2021) that can improve services and enhance operations (Vial 2019), and engender a positive impact on brand equity (Godey et al. 2016). Hence, there is a strong collection of stakeholders, policymakers, and academics who favour the upgrading of the digital infrastructure for reasons relating to the benefits to firms.

An alternative focus is on the benefits to individuals where there tends to be a different set of arguments favouring ICT infrastructure investments. Access to the internet provides individuals with an advantage in finding a job (Denzer et al. 2021, Metu et al. 2020), enabling online searching, access to information on jobs over a wider geographical area, increasing the number of job applications an individual can make, and providing greater access to networks through which they can promote their skills and availability (Denzer et al. 2021, Gürtzgen et al. 2021). For individual consumers, e-commerce can lower prices, reduce travel costs, increase choice, and save time (Ganning, Green 2021, de la Llave Montiel, López 2020, Dolfen et al. 2019, Goldfarb, Tucker 2019).

2.3 Urban vs. rural

The internet can enable and enhance interactions locally and over large geographical distances (Elmassah, Hassanein 2022, Kearns, Whitley 2019, Oh et al. 2014, Ellison et al. 2007), but the benefits to individuals and firms are not aspatial. Spatial disparities exist in the benefits of online retail, with shoppers in high-income countries benefiting most and with the cost of delivery sometimes being prohibitively expensive for remote dwellers in low-income countries (Ganning, Green 2021). This makes the claim for digital infrastructure investments to reduce spatial disparities problematic and contentious.

Remote and rural areas are underserved and have poorer quality connections to the internet (Aissaoui 2021, Riddlesden, Singleton 2014, Tranos, Mack 2016). For example, in the US, less than half of indigenous people residing on reservations and tribal lands have access to high speed broadband due to providers' reluctance to build ICT infrastructure in less populated areas (Early, Hernandez 2021). Bosworth et al. (2020) argue that a spatially uneven ICT infrastructure leads to inequalities in digital skills and an inability

to attract digitally skilled workers or firms to rural areas. They also advocate for a 'smart' countryside and argue that the lack of development of ICT infrastructure in rural areas affects their supply chain and labour market connections to urban areas with whom they are interdependent. Conroy, Low (2022) also emphasise the importance of internet access in rural areas to sustain remote communities, particularly the entrepreneurial activities of women who are more likely to work from home. SMEs and entrepreneurs require access to digital literacy programmes, online business support, high speed broadband access, and the creation of online co-working spaces (Conroy, Low 2022, Tiwasing 2021) that are more readily available in urban areas. Such arguments heighten the need to be spatially-aware when installing an online infrastructure.

However, evidence on the benefits of broadband access to rural entrepreneurialism is mixed. Couture et al. (2021) find that the expansion of broadband and access to e-commerce in rural areas does not lead to income gains for local workers per se, but rather for younger richer rural residents in the form of a lower cost of living. Duvivier et al. (2021, p. 1397) find positive effects of broadband on establishment births in urban and suburban areas but little evidence of an impact on rural areas other than for specific industries (tourism, creative, and business services): 'broadband is clearly not a panacea and certainly not sufficient for creating a good entrepreneurial context in structurally weak areas. As such, focusing exclusively on improving broadband access is likely to generate little impact on local economic development in most areas.' From an economic development perspective therefore, it is possible to see how support for rural ICT infrastructure investments may weaken, particularly when policy is directed towards cities with larger benefiting populations (Rodríguez-Pose 2018). Support for investments in infrastructure is likely to wane if policies do not account for spatial changes in business ecosystems due to digitization and globalisation, or if they do not also address future challenges of climate change, aging, social inclusion, and health (Tödtling, Trippl 2018).

2.4 Health, education, wellbeing, and/or identity

Those advocating for DE investments to enhance individual and community wellbeing argue that the benefits are derived through greater access to healthcare, social networks, and education. Access to the internet has been argued to be both a social determinant of health (Benda et al. 2020) and a basic need that is necessary to thrive in the digitally dependent world (Early, Hernandez 2021). Digital healthcare provides patients with more access and control of their medical records (Rodriguez, Bates 2020), supports older people living the community (Hamblin 2020), and reduces the burden for care givers (Kim et al. 2021). Covid-19 highlighted that the internet provides crucial access to information and advice, online consultations, and services. The shift to digital gives healthcare providers the capability to deliver more efficient and effective care, particularly to those living in remote areas (Kim et al. 2021, Gann 2019, Srivastava, Shainesh 2015).

However, the digital divide is known to lead to uneven health outcomes. Racial and ethnic minorities, low socio-economic groups, the elderly, and rural populations suffer the worst healthcare outcomes and are also those affected most by the digital divide (Hadeler et al. 2021, Kim et al. 2021, Gann 2019). Early, Hernandez (2021) argue that Covid-19 widened the digital divide and amplified systemic racism in the US, where people from Black and Hispanic backgrounds were found to have lower rates of digital access (Dolcini et al. 2021). Black and Hispanic adults were twice as likely as White adults to cancel internet subscriptions due to financial constraints (Vogels et al. 2020) and a lack of broadband access may contribute to lower vaccination rates among these groups (O'Brien 2021). Equitable digital healthcare requires increases in broadband access alongside culturally sensitive digital health tools, greater access to interpreters, and digital training (Hadeler et al. 2021), which strengthens the case for greater access to online facilities from a health perspective. However, Hamblin (2020, p. 120) highlights the lack of clarity over the potential for digital healthcare devices in practice, noting the risks of a pro-innovation culture within local authorities that support small scale pilots with little focus on sustainability, scale, or spread: 'it ... remains unclear if these devices can deliver the outcomes required in diverse local [adult social care] contexts with different demands and policy legacies.'

Covid-19 underscored the essential role that the internet can play in providing access to education, leading to widespread discussion linking the digital divide to pre-existing socio-economic gaps in educational achievement (Benda et al. 2020). It is possible that the return to in-person teaching may lessen calls for DE improvements for education, or for the digital divides faced by children to be addressed, particularly as other issues, such as the cost of living, take to the fore. Children are not naturally well equiped for their digital futures and need to be educated and empowered to shape and utilise future digital technology (Iivari et al. 2020, Binsfeld et al. 2017) requiring a shift in curriculum emphasis and further ICT training for teachers before interventions become effective. If the digital education attainment and skills of the next generation is to drive future development, then investments in ICT infrastructures, and the facilitation of access so that marginalised groups can participate in the DE, remain key for future prosperity.

