UNIVERSIDAD DEL DESARROLLO
FACULTAD DE INGENIERÍA

PROCUREMENT, RELATEDNESS AND COMPARATIVE ADVANTAGE: EVIDENCE FROM CHILEAN MUNICIPALITIES.

PEDRO ÁVILA VILLENA

Thesis submitted
in partial fulfillment of the requirements for the degree of
Master of Science in Engineering

Advisor:
DR. CRISTIAN CANDIA

Santiago de Chile, October 2023

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Grateful to have met you

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ABSTRACT

In this work, we investigate the expenditure behavior of Chilean municipalities using procurement data from January 2007 to December 2022. Drawing from the Principle of Relatedness from economic complexity, we aim to uncover the underlying dynamics and factors influencing municipal spending behaviors. Through a comprehensive examination of this extensive dataset, the research sheds light on the interconnectedness of municipalities, their financial decision-making processes, and the broader economic implications. The findings not only offer insights into the intricacies of municipal expenditures but also contribute to the broader discourse on economic complexity and its application in understanding regional financial behaviors.

Keywords: Public procurement, relatedness, economic complexity, Revealed Comparative Advantage, Balassa index, networks, municipalities.

1. INTRODUCTION

Public procurement, encompassing the acquisition of goods, services, and works by governments and state-owned enterprises, plays a pivotal role in shaping national economies and driving socio-economic development (OECD, 2019). As an essential policy tool, public procurement allows decision-makers to foster inclusive growth, stimulate innovation, and bolster economic expansion (Edler & Georghiou, 2007; Uyarra & Flanagan, 2010; Aschhoff & Sofka, 2009). Public procurement constitutes a significant portion of governmental expenditures within OECD countries, with an estimated 30% of GDP on average in OECD countries and over 40% in some developing countries (OECD, 2019).

In response to the economic importance of public procurement mechanisms, for instance, the European Commission has developed a common framework designed to promote equal opportunities, enhance transparency, minimize fraud and corruption, and remove legal administrative barriers for cross-border tender participation (European Commission & Policy, 2018). This underlines the significance of public procurement data for analyzing and evaluating the efficacy and implications of public sector activities across diverse scales and dimensions.

Despite the recognized importance of public procurement on national-wide economies to improve its efficiency, reduce corruption, and foster economic growth, existing research offers limited guidance on methodologies that address spending dynamics' non-linearities or explore the inference potential in public procurement data (Kristoufek & Skuhrovec, 2012; Fazekas & Wachs, 2020; Wachs, Fazekas, & Kertész, 2021; Walker & Phillips, 2009; Curado, Damásio, Encarnação, Candia, & Pinheiro, 2021). In order to bridge this gap, we draw inspiration from the economic complexity literature. Our focus narrows down to the public expenditure trends of Chilean municipalities, analyzing procurement data spanning January 2007 through December 2022, leveraging the Principle of Relatedness as our primary analytical lens.

Building on the Principle of Relatedness, we delve into the idea that products, services, or industries in an economy are connected in a complex network, where knowledge from one domain can inform and support the development of another (C. A. Hidalgo, Klinger, Barabási, & Hausmann, 2007; Boschma, Coenen, Frenken, & Truffer, 2017; Jara-Figueroa, Jun, Glaeser, & Hidalgo, 2018). This principle suggests that regions or countries will find it easier to diversify into products or industries that are closely related to the ones they already possess. It's a principle anchored in the concept of path-dependency, where historical knowledge and capabilities influence the trajectory of future economic development.

In the context of public procurement in Chilean municipalities, the Principle of Relatedness can offer fresh insights. It can help understand why certain regions may favor particular types of products or services, based on their historical procurement patterns and the expertise developed therein. Moreover, by examining the relatedness of different procurement categories, policymakers can make more informed decisions, steering their regions towards more sustainable and inclusive economic growth.

It's worth noting that while relatedness provides a strong foundational perspective, it's essential to integrate other socio-economic and political factors. The complex interplay between these factors and the existing capabilities of regions determines the ultimate trajectory of public expenditure and the associated economic outcomes. By synthesizing the Principle of Relatedness with these broader dynamics, our study aims to provide an understanding of public procurement trends in Chile, and potentially inform strategies for more effective and sustainable public expending in the future.

2. CHAPTER 1

Public expenditure, which refers to the spending by government on goods and services, is a core component of a country's fiscal policy. This encompasses various sectors, from health and education to infrastructure and defense. However, it's not just national or federal budgets that matter; a significant portion of this expenditure happens at the municipal or local government level (OECD, 2019).

Fiscal capacity has long been recognized as a critical determinant of public expenditure patterns (Connolly & Mason, 2016), with some studies highlighting the importance of fiscal decentralization and fiscal autonomy in shaping local public spending (Baskaran, 2011; Baskaran, Feld, & Schnellenbach, 2016). Political factors, such as the political ideology of the ruling party, electoral cycles, and political competition, have also been shown to influence public expenditure decisions (Darby, Li, & Muscatelli, 2004; Corvalan, Cox, & Osorio, 2018; Bove, Efthyvoulou, & Navas, 2017; Kleider, Röth, & Garritzmann, 2018). Furthermore, economic, demographic, and institutional factors, such as economic growth, population size, and institutional quality, have been found to play a role in determining municipal spending behavior (Kleider et al., 2018).

In this chapter, we will describe the dataset used for the analysis, which covers the period 2007-2022 and contains information on approximately 30 million public procurement contracts involving Chilean municipalities. Then we explore the possible relationships between variables and then present the results of our preliminar predictive models.

2.1. Dataset description

We used data on Chilean public procurement contracts sourced from the official procurement website (ChileCompra, 2023). The database comprises $32.732.731$ contracts issued by a municipality between January 2007 and December 2022. Each contract has information about the issuer and supplier, the amount of money being transacted, and an

eight digit number that identifies the good or service related to that contract, the United Nations Standard Products and Services Code (UNSPSC).

The UNSPSC code is a hierarchical classification system used to standardize the categorization of goods and services in various industries. It provides a global, multi-sectoral, and consistent classification framework that facilitates the efficient exchange of information and communication between organizations and across different marketplaces (United Nations Global Marketplace, 2023). The first pair of digits (from left to right) represent the ”segment” associated with an specific good or service and is the first level on the hierarchical structure. We use this level of agregation for the categorization of the contract in the database, which give us 55 categories that represents all the types of goods and services being transacted by Chilean Municipalities.

Chile has 346 communes which are administrated by 345 municipalities (there is one municipality responsible for two communes). We discard Eastern Island since it can be considered an outlier from the mainland and so we kept 344 municipalities. We aggregated the contracts on a municipality at a yearly level, but before that we combined the municipalities with their respective municipal firm if they had one (they are called corporations in Chile, and they constitute a separated entity from the municipalities but they transact on the same commune).

Furthermore we pre-process the database following several criteria:

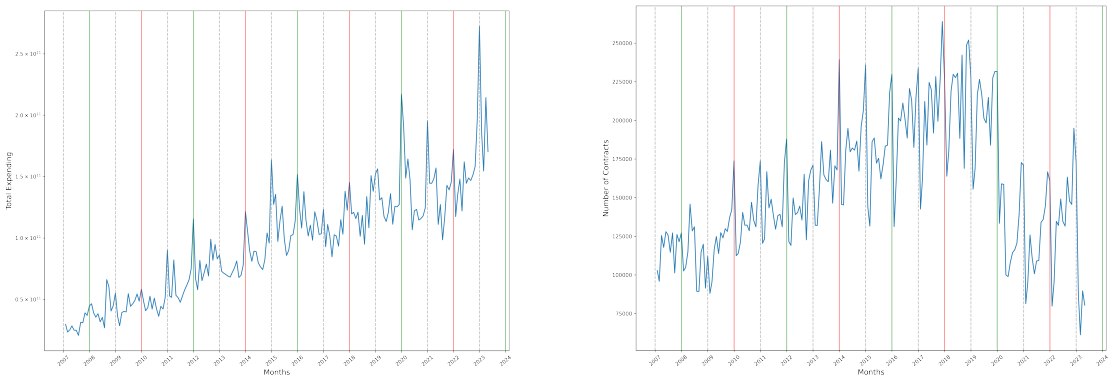
- Keep in the contracts dabatase the contracts with a valid *Sent Date* (when the municipality notified the supplier about the contract) that does not has a *Canceled Date*. This is because we detected that even if the database includes an *Accepted Date* (when the supplier notifies the municipality that it has accepted the contract), there are some time periods in which that variable was not being used, resulting in about 10 million contracts being dropped.

- The contracts are being transacted in different currencies but the local currency, Chilean Pesos (CLP), alongside USD comprises more than 99% of the contracts so we choose to keep only those two.
- USD was converted to CLP and CLP was adjusted by inflation rate according to the year the contract was transacted on.
- Keep only contracts with valid UNSPSC codes.
- Keep contracts with values larger than one.
- We detected an anomaly that is caused by the way the information about the contracts is being collected (issuer and supplier both manually enter the required information in the system). The way the total value of the contract is being determined is by multiplying the number of goods/service being transacted by the unit value of such good/service. What we detected is that in some cases the person filling the information would write the unit value in both cells, as the number of good/services and the unit value, which ends up causing some extreme outliers. We opt to discard the cases when those two variables have the same value.
- Remove some outliers manually. Specifically we removed four observations that were issuing contracts for over Chile's GDP.

The final dataset comprises $30.669.227$ contracts totaling a value of $\sim$2.5 billion CLP.

We sourced the yearly population by commune using official statistics published by INE (Instituto Nacional de Estadísticas, 2023), the yearly budget for each municipality and distance from the regional capital from SINIM (http://www.sinim.cl/) and created a dataset that shows if the current municipality's governor is part of the goverment coallition, from the opposition or if it is independent.

We begin by exploring the temporal behaviour of the segment pooled data. Figure (2.1) shows a tendency to increase the expending throughout the years, but also display peaks around the end of the years. This expending behaviour is due to two reasons:



(a) (b)

Figure 2.1. (a) Total monthly expenditures made by municipalities between 2007 and 2022. (b) Total number of monthly expenditures made by municipalities between 2007 and 2022.

- They coincide with municipal and presidential elections. For example, the big jump at the year 2014 (figure 2.1b) correspond to presidential elections, which are held nationwide every 4 years.
- The municipalities are given a yearly budget by the state that does not carry over the next year, so there is an incentive to spend most of the budget as possible before the end of the year.

Interestingly enough, the coronavirus pandemic did not affect notoriously the expending behaviour of the Chilean municipalities, but it did have and impact on the number of contracts being issued as can be seen in the right portion of Figure (2.1b). As the expending was mostly unaffected from a global perspective, we decided to keep the data post 2020 in our analysis.

From the treemap shown in Figure (2.2), the category Building and Facility Construction and Maintenance Services represents the most transacted services, with a 19.7% of the total share for the yearly expenses of 2022. In the spaghetti plot of the Appendix (.4), in terms of total expenses we can see that the segment associated with Building and Facility Construction and Maintenance Services is by far the category that concentrates the most expenses, but it does not concentrate the most number of procurement contracts, which

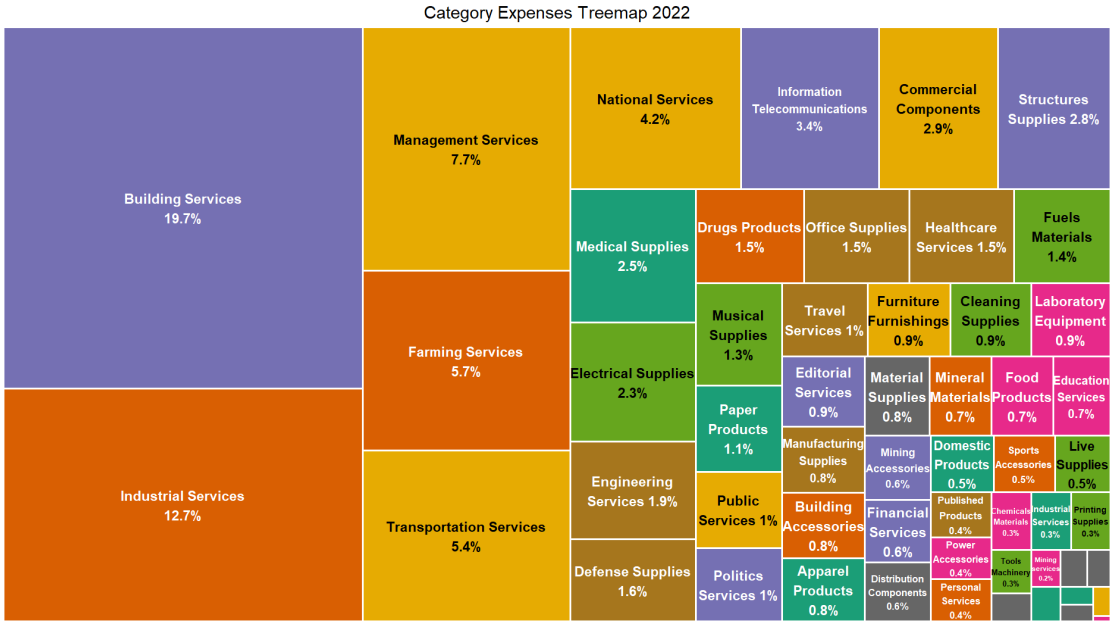


Figure 2.2. Treemap for the expenses categories. Below the name of each category lies the share percentage of the total expenses for the year 2022. The names have been shortened on purpose to ensure a correct visualization (refer to the Appendix .4 for the list of full names).

is Office Equipment and Accesories and Supplies. In terms of the category with the least share, Enviromental Services is the least transacted category both in total expending and the number of contracts.

Spatial aggregation patterns can shed light on localized spending trends. To discern such patterns, we amalgamated expenses across all categories and depicted them on a choropleth map. Considering Chile's unique elongated geography, the map is split into three sections, representing north, center, and south, which can be viewed sequentially from left to right, as depicted in Figure (2.3) and (2.4).