Akerlof, Kranton (2010) argue that people make behavioural choices based on both monetary incentives and their identity. The nurturing of one's identity and relative performance is known to be important for an individual's subjective wellbeing (Stutzer 2004, Frey et al. 2008) and engagement in social media can increase the visibility of an individual's identity. Douglas, Isherwood (1979) saw identity as both intra-individual (i.e. psychology) and inter-individual (i.e. social), so ensuring that everyone is able to participate in social media by guaranteeing them access to participate in the DE may reduce feelings of social exclusion.

Extending internet access to deprived communities can improve social isolation and mental health (Gann 2019, Kearns, Whitley 2019). However, the positive impacts of the internet on mental health are questionable, as disengagement from social media can increase socialisation with family and friends and increase subjective wellbeing (Allcott et al. 2020). Moreover, girls in particular are at risk of experiencing poor mental health and poor wellbeing due to social media effects (Hartas 2021), although Beeres et al. (2021) suggest that high levels of social media usage may be an indicator rather than a risk factor in mental health. Among older adults, engagement in social media is found to have only marginal impacts on social connection (Quinn 2021).

2.5 Consensus, but devil in the detail

Although existing literature tends to view the advocation of DE investment as unquestionable, there are emerging grounds on which to reassess the perceived net benefits and hence the prioritisation of ICT investments, especially at a time when resources are squeezed during the recovery from the pandemic. Increasing debate about the magnitude of benefits from online access highlights the need to dissect the above arguments and delve deeper to identify the reasons for different influential parties' support for DE investments. If the strength of argument from an influential body advocating further DE investments begins to wane and begins to stress alternative policies, then the prioritisation of further DE investments will be questioned. Moreover, although cost-benefit analyses are often used to justify the prioritisation of resource allocations, each cost and benefit will attract different weightings depending on the underlying epistemological stance. A debate therefore arises on whether the strength of the ICT infrastructure and DE investment narrative is weakening.

To identify the intensity of support for further DE investments it is necessary to explore the strength of narratives relating to their costs and benefits. To fill this gap in the literature we need to know whether policymakers, stakeholders, and academics all agree on who benefits from digital investments, how they benefit, why they benefit, why they should benefit now rather than later, and whether investments should continue to remain a priority. This research sought to understand the narrative and epistemological stance of a variety of stakeholders, policymakers, and academics, which is important given Shiller's contention (Shiller 2017) that discursive narratives, factual or otherwise, effect the occurrence, spreading, and possible control of economic fluctuations. As narrative motivates spending patterns and investments that shape the evolution of the economy, it is important to recognise and understand what underpins DE policy narratives and whether those narratives are weakening. As a narrative is unlikely to be accepted if it is deemed to be implausible, lack credibility, or lack competence from an onlooker's perspective (Govier

1980), a policy narrative will weaken when the strength of a perspective wanes. Hence, our research sought to understand the foundations of different narratives concerning if and why DE investments are a priority, gage the extent that each perspective is likely to continue to have credence, and assess whether there are likely to be emerging gaps in the narrative supporting the continued development of ICT infrastructure.

3 Research approach

This research investigated knowledge and attitudes towards ICT infrastructure and the digital economy within and across New Zealand, which is a high-income country that explicitly prioritises wellbeing in its annual Budget. The research sought to increase understanding of the successes, visions, challenges, and apprehensions of investing in DE through interviews with policymakers, stakeholders, and academics. Interviews were considered to be more appropriate than questionnaires given that questionnaires are less able to capture complexities such as the inter-relationships, relative weightings, and the cumulative influence of factors (Lightbody 2009).

A detailed semi-structured interview schedule was developed to ensure that a full range of expected issues were included in the discussion while also ensuring space and flexibility for deeper discussion of both expected and unexpected issues if and when interviewees wished to go in those directions. Given NZ's Budget focus on wellbeing, we started the semi-structured interview with questions relating to if and how DE investments were aligned to growth and wellbeing issues, and then discussed whether DE investments were likely to benefit growth more than wellbeing. The semi-structured interview schedule then proceeded to discuss whether DE investments were geared towards reducing the rural-urban divide and whether they improved the wellbeing of remote communities or affected people's level of loneliness. The schedule then moved towards a discussion of the sectors that are likely to benefit most. Finally, the schedule proceeded to discuss ambitions for the future of DE and to identify what the future may hold for different parts of NZ's social economy.

The sample of interviewees was developed initially from contacts, and those contacts introduced new contacts using a snowball sampling approach. An important consideration was that a wide and diverse range of representatives from policy-focused and pressure group organisations should be included to ensure a broad range of contending perspectives and to draw on a contrasting range of experiences and expertise. Gilbert (2005, p. 61) argues that 'where the researcher's aim is to generate theory, a wider understanding of social processes or social actions, the representativeness of the sample may be less important, and the best sampling strategy is often focused or judgemental sampling.' Ensuring that the sample was broad and heterogeneous should enable the identification of both consistent and contrasting attitudes towards the DE infrastructure and the digital economy more generally.

Informed policymakers, academics, and respected intermediaries were approached through existing contacts; a sample of ten senior policymakers, stakeholders, and academics agreed to participate in detailed semi-structured interviews that were expected to last for between 40 minutes and one hour. In practice, however, the semi-structured interviews lasted for an average of 80 minutes and ranged from between 40 minutes to $2\frac{1}{2}$ hours depending on both the enthusiasm of the interviewee to engage with the topic with the researcher and their time available for this engagement. Interviewees were assured of their anonymity and encouraged to discuss their own views that may not necessarily align with the public messaging from the organisation that they worked for. Although the number of interviews appears small, and the primary data collection was undertaken in November and December 2019 prior to the outbreak of the Covid-19 pandemic, the remarkable depth of information shared in the process aligns with the guiding principle to achieve naturalistic generalisation (rather than statistical significance). This naturalistic generalisation relies on the researcher's understanding of the interviewees' tacit knowledge present about "how things are, why they are, how people feel about them, and how these things are likely to be later on or in other places with which the person is familiar" (Stake 2000, p. 22).