At first glance, the map does not exhibit any strong spatial clustering; had there been any distinct pattern, we would observe localized clusters sharing the same color. This observation nudges us towards a preliminary understanding of relatedness. Intuitively, one would anticipate neighboring municipalities, owing to their shared geographic, climatic, and often socio-demographic attributes, to have analogous expenditure patterns, both in

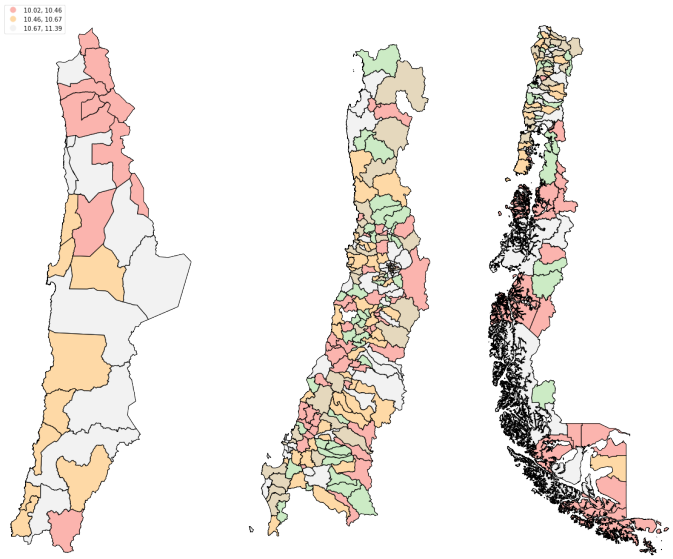


Figure 2.3. Total (log) expenses across all categories and years in the period 2007-2022

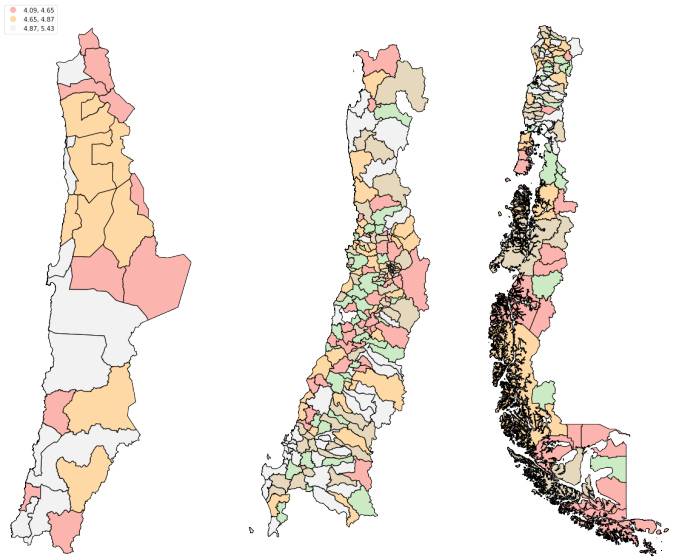


Figure 2.4. Total (log) number of contracts across all categories and years in the period 2007-2022

aggregate and at a granular category level. Yet, the visuals challenge this assumption. Could this divergence imply a lack of inter-municipal coordination in Chile when addressing localized challenges? While certain inefficiencies in municipal operations have been

highlighted (Francisca Pacheco & Villena, 2021), the fact that municipalities might operate in near-isolation, without drawing inspiration or solutions from neighboring regions, does not seems to be possible.

Delving deeper into the theme of neighboring associations, and as we start to unravel the concept further, conventional wisdom might suggest a presence of clustering tendencies around categories that are either analogous or complementary in nature. A glance at Figure (2.5) supports this hypothesis, showcasing distinct clusters of categories. Notably, clusters emerge around medical goods and services, national security goods and services, and a prominent cluster centered on office goods and services. What's more, the absence of negative correlations indicates that expenditures in one category don't seem to adversely affect expending in another; if anything, there appears to be a complementary relationship.

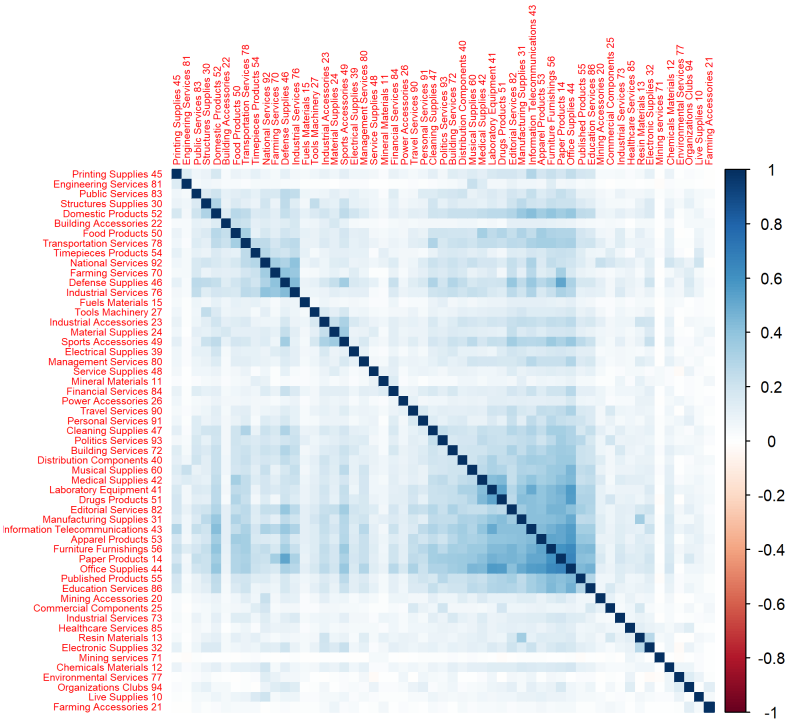


Figure 2.5. Correlation (pearson) matrix for the categories expenses. A hierarchical clustering was used in order to reveal the potential clusters. The category names are followed by their corresponding two digit code.

Also, in terms of correlations, we explore the relations between municipalities expending and their budget, along with population, area and distance from the regional capital. The correlogram in Figures (2.6) and (2.7) and compiles all the pairwise correlations, scatterplots and distributions. While Figure (2.6) offers a baseline understanding of the expected interactions between these variables, Figure (2.7) suggests the potential for unique patterns specific to certain categories. Taking the "Building and Facility Construction and Maintenance Services" category as a case in point: its pairwise correlations with expenditure significantly deviate from the baseline, especially considering its dominant contribution to annual expenses. Intriguingly, no significant correlation emerges between the budget and expenses in this category. One could argue that this isn't entirely unexpected. Often, substantial construction projects are funded by the central government, either through direct transfers or analogous mechanisms. Yet, this underscores a broader implication: each category could possess distinct characteristics or nuances that set it apart.

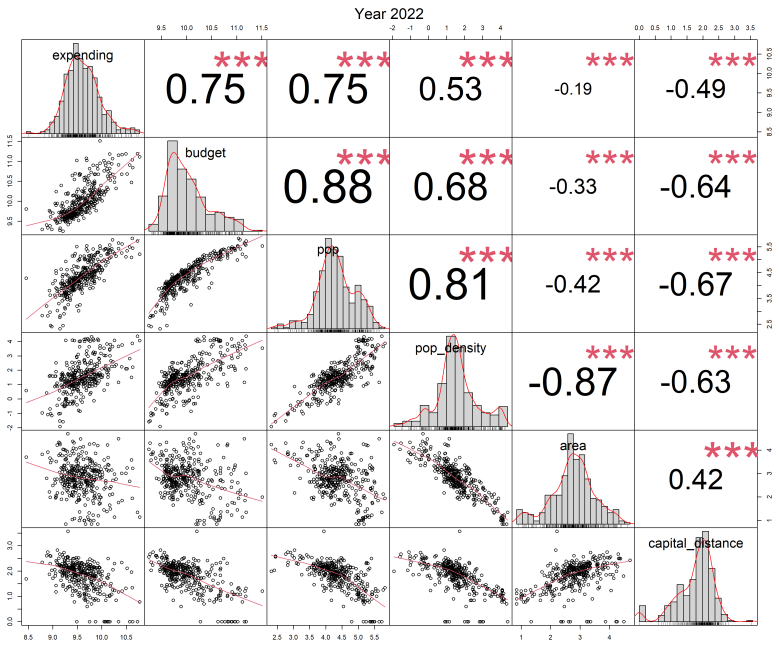


Figure 2.6. Correlogram for a set of variables of interest during the year 2022. All categories have been pooled and variables are log transformed.

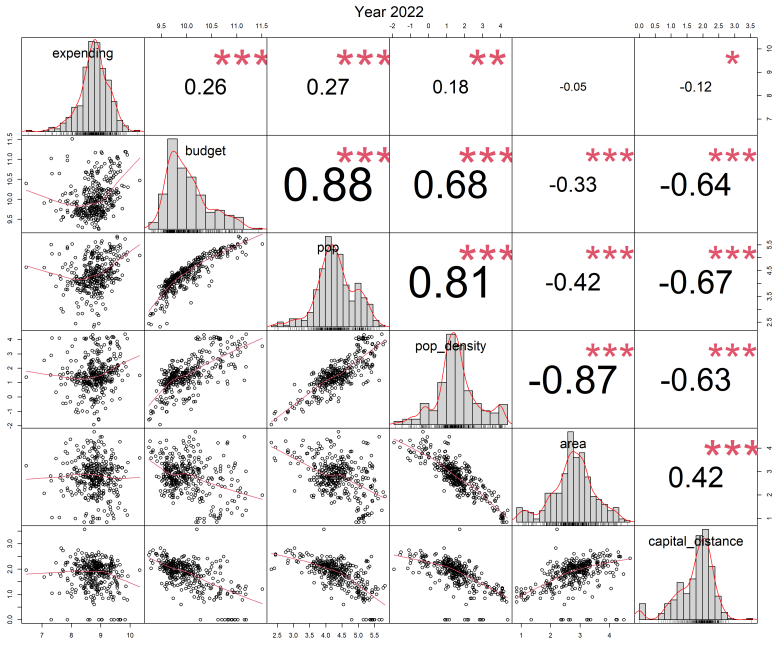


Figure 2.7. Correlogram for a set of variables of interest during the year 2022. Focused on the category Building and Facility Construction and Maintenance Services. Variables are log transformed.

Within the framework of complexity economics, this study aims to investigate patterns in municipal expending by employing multivariate regression models. These models incorporate fixed effects that account for the variability across municipalities, categories of expenses, and years. The inherent nature of fixed-effect models implies that characteristics such as geographical area or distance to the capital are inherently incorporated, thereby eliminating the need for explicit consideration.

To mitigate potential noise or anomalies in the data, we grouped the expenses within a rolling window of four years. Adopting an annual perspective on expenses could inadvertently introduce artifacts, as contracts may not necessarily execute within the same fiscal year they are processed (Curado et al., 2021).

Before delving into the model results, it is pertinent to clarify the political variable we employ in our analysis. We categorize political affinity using a binary variable, where a

value of "1" signifies that the mayor of a municipality is aligned with the central government coalition, while "0" indicates non-alignment. For models that span multiple years, the political affiliation from the most recent year within that period determines the political affinity for the entire timeframe. The logic behind this classification stems from the idea that mayors might strategically modify their municipality's expenditure patterns to achieve certain political outcomes. Alternatively, the central government might favor municipalities affiliated with its coalition in terms of budgetary allocations (Veiga & Veiga, 2007; Corvalan et al., 2018). While the prevalence of such dynamics related directly to expending behaviour in the Chilean context remains to be verified, its potential significance is well-documented in existing literature.

Table 2.1. Expending models.

	Dependent variable:					
	expending current [current year]	expending lead [4y after]		expending current [current year]	expending lead [4y after]	
	(1)	(2)	(3)	(4)	(5)	(6)
log(expending) [4y before]	0.103***			0.499***		
	(0.021)			(0.002)		
log(expending) [current and 3y before]		-0.056***			0.367***	
		(0.013)			(0.002)	
log(expending current) [current year]			0.036***			0.289***
			(0.010)			(0.001)
log(budget)	0.399***	0.103***	0.071**	0.202***	0.019	0.007
	(0.053)	(0.032)	(0.032)	(0.021)	(0.015)	(0.015)
log(population)	0.719***	0.612***	0.554***	0.350***	0.482***	0.506***
	(0.191)	(0.118)	(0.118)	(0.076)	(0.056)	(0.056)
Pol. Affinity	0.020***	0.001	0.0001	0.003	-0.008***	-0.007***
	(0.008)	(0.005)	(0.005)	(0.003)	(0.002)	(0.002)
Full R Squared	0.77	0.887	0.887	0.634	0.724	0.72
Projected R Squared	0.031	0.015	0.013	0.176	0.17	0.158
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Category FE	No	No	No	Yes	Yes	Yes
Observations	4,106	4,108	4,108	203,540	200,538	200,538
Residual Std. Error	0.198	0.124	0.124	0.545	0.401	0.404
Note:						*p<0.1; **p<0.05; ***p<0.01

The findings presented in Table (2.1) reveal intriguing dynamics in municipal spending. When assessing spending for a single year based on the preceding four years, a

discernible upward trend is evident in both the model with fixed effects for municipality and year and the model incorporating all three fixed effects. This upward trajectory aligns with the observations made in Figure 2.1, indicating that a municipality's past expenditures are indicative of its future spending. This correlation holds true whether the model is predicting current or future expenses.

Examining the impact of other variables, it is observed that the budget does not significantly influence future spending in models with three-way fixed effects (columns 5 and 6). This could suggest that expenditures in certain categories remain unaffected by budgetary constraints. Essential municipal services such as waste collection, public infrastructure maintenance, and public servant wages might be areas where spending is obligatory, irrespective of the fiscal landscape.

Population size, as anticipated by Figure (2.6), exhibits a direct correlation with future expenditures. Larger municipalities are predisposed to higher spending, a relationship that is inherently tied to the structure and categories of municipal budgets. For instance, in the category of taxes, an increase in population naturally corresponds to a surge in the budgetary allocation, underscoring the interdependence between demographic dynamics and fiscal planning.

The variable of Political Affinity demonstrates significance in select models, albeit with a seemingly minimal impact. However, given the substantial scale of expenditure variables, even a seemingly small effect of 0.020 translates to a 2% increase in spending for the subsequent fiscal period. In concrete terms, for an expenditure level of the order of 10^{10}, this signifies an escalation of 200 million CLP, underscoring the material implications of such shifts.

Regarding goodness of fit, given the employment of fixed effects in the model, both Full R-Squared and Projected R-Squared are reported. The former represents the overall variance explained by incorporating fixed effects, while the latter elucidates the within-group variance explained by fixed effects. The models reveal substantial variability in

explanatory power. Category pooled models exhibit high R-Squared values, indicating that a significant proportion of the variance can be attributed to fixed effects alone. In contrast, three-way fixed effect models, while achieving moderate to high R-Squared values, demonstrate that the included variables do offer insights into the within-group dynamics, explaining approximately 17% of the variance.

In summary, while municipal expenditures seem to follow a rising trend, a closer examination uncovers discrepancies when these expenditures are broken down by category. Given the diverse behavior of the explanatory variables, there's a pressing need for a detailed investigation of the data. An in-depth study of granular expenditure models is crucial to deciphering the intricate patterns of municipal spending. As we move forward in this analytical endeavor, it's vital to first lay down the fundamental concepts and explore potential explanatory variables, as they hold the key to understanding the nuanced financial behaviors of municipalities.

In this chapter, we present a range of measures that encapsulate various facets of relatedness in municipal spending patterns, complemented by other pertinent metrics from the economic complexity literature.

2.2. Relatedness measures

Revealed Comparative Advantage (RCA) is a widely used indicator to assess the comparative strength of a region or country in a specific sector or industry. The concept of RCA was first introduced by Balassa (1965) to measure a country's trade performance in specific sectors relative to its overall trade performance and that of other countries. Since then, RCA has been widely applied in various fields such as international trade, regional economics, and economic geography (C. A. Hidalgo & Hausmann, 2009). The RCA allows researchers to identify sectors in which a region or country has a comparative advantage, based on its observed performance relative to a benchmark, such as the performance of other regions or the global average.