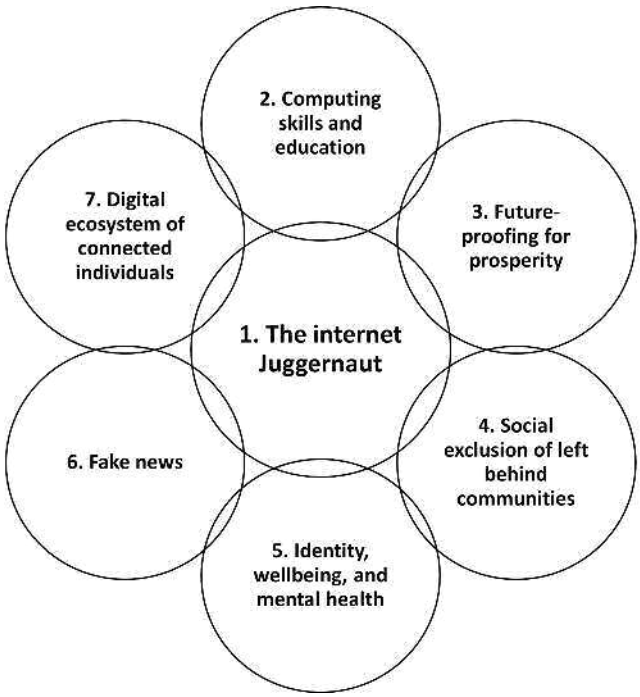

Figure 1: The internet Juggernaut and associated concerns

We suggest therefore that the size of the sample is sufficient given the small size of the possible population of policymakers, stakeholders, and academics, the aims of the study, the quality and depth of the dialogue, and the analytical thematic strategy. The interviewer also observed that the sample was tending towards saturation. Given these strengths, it is likely that the sample of interviewees provided information with a very high level of validity and reliability, with good potential for generalisable inferences out of the immediate context.

4 Findings and policy recommendations

Content analysis of the information sourced through the semi-structured interviews reveals seven distinct partially overlapping themes concerning the socioeconomic importance of ICT infrastructure and the DE, as shown in Figure 1. The analysis also reveals distinct differences in epistemological foundations underpinning these themes.

4.1 The internet Juggernaut

The DE was understood as a juggernaut; all of the interviewees recognised the sizable benefits of climbing aboard, ensuring that they are not left behind, reaping the rewards from early engagement, and dispersing the benefits to the wider community. There were universally positive views about the benefits of the internet for society; for instance, there was evidence consistent with Early, Hernandez (2021) that it provides opportunities for members of society to engage with each other, and perspectives consistent with Gallardo et al. (2021) that any policies or initiatives that inhibited its growth and development within their economy would either be detrimental for socioeconomic development of their economy or, more likely, impotent, and futile. There was almost universal agreement that policies should be prioritised and focused on facilitating the development of the online economy so that they did not slip behind their international competitors. Part of the reason for this stance was the belief that a stronger ICT infrastructure would permit, facilitate and even stimulate prosperity and regeneration through closer virtual connections, which is consistent with the findings of Canzian et al. (2019), Duvivier et al. (2021), and Vial (2019).

Interviewees perceived businesses that engage with the DE tend to be illustrious and a have many customers, whereas businesses that do not engage with the DE will progressively lose market share and revenues that in turn reduce their ability to invest and be competitive in the long run. This part of the collective narrative is consistent with the emphasis of Vial (2019) on the importance of internet access for firm growth, innovation, reputation, and competitiveness. The interviewees saw three main reasons for business managers to avoid engagement with DE: i) a perception that the benefits from engagement were less than the costs (in time and/or money), ii) engagement was perceived to be too complicated and beyond the abilities and/or interests of managers, and/or iii) a belief that targeted consumers were influenced more by personal contacts and customer service than online engagements. Note that this narrative about not engaging with the DE is not strictly about a firm's online growth and is instead about organisational sustainability and the satisficing principle, managerial confidence in their own abilities, and having informed knowledge about their customers. There was also a belief that some reticent managers only engaged with the online world as a defensive mechanism to avoid losing customers as opposed to gaining new customers. There was the general perception that firms engaging with the DE were more interested in going for growth, whereas firms not engaging were more interested in managerial satisficing and organisational sustainability. Participation in the DE may therefore be an indicator of ambition and drive for growth with online engagement partly fulfilling those ambitions, rather than the DE being a panacea or a mechanistic relationship whereby online engagement creates growth. Comprehending the breadth and importance of managerial objectives may be key to successful growth enhancing DE-related policies.

Interviewees emphasised that policymakers are observing what each other does to help keep businesses within their jurisdictions at the frontier of digital engagement. There is the need for policymakers to be informed of potential obstacles in the development of the DE that may currently or in the future limit the benefits from engaging with the DE. These blockages include a range of issues and vary from the slow rolling out of 5G and superfast fibre broadband to facilitating meetings that encourage greater and deeper business and consumer engagement with the DE, yet the unblocking of these paths may be more easily achieved in urban rather than rural areas.

Limited discussion took place about the detrimental effects on a local economy of purchasing products online from a shopfront elsewhere. The discursive narrative of the effects being net-positive was so clear that there was little explicit recognition of the possibility that increased online purchases could lead to fewer local purchases, reduced local spending, and less derived demand for local workers. When much greater proportions of purchases are conducted online, as has been stimulated by the pandemic, the long-term effect is likely to be at least a restructuring of local economies towards more locally-embedded experiential goods and services, though some areas may well experience an effect that sways the narrative away from greater online engagement.

The spatial spread of the benefits of engagement with the DE were briefly discussed. Although there was a clear perception that the absolute quantity of benefits would be greater in urban areas, there was also recognition of the many benefits for firms located in rural areas participating in the DE, especially due to overnight delivery of purchases. There was an understanding that rural firms not engaged with the DE were missing the opportunity to sell their goods to consumers in urban areas, and that a lack of economies of scale could limit the growth of rural firms and hence limit the derived demand for local workers. Enhancing ICT infrastructure in rural areas may be only half the battle in raising rural productivity, as managerial objectives would also need to be steered towards more ambitious growth plans.

Policymakers could increase the visibility of discussions and initiatives concerning the benefits for local firms engaging with the DE. Although it may be necessary for local government to second-guess managerial motivations for running firms (maintain market share, ensure sustainability, high growth, etc.), there was emphasis on the need to run local meetings in urban and rural areas that inform managers of the whats, whys, and hows of digital engagement. These can prove beneficial not only to enlighten and convince the managers of the benefits of online engagement but also to provide clear details of how

to engage. Education concerning the benefits and ease of digital engagement was seen as key.

4.2 Computing skills and education

Internet and computing skills were considered core proficiencies for engagement in the DE and necessary both for effective engagement with the rest of the world and for prosperity, welfare, and wellbeing. This is consistent with the emphasis of Aissaoui (2021) on digital divides and particularly the dimension concerning the inability to use the internet. But it is also necessary for ICT infrastructure to be in place as a lack of internet accessibility reduces the ability to hone digital skills and would be a barrier to the relocation of firms to the area (Bosworth et al. 2020). Interviewees stressed the need for the education of basic computing and internet skills to start from a very young age and enable children to learn further skills as they grow into the DE. Schools need to be alert to children who do not appear to be developing those skills and there should be fun, enjoyable, and engaging extracurricular activities provided both by schools and local community groups that develop those skills and ensure that their inhabitants are not left behind.

Interviewees emphasised the importance of benevolent members of communities that are highly skilled in internet and computing skills to step up and run community classes that facilitate the inter-personal transfer of these skills. Community-led lessons already exist that teach programming, coding, robotics, trading, and website design; however, these classes tend to be organised and run by knowledgeable and experienced digitally engaged users in the community who want to ensure that the next generation are ready for the evolving DE. This reliance on community-minded local residents to provide digital education exposes the importance of the role for the community and heightens the recognition that communities without these benevolent individuals risk being left behind. Those communities with more digitally engaged benevolent users are likely to be at an advantage in providing these services, whereas those communities with few if any digitally engaged users, typically due to their own labour market backgrounds, are likely to be increasingly left behind. Payments to providers for extra-curricular digital education was known to be low if it existent at all, and hence there is the need to identify whether such benevolent service providers exist everywhere.

Although it was deemed to be fully appropriate that these benevolent individuals are able to undertake altruistic activities, it is questionable whether local communities should expect those individuals to also possess the skills and the facilities to organise and advertise the sessions. Their efforts and enthusiasm can be stifled by red tape, administrative barriers, and a lack of community facilities. Local communities and government need to ensure that these activities are supported and prioritised so that digital initiatives created by community-minded initiatives are established for the public good. One option is to have 'Community Enablers' who open doors, facilitate and arrange activities, identify solutions to encountered problems, and encourage greater engagement by community-minded members of the public who have the skills, knowledge, and experience that are worth sharing in the wider community. If the local narrative is not strong enough to stir emotions and motivate community-minded digital education provision, then the local economy may be left behind.

4.3 Futureproofing for prosperity

There was the view that government should ensure that the economy is futureproof and take a paternalistic role to ensure inclusivity rather than let market forces dominate the supply of internet access and potentially limit future prosperity. Interviewees recognised that the roll-out of ICT infrastructure requires a significant amount of financial resources, and that this will only be undertaken by private sector companies where there were clear profits and revenue streams to be made from expanding the size of the digital network. The financial incentives to route fibre optic cables to sparsely populated difficult to access locations will be small, reducing the incentive to connect those areas. This is consistent with the findings of Aissaoui (2021), Riddlesden, Singleton (2014), and Tranos, Mack

(2016) who stress that remote and rural areas are underserved and have poorer quality connections.

The interviewees did appear to appreciate the argument of Bosworth et al. (2020) that a spatially uneven ICT infrastructure leads to inequalities in digital skills and an inability to attract digitally skilled workers or firms to rural areas. If the effects of providing access to better quality internet access are not simply one-off but are dynamic, this implies that there are cumulative negative effects of postponing DE expenditure, which further widen the digital divide. Investments often require the calculation of net present value estimates to identify whether and where to allocate resources, but the failure to invest in appropriate digital infrastructure now will affect the competitiveness of a local economy in the future and may put a local economy on the path to greater dependency for extra government resources further down the line.

4.4 Social exclusion of left behind communities

There were concerns that sections of society would be left behind and not accrue the benefits from engagement with the DE. Several reasons were behind this concern, including the lack of availability of ICT infrastructure in some geographical areas, a lack of people's knowledge and ability to engage, a lack of perceived benefit from engagement, the presence of social and/or cultural expectations to abstain from using the internet, and a lack of digital experiences that are of interest to sections of society. These issues encompass a range of socioeconomic behaviours and spatial considerations, some of which are more easily amenable to policy interventions.

Early provision of ICT infrastructure provides local inhabitants with an advantage, but late provision of that infrastructure can often disadvantage or stigmatise local inhabitants and reduce their likelihood of engagement with the DE. Early provision of ICT services can make a disadvantaged community feel lucky and special, and this could stimulate them to take advantage of these services and enable them to grow out of their left behind state. Part of some interviewees' narrative for ICT infrastructure investments is illustrated in Figure 2, where a lower perception of the personal, economic, or social benefits of engaging with the DE, such as the perception that doing so is mainly for "internet geeks", can make some individuals opt out and identify themselves with other groups within a community; identity is key (Akerlof, Kranton 2010, Douglas, Isherwood 1979).

Low levels of connection to all things digital can peripheralize parts of the population and reduce their ability to access information and services, such as when local government notices and forms are only provided through the internet. This disconnection can alienate residents and increase their loneliness, leading to a deterioration in their mental health and wellbeing (Stutzer 2004, Frey et al. 2008). This cumulative circular effect can become a negative spiral when there are social and/or cultural expectations not to engage with the internet, or when the expectation that those who do engage with the digital economy are from a different group within society, such as when retirees assume that the DE is mainly for youths and big business. Intersectionalities occur in this area, and can cut across ethnicity, gender, age, culture, race, and incomes, etc.

4.5 Identity and mental health

A major view expressed by interviewees was that people unquestionably gain social and economic benefit from connecting to the internet, which is consistent with the ideas of Gann (2019) and Kearns, Whitley (2019). The social and personal costs of engaging with the internet, such as a potential detrimental effect on mental health, were played down, and the narrative was overwhelmingly positive. When issues such as mental health were discussed, there was a tendency to highlight the benefits to mental health rather than consider the costs. Greater and faster internet access was seen to be an instrumental way of giving people opportunities to express themselves and to connect to their families, wider communities, and/or social groups. Digital connectivity was viewed as a way to enable people to develop and strengthen their identity even though this is contrary to Quinn's findings that engagement by older adults in social media only has marginal impacts on social connection (Quinn 2021).