In the context of public expenditure, RCA can be used to analyze the comparative strength of municipalities in terms of public procurement spending across different segments. It can help identify regions with similar spending profiles and reveal potential spatial clustering of public expenditure (Hidalgo & Hausmann, 2009). This approach allows for an examination of the comparative advantage of regions or municipalities in procuring specific goods and services. For example, a high RCA value in a certain procurement category for a municipality may suggest that the municipality specializes in that category, potentially due to factors such as regional expertise, resource endowments, or strategic investments in that sector (Hausmann & Klinger, 2007).

The formula for the RCA is as follows

$$\text{RCA}_{ijt} = \frac{\frac{X_{ijt}}{\sum_{i'} X_{ij't}}}{\frac{\sum_{i'} Xi'jt}{\sum_{i',j'} X_{i'j't}}} \tag{2.1}$$

Where X_{ijt} represent the expenses made by the municipality i in category j during the year t.

Also, following the literature, we say that a municipality i has a comparative advantage or is balassa active on the segment j for the year t if $\text{RCA}_{ijt} > 1$. This motivates the folowing definition

$$\text{B}_{ijt} = \begin{cases} 1 & \text{if RCA}_{ijt} > 1 \\ 0 & \text{if RCA}_{ijt} \leq 1. \end{cases} \tag{2.2}$$

An RCA value greater than 1 indicates that a region has a comparative advantage in the specific industry, while an RCA value less than 1 suggests a comparative disadvantage (Balassa, 1965). In other words, if a region has comparative advantage on an investment j, it means that it is investing more on j than would be expected from that region total investments and the size of that investment market.

Furthermore, motivated by the works of (C. A. Hidalgo, Klinger, Barabási, & Hausmann, 2007; C. Hidalgo et al., 2018; C. Hidalgo, Castañer, & Sevtsuk, 2020), we define a relatedness and density measure as follows

$$\phi_{ii't} = \frac{\sum_j \mathrm{B}_{ijt}\mathrm{B}_{i'jt}}{\max\left(\sum_j \mathrm{B}_{ijt}, \sum_j \mathrm{B}_{i'jt}\right)} \tag{2.3}$$

$$\mathrm{W}_{ijt} = \frac{\sum_{i'\neq i} \mathrm{B}_{i'jt}\phi_{ii't}}{\sum_{i'\neq i} \phi_{ii't}} \tag{2.4}$$

The first value, $\phi_{ii't}$, corresponds to a relatedness measure that determines how many categories in common the municipalities i and i' have when they are balassa active for the year t. In other words, ϕ is a similarity matrix that measures how similar is the expending behaviour of a pair of municipalities when they are investing more than is expected for them.

The second value, W_{ijt}, correspond to a density measure that captures how similar is the municipality i with respect to all other municipalities i' that are balassa active for the segment j at the time t. The rationale behind this is the idea of a path dependence in the activation of segments: if a municipality is similar to others when they are balassa active, save for a few segments, then is highly possible that the municipality is going to become active in the next period in one or several of those few segments.

We also define diversity as

$$\text{diversity}_{it} = \sum_j \mathrm{B}_{ijt} \tag{2.5}$$

and ubiquity as

$$\text{ubiquity}_{jt} = \sum_i \mathrm{B}_{ijt} \tag{2.6}$$

Diversity is a measurement related to a municipality and it computes how many comparative advantages has across all categories and the ubiquity of a category computes how many municipalities are balassa active in that category.

Lastly, we define expending by similar expending (ESE) and expending by similar budget (ESB) as

$$\text{ESE}_{ijt} = \sum_{k \neq i} \phi^{E}_{ikt} \times \text{expending}_{kjt} \tag{2.7}$$

$$\text{ESB}_{ijt} = \sum_{k \neq i} \phi^{B}_{ikt} \times \text{expending}_{kjt} \tag{2.8}$$

where ϕ^{E}_{ikt} corresponds to the similarity matrix constructed with the RCA associated with expending, as seen in (2.1) and ϕ^{B}_{ikt} is the similarity matrix constructed with associated with budget in the RCA equation (2.1), so X_{ijt} in that case is the budget of the municipality i in the budget category j during the year t. The rationale behind ESE and ESB is that both variables should predict expending of a focal municipality, since the first one captures the expending similarity and the second one the budget similarity.

3. CHAPTER 2

3.1. Models

We chose to use the structure of the model (5) of Table (2.1) purely because it was the one who explained the most variance, hence our first model is

$$\begin{aligned}\text{log(expending lead)}_{ijt} = \beta_0 &+ \beta_1 \text{log(expending)}_{ijt} + \beta_3 \text{log(ubiquity)}_{jt} \\ &+ \beta_4 \text{log(diversity)}_{it} + \beta_5 \text{log(ESE)}_{ijt} \\ &+ \beta_6 \text{log(ESB)}_{ijt} + \beta_7 \text{W}_{ijt} + \beta_8 \text{B}_{ijt} \\ &+ \beta_9 \text{log(population)}_{it} + \beta_{10} \text{log(budget)}_{it} + \beta_{11} \text{pol\_affinity}_{it} \\ &+ \eta_t + \mu_i + \nu_j + \epsilon_{ijt} \end{aligned} \tag{3.1}$$

where η_t, μ_i and ν_j are fixed effects representing the year, municipality and category respectively, and ϵ_{ijt} is the error term. We also employ a second model which has the same structure as the first one, but now every variable is interacted with RCA.

Additionally, at the end we fit a logit model to study the effect of the variables over the RCA in the future

$$\begin{aligned}\text{logit(p)}_{ijt} = (\beta_0 &+ \beta_1 \text{log(expending)}_{ijt} + \beta_3 \text{log(ubiquity)}_{jt} \\ &+ \beta_4 \text{log(diversity)}_{it} + \beta_5 \text{log(ESE)}_{ijt} \\ &+ \beta_6 \text{log(ESB)}_{ijt} + \beta_7 \text{W}_{ijt} + \beta_8 \text{B}_{ijt} \\ &+ \beta_9 \text{log(population)}_{it} + \beta_{10} \text{log(budget)}_{it} + \beta_{11} \text{pol\_affinity}_{it} \\ &+ \eta_t + \mu_i + \nu_j + \epsilon_{ijt}) \times \text{B}_{ijt} \end{aligned} \tag{3.2}$$

where p is the probability to be balassa active in the future period. The idea of both models is to explain the dependant variable for the rolling window of 4 years in the future, while the independant variables are aggregated for the current year t and the past 3 years.

3.2. Results

Before diving into the models, we will examine some preliminary results that will help with the interpretation of the models.

Figure (3.1) correspond to the binning of the density for municipalities that in the past were not balassa active, and the Y axis counts all those municipalities and checks if in the present time they are balassa active. What the figure tells is straightforward: the more related a municipality is to others, in the sense of the density W, the more probable is that it becomes active in the future.

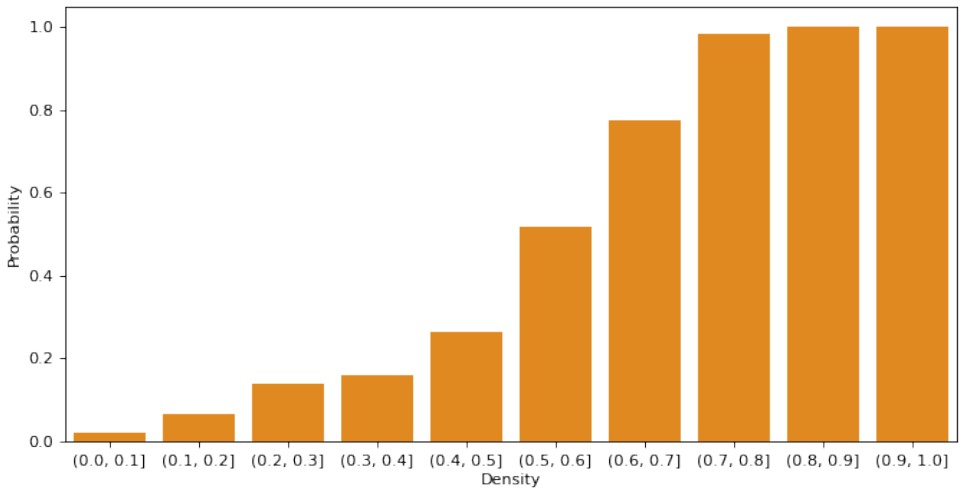


Figure 3.1. The probability of becoming balassa active increases with density

We designed a visualization using the similarity adjacency matrix for the municipalities. Initiating with the edges provided by the maximum spanning tree, we progressively incorporated important edges until achieving an average node degree of 6. Following this, we applied the Louvain clustering method, assigning colors to nodes based on their

determined clusters. The size of each node represents the municipality's expenditures from 2019 to 2022. The outcomes can be observed in Figure (3.2). From this depiction, it's evident that municipalities form clusters, though the distinguishing factors for each cluster aren't immediately discernible. One discerning observation, paralleling our earlier insights from Figure (2.3), is that municipalities don't necessarily cluster with their immediate geographical neighbors.

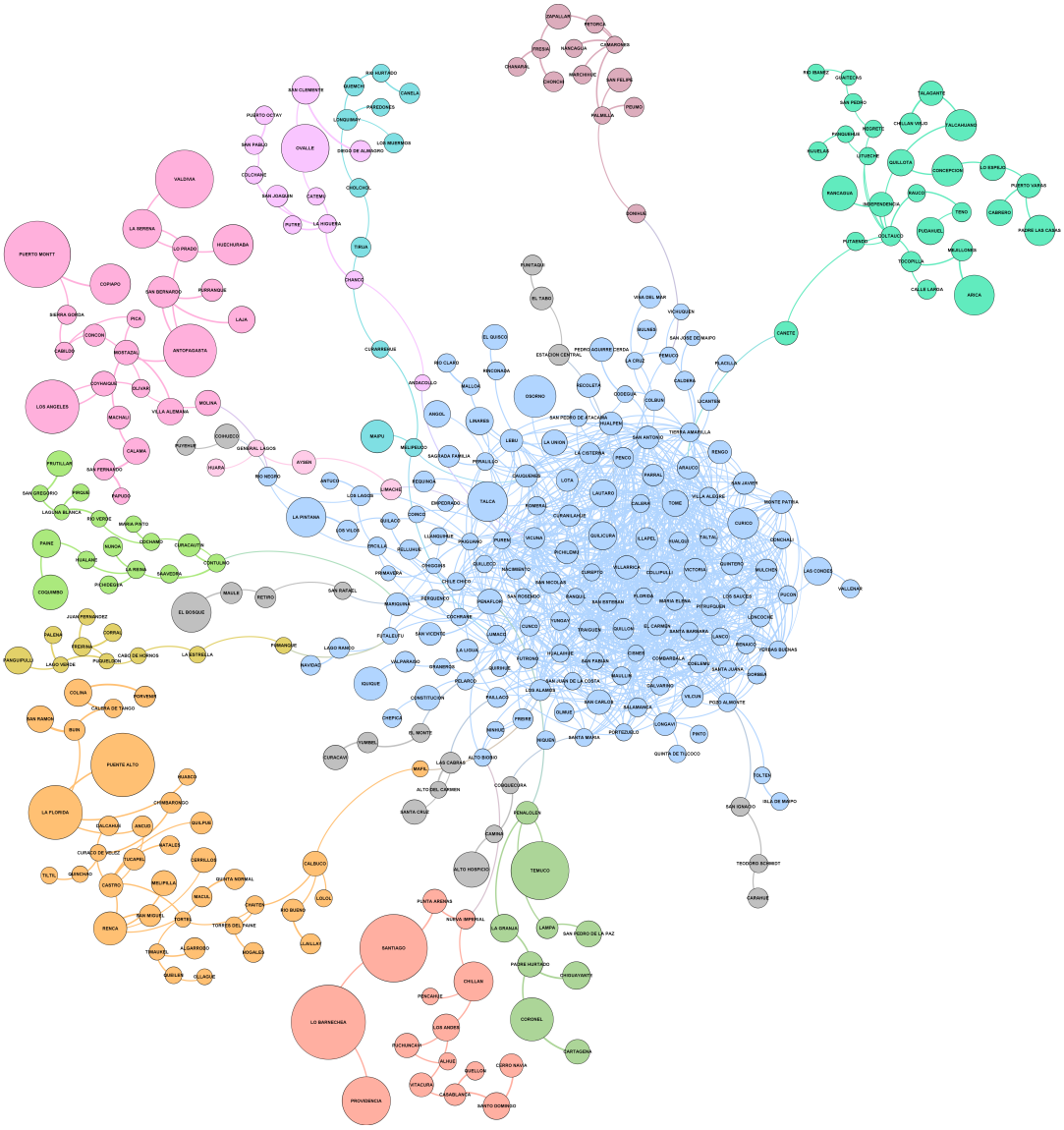


Figure 3.2. Network visualization for the municipalities similarity adjacency matrix for the period 2019-2022.

We detail the results for models explaining future expenditures in Table (3.1). Notably, certain variable effects, such as those for diversity and ESE, shift signs when introducing new variables into the model. This shift could be explained due to the correlation observed among diversity, ESE, ESB, and density (see Appendix .7, .8). In the baseline model (2.1, column 6), directions for past expenditure, population, and budget align with those in Table (3.1), and the magnitude of their effects is comparably consistent. For other variables, ESB, density, RCA, population, budget, and political affinity exhibit a positive influence, while ubiquity, diversity, and ESE present a negative impact on future expenditures. Notably, if municipalities with analogous budgets augment their spending, the focal municipality likely follows suit. An illustrative 14% spending increase from a 10% ESB surge suggests the focal municipality's inclination to mirror peers. Similarly, density implies municipalities with pronounced values resemble those possessing RCA in specific areas. Either the focal municipality holds RCA, aligning it with others with RCA when having a high density, or it's on the brink of achieving RCA, as indicated by Figure (3.1). Given that the density metric ranges between 0 and 1, a 0.1 unit increase translates to a 6% expenditure surge. Concerning RCA alone, municipalities with established RCA in particular categories tend to outspend those without by approximately 5%. A 1% population rise signifies a 0.55% future spending increase. Given an average annual population growth of 0.84%, this factor, coupled with a budget increment, underpins the overarching upward trend evident in Figure (2.1a). An incremental 10% in budget corresponds to a 0.5% future expenditure increase, paralleling an observed average inter-annual budget growth of 12.59%.

Regarding negatively influencing variables, the ubiquity effect suggests as categories grow ubiquitous, municipalities may forgo heightened spending on them to achieve RCA. From a diversity standpoint, municipalities expanding RCA across various categories may curtail spending in other areas, risking the loss of RCA status or diminishing expenses in categories without RCA. ESE's inverse effect might be attributed to omitted variables bias, the main culprit of this effect being the expending (as seen in the ESE robustness tables in the Appendix). It indicates that unlike the ESB impact, focal municipalities

don't invariably emulate those with comparable expenditures. The political affinity effect remains consistently negative throughout models, signifying nearly a 1% spending dip when a municipality aligns with the governing coalition. A tangible interpretation is that a 1% cutback in a high-expenditure year, approximately 10^{10}, equates to a reduction of 100 million CLP.