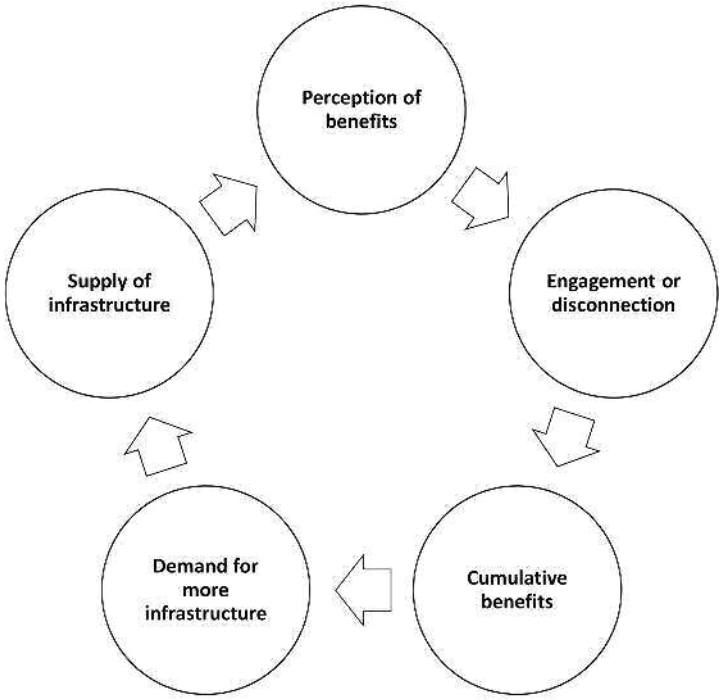

Figure 2: An engagement cycle in the digital economy

One downside of the spatial variation in access to the internet was that there are portions of society that are unable to nurture their identity in this way. Some interviewees recognised that policymakers need to be aware of individuals' needs to nurture their identity through the internet should they wish to do so, and that failure to do so may leave them feeling excluded and potentially lonely. Faster and stronger interpersonal connections through social media can boost social linkages, enhance people's feelings of belonging, and strengthen the fabric of society, thereby improving people's wellbeing. Areas that have poor or variable quality internet connections will not benefit from this aspect of the DE as much. Alternative ways of connecting people in inaccessible rural areas are needed to ensure that topography does not adversely affect the ability of certain groups of our society from engaging successfully with each other, such as is the case with the spatially dispersed farming community that typically have a strong sense of community. Given the sometimes lonely day-to-day duties of farm workers, it is perhaps even more important to ensure that these individuals are able to seamlessly connect with each other and with other sections of society in the same way that people are able to in urban areas.

There was a brief mention of the consequences of over-engagement and over-reliance on the internet as an outlet for self-expression, which was viewed as having potential addictive habits that adversely impact on an individual's other duties and roles within society. This is consistent with the observation by Hartas (2021) that girls are at risk of experiencing poor mental health and poor wellbeing due to social media effects. Negative experiences on social media, such as trolling with inflammatory posts, can be very upsetting and cause individuals to disconnect from online social media and from their wider social group.

Two main solutions were discussed by a select few interviewees and which both have different spatial dimensions. On the one hand, negative effects on social wellbeing on digital engagements were seen as a national if not a global problem, and if engagement with online social media required participants to sign up using their passport or driving licence, then any need for reprisals due to online bullying or other socially unacceptable behaviour could be targeted efficiently. On the other hand, victims of internet trolls may require local counselling and those who over-indulge in online services may require local support sessions similar to the services provided by Alcoholic Anonymous. Excessive

under- and over-engagement with the digital economy were viewed as being relatively small scale but real problems that policymakers need to include in their policy toolbox and providing these community services may be more cost effective in urban rather than rural areas. Nevertheless, the costs of disengagement, exacerbated effects of loneliness, and other negative effects of the DE were recognised as being under-identified. The respective interviewees did not provide an indication of who should pay for these support services, whether it is the sufferer or a public body, and this part of the narrative was under-developed. If greater awareness of these issues is developed through the media and identified as a growing concern, then greater awareness of these costs may influence the digital infrastructure policy narrative.

4.6 Fake news

Local government policies can target the reduction of real or imagined barriers. Internet skills training for the unemployed, internet virus and security training for retirees, good practices for general internet browsing engagements and emails, and Skype and Zoom training for people whose relatives have left the area, can all work positively for groups within society. All require internet access and thus ICT infrastructure. Interviewees recognised that local governments could organise classes for business leaders on how to install online payment systems on webpages, perhaps as a side initiative in a local group meeting of business people. Local government service providers could listen out for additional needs of their communities and respond to the needs of the local communities by setting up, facilitating, and/or providing on-demand services and education facilities. There was a strong narrative that improvements in knowledge would 'correct' reasons for non-engagement. Roles for government include emphasising the benefits of engaging with, strengthening and enhancing levels of trust in the digital system, and fulfilling the need to highlight the ease of protecting personal and financial information.

Concerns arise over the spread of fake news (Kant, Varea 2021, Talwar et al. 2019). A lack of trust in internet security and with the DE are commonplace but appear to improve with higher levels of experience and digital engagement. Underlining the perception of trust are the not infrequent discussions in the media of the presence of fake news, some of which are associated with some very high profile internationally known celebrities. The presentation of information as news that is later found to be false or misleading undermines the confidence people have with digital platforms as well as the perceived value of engaging with the DE. When the importance of fake news was discussed, there was an unmistakable recognition that fake news can mislead sections of society, undermine the path forward for society, and/or weaken the levels of trust that sections of society have in the DE. There were concerns that as sections of society increasingly engage with the digital economy the levels of engagement recede in other sections of society. The engagement gap grows, intensifying disparities in opportunities and compounding inequalities between those receiving benefits from engaging with the DE with those that do not.

Interviewee discourses that touched on this topic were based on the narrative that fake news is an inevitable ill of society and that society needs to recognise this, accept it, and move on by ensuring that any damaging and divergent effect is quashed, but that the digital platform is no different from other media platforms in this respect. Nevertheless, policymakers need to be cognisant of particular sections of society being left behind as a result. Drawing parallels with other parts of everyday life was emphasised as a plausible way forward to alleviate any fears while also ensuring that individuals remain alert to the possibility of fraudulent activities.

4.7 Digital ecosystem of connected individuals

Although all interviewees saw the DE as a juggernaut that policymakers and various communities should climb aboard and reap the rewards from early engagement, there was a further view that the whole social economy is intricately connected through ICT infrastructure. In this respect, it is vital to continually update that infrastructure to ensure connectivity and facilitate continued growth. At the same time, it was also

recognised that this ecosystem is constantly in flux, with new gaps and connections emerging while old ones disappear into obscurity. Some interviewees perceived that only the most agile communities will be at the forefront of the DE, with most communities always playing catch-up due to missed opportunities, which also reflects the rest of society. Fewer missed opportunities translate into more dynamism in the DE, with knowledge, skills, and experiences accruing in a continuous cumulative process.

Some interviewees voiced the importance to local communities of informed and respected intermediaries that bring them new digital knowledge. These respected intermediaries translate digital information into a form that benefits their community, illustrate to others the benefits of engaging with the DE, highlight the ease of prioritising and updating aspects of digital knowledge and skills, and lead by example. These trusted intermediaries are recognised as being important for the future development of a local economy by local layers of government who then purposefully integrate activities of respected intermediaries into their portfolio of activities. Not all areas have an equal supply of respected intermediaries, and this aspect of the DE narrative was not discussed, but may affect the spatial spread of benefits of the DE. Some interviewees voiced the need to share roles and responsibilities with engaged local community members, where available. These roles and responsibilities will be ones that enhance the size and effectiveness of the local DE participants while also increasing their connectivity with the outside world.

Scarce resources are a major reason for the lack of provision of DE training opportunities. There is the need for local government and influential development bodies from across the world to think and act smarter to enhance the engagement of their local community members to strengthen the resilience of their local economies by increasing connectivity with the wider DE. Consistent with other areas of the economy, the narrative underpinning investments in the DE emphasise that some areas will prosper from greater engagement and there will be opportunities for those left behind places to accelerate and catch up. However, the narrative is currently underemphasising the gaps and potential problems of being left behind in an increasingly online world; this aspect of the economic divide will exhibit spatial and social red flags.

5 Conclusions

The narrative of the digital economy was explored from different perspectives and interviews with policymakers, stakeholders, and academics revealed an overwhelming positive bias. This paper explored the reasons why different individuals advocate the prioritisation and development of the DE. This knowledge is crucially important for astute commentators and for advocates of continual investment in the digital economy should interest wane in support for further prioritisation and development of the digital economy.

The overarching aim of this research was to increase understanding about how local government can use the DE to enhance the wellbeing and life satisfaction of its residents while supporting their local economy. This research put digital engagement at the heart of local economic policymaking and initiatives to gain maximum traction. In this way, it sought knowledge that would enable fundamental change in the way local governments use digital technologies to enhance the wellbeing of their inhabitants. The voiced perspectives emphasised an overwhelmingly positive and diverse set of reasons for continued investments in ICT infrastructure but with much less recognition of the costs.

An important finding is that although proponents for continued investments in DE infrastructure ground their perspective on different issues, they currently align to collectively strengthen the case for further investment, including digital investments to enhance infrastructure and connectivity, investments in equipment to access that infrastructure, investment in education for individuals to both recognise the opportunities and pitfalls, and investments to be able to engage as actors in the DE. We identified seven distinct issues of concern, however, that are evolving in importance at different rates, that affect different groups of people, different communities, and have different consequences, but currently those issues are considered relatively minor in comparison to the perceived benefits. If those separate causes of concern grow in stature, then the coalescing narrative for greater DE investments may become undermined and deprioritised. This may be the

case when different advocates are more cognisant of the benefits for different society groups, such as the marginalised, less-educated, rural, or older proportions of society, or parts of the economy that appear to benefit less, such as low growth firms. Disagreements about who are or should be prospering from DE investment may strengthen and the need for further investments to benefit particular groups may wane. Hence, this study contributed to theory by demonstrating that policy decisions can draw on diverse narratives and multidimensional understandings but still coalesce on the same policy recommendation.

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Labour Market Areas and cluster subdivision for Spain 2011

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Abstract. Labour market areas (LMAs) are a type of functional areas that provide the appropriate framework for spatially-explicit analyses of the labour market to guide policymaking in this field. This resource presents a data base with the most recent definition of LMAs for Spain using a state-of-the-art methodology. All defined LMAs are highly self-contained in terms of travel-to-work flows and exceed a minimum size compatible with the usual requirements in terms of confidentiality and representativeness, allowing the recoding of microdata geographic referencing and therefore a much greater granularity compared to what is usual for this type of data. It can be downloaded from https://rua.ua.es/dspace/handle/10045/121236.

1 Introduction

Labour market areas (LMAs) are functional regions beyond the administrative boundaries, defined for purposes of compiling, reporting, and evaluating employment, unemployment, workforce availability, and related topics. An LMA is an economically integrated territory where the majority of people live and work. The boundaries of these regions are designed to ensure self-containment in terms of commuting flows; they embrace territorial units that present a high interaction among them, and by doing so, LMAs also tend to be self-contained in related socioeconomic activities such as housing, shopping, and leisure.

LMAs are potentially the most appropriate spatial units for sub-national economic policy (Brandmueller et al. 2017, Coombes et al. 2012, Stabler et al. 1996). The sensitivity of statistical econometric models with respect to different levels of spatial aggregation, the so-called 'modifiable areal unit problem', is a well-known issue (Openshaw, Taylor 1979). When the spatial econometric analysis is performed over well-defined LMAs, the spillover effects between regions are more consistent and less intense, thus easier to handle with spatial econometric techniques or safer to ignore (Osland, Thorsen 2013, Stimson et al. 2016, 2018). Another advantage over using administrative regions is that LMA boundaries can be updated periodically to reflect changing patterns in socioeconomic relations, using up-to-date data on commuting flows (Eurostat 2020, Martínez-Bernabéu, Casado-Díaz 2021). Defining these regions consistently in all countries allows for international statistical comparability of many socioeconomic aspects (OECD 2002, 2020, Halás et al. 2019), as sought by the Global Statistical Geospatial Framework in its third principle: common geographies for dissemination of statistics (United Nations 2019). The advantages of policy relevance, ease of use in econometric analysis, practical updatability, and international comparability have prompted numerous European countries to devise official LMA definitions (Eurostat 2020, 2021).

Spain does not have an official regionalization of its territory into LMAs or other forms of functional regions based on commuting flows. In the statistical analysis of the Spanish socioeconomic phenomena, the Administration and researchers most often use municipalities (LAU2), provinces (NUTS3), or autonomous communities (NUTS2) as the spatial framework. These administrative regions were historically or arbitrarily defined in the past two centuries, and do not generally represent the spatial labour and socioeconomic reality of Spain.