We're beginning to unravel the consistent expenditure trends among municipalities. However, RCA stands out as a recurring explanatory factor intertwined with most aforementioned variables. It prompts the question: how do municipalities behave concerning achieving RCA across categories? Given our forward-looking stance, we can evaluate municipalities based on past and anticipated RCA stances, reminiscent of a 2x2 design. To this end, we factor in RCA from the prior period, interacting with variables from the full model (3.1, column 7).

Table 3.1. Three ways fixed effects relatedness models

	Dependent variable:						
	log(Expending lead)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
log(expending)	0.367***	0.368***	0.368***	0.365***	0.365***	0.336***	0.315***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
log(ubiquity)		−0.110***	−0.110***	−0.114***	−0.108***	−0.738***	−0.576***
		(0.017)	(0.017)	(0.017)	(0.017)	(0.025)	(0.027)
log(diversity)			0.020***	−0.020**	0.019*	−0.029***	−0.040***
			(0.005)	(0.009)	(0.010)	(0.011)	(0.011)
log(ESE)				0.050***	−0.010	−0.105***	−0.088***
				(0.009)	(0.012)	(0.013)	(0.013)
log(ESB)					0.067***	0.143***	0.140***
					(0.010)	(0.010)	(0.010)
density						0.824***	0.591***
						(0.023)	(0.027)
rca							0.049***
							(0.003)
log(population)	0.482***	0.483***	0.492***	0.493***	0.503***	0.554***	0.556***
	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)
log(budget)	0.019	0.019	0.023	0.025*	0.029**	0.049***	0.049***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
pol. affinity	−0.008***	−0.008***	−0.007***	−0.007***	−0.008***	−0.007***	−0.007***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Full R Squared	0.724	0.724	0.724	0.724	0.724	0.726	0.726
Projected R Squared	0.17	0.17	0.17	0.171	0.171	0.176	0.177
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Category FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	200,538	200,538	200,538	200,538	200,538	200,538	200,538
Residual Std. Error	0.401	0.401	0.401	0.401	0.401	0.400	0.399
Note:							*p<0.1; **p<0.05; ***p<0.01

From Table 3.2, we'll focus our discussion on significant interaction terms. The model provides multiple insights:

(i) Ubiquity's negative effect intensifies when a municipality possesses RCA, reinforcing our earlier interpretation. As a category becomes increasingly ubiquitous, upholding its RCA becomes costlier.

Table 3.2. Relatedness model with interacting RCA

	Dependent variable:
	log(Expending lead)
log(expending)	0.326^{***}
	(0.003)
log(ubiquity)	-0.597^{***}
	(0.031)
log(diversity)	-0.073^{***}
	(0.012)
log(ESE)	-0.076^{***}
	(0.014)
log(ESB)	0.131^{***}
	(0.011)
density	0.605^{***}
	(0.035)
log(population)	0.600^{***}
	(0.056)
log(budget)	0.018
	(0.015)
pol. affinity	-0.011^{***}
	(0.003)
RCA	-1.193^{***}
	(0.092)
log(expending)×rca	−0.007
	(0.006)
log(ubiquity)×rca	-0.111^{***}
	(0.043)
log(diversity)×rca	0.134^{***}
	(0.015)
log(ESE)×rca	0.063^{***}
	(0.016)
log(ESB)×rca	−0.015
	(0.015)
density×rca	0.165^{***}
	(0.049)
log(population)×rca	-0.027^{***}
	(0.006)
log(budget)×rca	0.095^{***}
	(0.008)
pol. affinity×rca	0.011^{***}
	(0.004)
Full R Squared	0.724
Projected R Squared	0.17
Year FE	Yes
Municipality FE	Yes
Category FE	Yes
Observations	200,538
Residual Std. Error	0.398
Note:	*p<0.1; **p<0.05; ***p<0.01

(ii) Concerning diversity, possessing RCA translates to a positive impact on future expenditures. This is possibly because certain categories are interlinked in expenditure terms (refer to Figure 2.5 and in the Apendix, Figure .6). Thus, when

a municipality achieves RCA in one such interrelated category, its spending also escalates in tandem with the correlated ones.

(iii) The effect of ESE is marginally negative when RCA is in play. Density retains its influence direction. However, its magnitude slightly amplifies in the presence of RCA.

(iv) The intertwined effect of density and RCA might hint at a phase wherein all analogous municipalities possessing RCA in a specific category (or a cluster of related ones) need to sustain particular spending levels.

(v) The budget effect magnifies twofold in the presence of RCA. This is perhaps straightforward: if a municipality is investing in a category where it has RCA, an enhanced budget implies sustained future investments in that category.

(vi) Interestingly, the presence of RCA appears to neutralize the adverse impact of political affinity.

In essence, RCA emerges as a pivotal metric for deciphering expenditure patterns. Naturally, this prompts the question: which factors can elucidate the evolution of RCA over subsequent spending periods, as seen in Figure (3.3)?

The model presented in Table (3.3) reveals even more insights:

(i) Municipalities that spend more have increased odds of either developing or retaining RCA. However, sustaining an existing RCA is simpler than acquiring a new one.

(ii) As a category becomes more ubiquitous, the challenge of establishing or sustaining RCA escalates. Among the factors, this one most drastically lowers the chances of obtaining RCA in the future.

(iii) If a municipality's diversity rises, preserving an RCA status becomes more feasible than securing one from scratch.

(iv) An increase in ESE, consistent with prior models, makes RCA attainment or retention more challenging. This aligns with the idea that when municipalities