2 Background

The data on commuting flows from the latest census (2011) was made available to researchers (under contract) in 2014. Using this data, Martínez-Bernabéu, Casado-Díaz (2016) developed a set of functional, highly self-contained, LMAs whose population exceeds 20,000 inhabitants in both 2001 and 2011. The minimum of 20,000 inhabitants reflects the specific threshold that, as happens in other countries, is imposed by the Spanish National Statistics Office (Instituto Nacional de Estadística) in order to comply with confidentiality regulations and sample representativeness in microdata dissemination. In this way, it is possible to recode the geographic references of the 2001 and 2021 census microdata (and potentially also of other data from statistical operations with large samples), so that the geographic reference to the place of residence, work, origin (in the case of migrants), among others, becomes a functional unit instead of an administrative one. In the Spanish case, for example, the geographical reference in census microdata is the municipality only when it has more than 20,000 inhabitants; otherwise, only information on the province and the size range of the municipality of residence is given, which greatly limits the analyses, especially in less densely populated settings. LMAs are further subdivided into clusters of at least 20,000 inhabitants (in both 2001 and 2011) to enhance geographical detail in microdata analysis when finer-grained resolution is more important than functional self-containment.

The method used to define these LMAs was a grouping evolutionary algorithm (GEA) previously applied to the 2001 Spanish Census by Martínez-Bernabéu et al. (2012). This optimization algorithm maximises the overall internal cohesion (integration) of LMAs by iteratively making stochastic changes in the partitioning of municipalities into LMAs and selecting the ones with the highest cohesion, subject to restrictions of minimum levels of labour force self-containment and population size of the LMAs. This method proved itself capable of identifying more LMAs with similar average self-containment than other methods like the well-established Travel-To-Work Areas method (Coombes, Bond 2008). It was also successfully applied to Chile (Casado-Díaz et al. 2017), and the results were shared with the academic community (Rowe et al. 2017).

The above-mentioned proposal of LMAs for Spain 2011 was further improved with an enhanced methodology in Martínez-Bernabéu, Casado-Díaz (2021). It uses a combination of heuristics along with GEA to implement a three-step optimization process. In this process, the input matrix of commuting flows is first compacted in a simple hierarchical clustering algorithm that groups together municipalities with enough inter-dependence in terms of the ratio of residents that commute between areas. Then, GEA performs the regionalisation of the compacted matrix into LMAs. Finally, a greedy heuristic further optimizes the resulting LMAs in terms of local indicators on self-containment and commuting interaction between each municipality and the neighbouring LMAs, allowing the compacted municipalities to be reallocated independently. The results showed significant improvements in terms of dependence between municipalities and their LMA and greatly reduced the appearance of arguably inconsistent regions, all in all making the final phase of adjustments significantly easier and faster. The present resource paper publishes the geography resulting from this improved methodology and makes it available to researchers and practitioners.

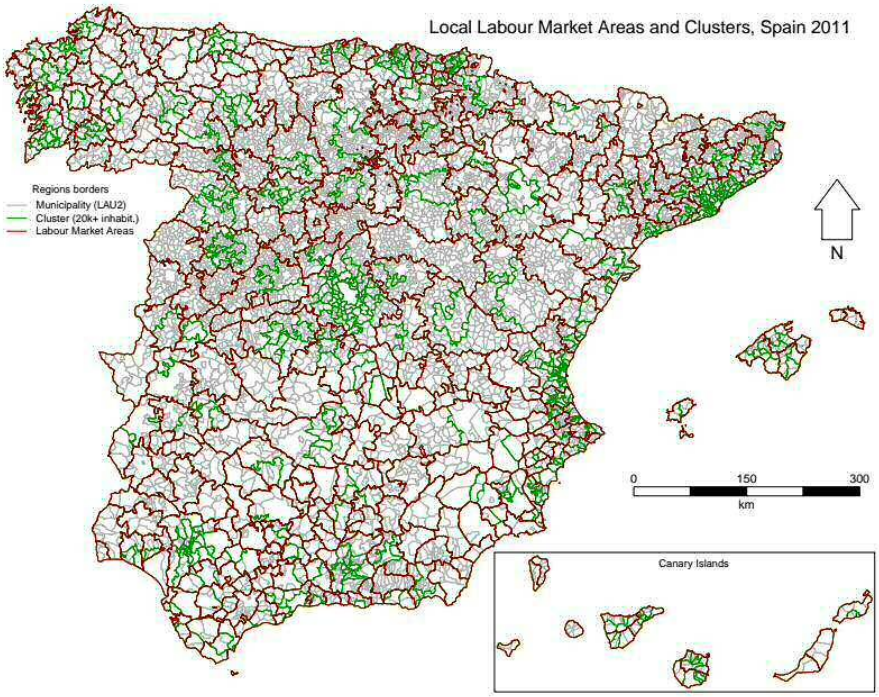

Figure 1: LMA and cluster borders

3 Description of the resource

The data set includes 287 LMAs, further subdivided into 822 clusters, providing full coverage of the Spanish territory (Figure 1). The linked resource contains the correspondence between municipalities (the basic territorial units considered here), cluster and LMA, in CSV and XLS format. The XLS file also contains statistics on area, inhabitants, working residents, jobs, and supply- and demand-side self-containment for individual LMAs and clusters. The boundaries of municipalities, clusters, and LMAs are provided in Shapefile format. It also includes a PDF file with a plotted map of the LMA and cluster boundaries.

These LMAs were defined to maximise internal commuting interaction while reaching a minimum self-containment of 75% for populations of at least 20,000 inhabitants (except for the case of the island El Hierro in the Canary Islands, whose whole population is 9922), linearly relaxed to 66.7% for populations over 100,000 inhabitants. These functional areas exhibit high degrees of internal cohesion and external self-containment in terms of travel-to-work flows and, accordingly, are an appropriate geography for spatially-explicit studies that benefit from reduced spillover effects between regions.

The clusters within each LMA were defined with the priority of maximising geographical detail (number of separate regions). When several groupings with the same number of regions were possible, the one that maximised internal cohesion was chosen. These regions cannot be considered as functional areas due to their limited level of self-containment. However, they allow researchers to perform microdata spatial analyses that benefit from finer-grained geographical resolutions (median area is 291 km^2 for clusters and 1343 km^2 for LMAs). Although lower levels of self-containment imply larger spatial spillovers, this effect is nuanced by the fact that such spillovers are more easily handled because they are mostly limited to other clusters within the same LMA.

4 Potential applications

A definition of LMAs for Spain entails an opportunity to better understanding the structure and dynamics of labour markets and their effects on other socioeconomic phenomena,

particularly since its use reduces the impact of the MAUP issue when performing spatially-explicit analyses. The literature provides numerous and varied examples of analyses that benefit from using functional instead of administrative regions. As an illustration of such studies, Kosfeld et al. (2006) investigate regional convergence of labour productivity and income per capita in Germany using LMAs to avoid distortion due to commuter flows between administrative districts. Autor et al. (2015) analyse the simultaneous impacts of technology and trade on US employment levels and job composition, juxtaposing their effects across local labour markets, over time, between sectors and occupations, and among workers of different education, age and sex categories, using commuting cones that approximate local labour markets as the appropriate spatial unit of analysis. In the UK, Jacob et al. (2019) study the impacts of increased commuting on well-being, considering the characteristics of the local labour market and differentiated by gender. Coile (2021) also use US commuting zones to analyse the employment rates at older ages. Stimson et al. (2018) measure the endogenous performance of regional markets across Australia, and recommend to focus the efforts of policy-makers on region-specific development policies. Eliasson et al. (2021) study geographical disparities in human capital and income in Finland and Sweden. In Chile, Carriel et al. (2022) identify and explain the determinants of long-distance commuting among different sectors, worker skills and levels of education, and Goya (2022) analyse the Marshallian and Jacobian externalities in creative industries across Chile, both works supporting the use of LMAs in the analyses. Vallone, Chasco (2020) evaluate, also in Chile, the influence of spatial proximity on the evolution of cities to detect regional differences in their spatio-temporal dynamics, and they use LMAs as a robustness check.

In addition to the advantages associated with the usual uses of LMAs as the reference unit for the study of labour phenomena at the local level, it should be added that in this specific case they have been defined in such a way that they allow, as has been pointed out, the recoding of the geographical references in the census microdata (in this case those corresponding to two waves, those of 2001 and 2011). This is a substantial improvement for two reasons. On the one hand, it makes it possible to incorporate contextual variables (associated with characteristics of the LMA of residence, for example) into the individual records, thus substantially enriching the information available for each individual when carrying out analyses based on microeconometric models. On the other hand, when the unit of analysis is a territorial unit instead of the individual, the availability of this recodified microdata makes it possible to define a large number of variables that can be calculated as the average value of the variables in the individuals who reside (or work, for example) in the territory analysed or by calculating the relative weight of a specific characteristic (or an ad hoc combination of them) in that territory, substantially enlarging the range of territorial characteristics available when the information is disseminated at the level of municipalities (LAU 2), without the loss of spatial resolution that implies using provinces (NUTS 3).

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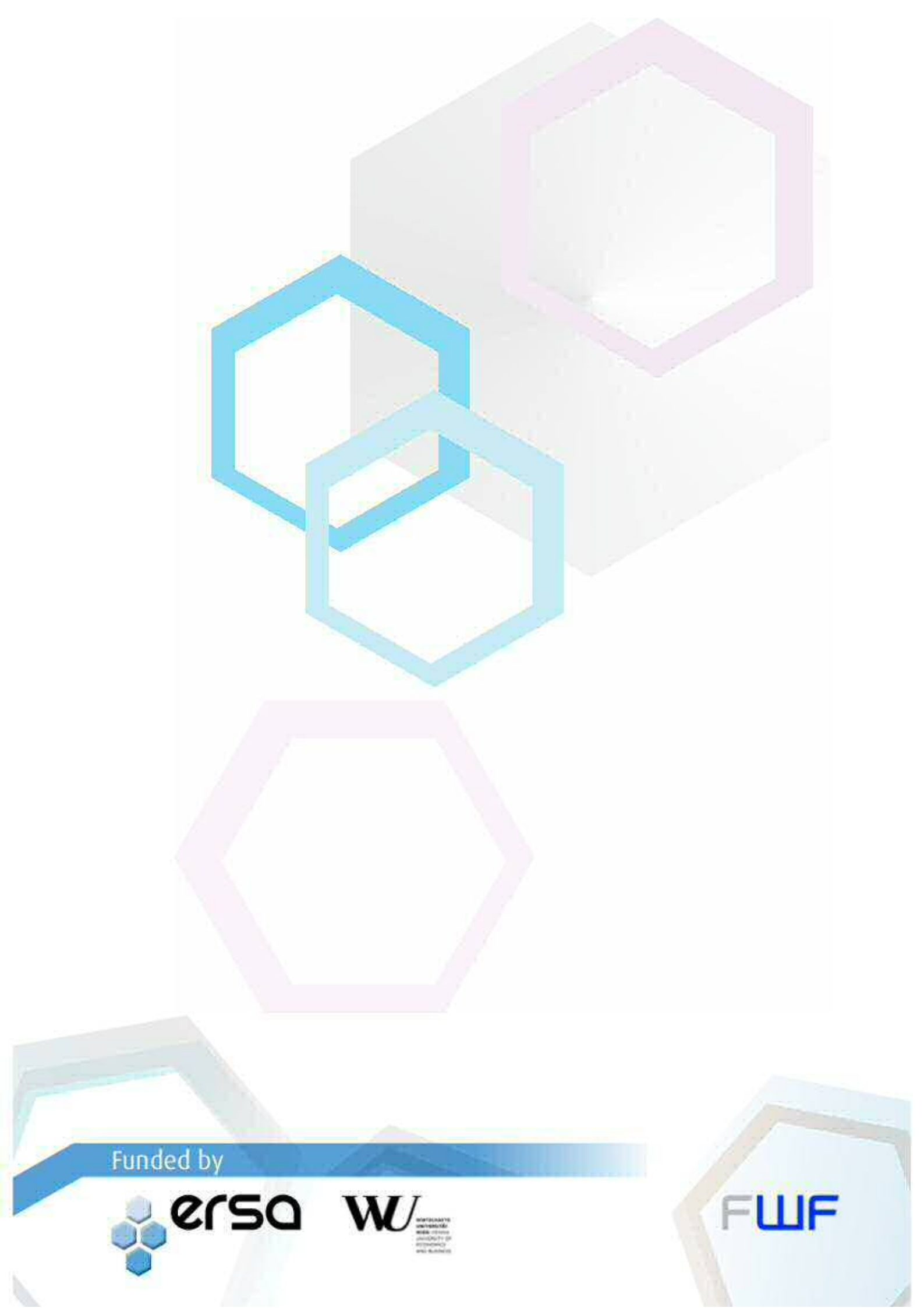

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