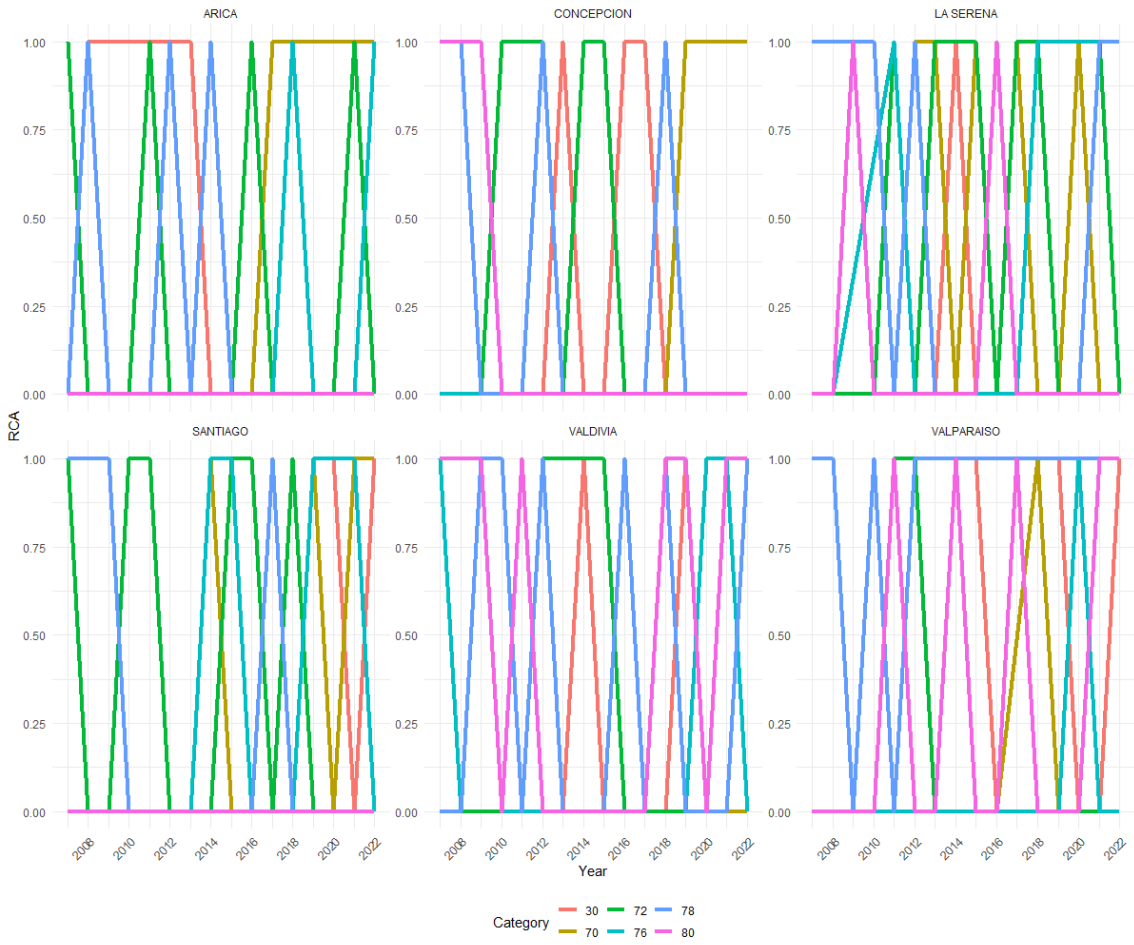


Figure 3.3. RCA over time for six capital regions.

with spending patterns similar to the focal municipalities amplify their expenditures, they are either on the verge of achieving RCA status, maintaining it, or possibly rendering some categories more widespread.

(v) An increase in ESB consistently enhances the likelihood of acquiring or retaining RCA.

(vi) Density plays a pivotal role, with the most positive influence on the chances of future RCA. If municipalities with analogous expending habits become more proactive, a municipality within that group is likely to obtain or even more likely to retain RCA.

	Estimate	Std. error	z value	Pr(> |z|)
rca	-3.73***	0.54	-6.93	0.00
log(expending)	1.13***	0.02	55.91	0.00
ubiquity	-4.98***	0.19	-26.72	0.00
diversity	-0.92***	0.07	-12.62	0.00
log(ESE)	-0.83***	0.08	-10.00	0.00
log(ESB)	0.40***	0.07	5.99	0.00
density	3.66***	0.21	17.46	0.00
log(population)	-1.92***	0.33	-5.86	0.00
log(budget)	-0.21**	0.09	-2.42	0.02
pol. affinity	-0.04***	0.02	-2.88	0.00
log(expending)×rca	0.32***	0.03	9.39	0.00
ubiquity×rca	-0.25	0.25	-1.01	0.31
diversity×rca	0.86***	0.09	9.90	0.00
log(ESE)×rca	0.03	0.09	0.28	0.78
log(ESB)×rca	-0.08	0.09	-0.96	0.34
density×rca	1.74***	0.29	6.08	0.00
log(population)×rca	-0.06*	0.04	-1.77	0.08
log(budget)×rca	0.12**	0.05	2.59	0.01
pol. affinity×rca	0.03	0.02	1.51	0.13

Table 3.3. Estimates and their significance levels. Significance codes: '***' $p<0.01$, '**' $p<0.05$, '*' $p<0.1$. Logit model, the dependant variable is the lead RCA.

(vii) Population growth presents a negative influence for the first time. A larger population growth translates to a tougher challenge in acquiring or holding onto RCA status.

(viii) Similarly, a growing budget works against a municipality's odds of developing RCA, an event that occurs frequently. However, this negative impact is marginally reduced when the objective is to preserve an existing RCA.

(ix) Political affinity persists in its negative influence, this time hindering a municipality's chances of achieving RCA, aligning with its effects observed in earlier expenditure models.

3.3. Discussion

This research aimed to delve deep into the expenditure patterns of Chilean municipalities, with a primary focus on the Principle of Relatedness (C. A. Hidalgo, Klinger, Barabási, & Hausmann, 2007; Boschma et al., 2017). To achieve this, we established various measures to predict future municipal spending. Notably, two of these measures, the ESE and the ESB, were custom-designed for this study and yielded surprising outcomes.

The ESE's negative impact is particularly intriguing. When the ESE rises, it indicates that municipalities similar to the focal one are increasing their spending. However, paradoxically, this leads to a reduction in the focal municipality's expenditure. In contrast, density showcases a significant positive effect. For this effect to manifest, it necessitates similar municipalities to be balassa active. It appears that once a certain expenditure threshold is surpassed, if similar municipalities increase their spending, the focal municipality follows suit. Conversely, below this threshold, the focal municipality tends to reduce its spending.

The ESB, on the other hand, positively influences expenditure. This can be attributed to its unique approach to gauging similarity by examining similar budgets. It's logical to infer that if a municipality spends more, it doesn't necessarily lead to reduced spending by the focal municipality. This is because they share similar characteristics, as delineated by various categories of income, which makes the ESB a direct manifestation of the Principle of Relatedness.

Addressing a pivotal question posed earlier: Is there tangible evidence suggesting a mechanism that connects (and perhaps coordinates) similar municipalities? Until this point, our interpretations were primarily based on correlograms, visual representations, and model outcomes. We operated under the assumption that information about the behavior of similar municipalities, in terms of relatedness, would naturally permeate to a focal municipality. However, as evident from Figures (2.3) and (3.2), there's a noticeable absence of geographical clustering among direct neighbors. Moreover, the municipal

network seems to group municipalities without considering their geographical proximity. This raises a pertinent question: How is it that when the ESE surges, the typical response is to decrease spending, but when the ESB rises, spending amplifies?

One possible explanation could be the influence of non-geographical factors, such as shared administrative policies, historical ties, or socio-economic similarities. These connections might play a pivotal role in shaping expenditure behaviors, even in the absence of direct geographical proximity. Another avenue worth exploring is the role of communication channels and information dissemination mechanisms among municipalities. Perhaps there exist formal or informal networks through which municipalities share insights, best practices, and expenditure strategies, thereby influencing each other's spending behaviors.

Furthermore, the dynamics of municipal expenditure cannot be viewed in isolation. External factors, such as national economic policies, regional development initiatives, and global economic trends, can also exert significant influence over the fiscal capacity. For instance, national grants or subsidies targeting specific sectors or projects might lead to synchronized spending patterns among municipalities, irrespective of their geographical proximity or relatedness.

Additionally, the role of local leadership cannot be understated. Municipal leaders, through their vision and decision-making, can significantly sway expenditure patterns. If leaders from different municipalities share a common vision or collaborate on regional projects, this can lead to similar spending behaviors. Conversely, divergent leadership styles and priorities can result in varied expenditure trajectories, even among municipalities that are otherwise similar in terms of budget or relatedness.

It's also worth considering the impact of technological advancements and digital communication. In today's interconnected world, municipalities can easily share and access information, best practices, and innovative solutions through digital platforms. This ease of information exchange can lead to rapid adoption of successful strategies across municipalities, resulting in synchronized spending patterns. For instance, if one municipality

successfully implements a digital infrastructure project and shares its learnings, others might be inclined to allocate funds to similar projects, influenced by the demonstrated success.

Another dimension to consider is the socio-cultural aspect. Municipalities with shared cultural, historical, or social ties might have similar spending priorities. For example, municipalities that celebrate the same local festivals or events might allocate similar budgets for preparations and celebrations. Similarly, municipalities with shared historical events or landmarks might prioritize funds for preservation or tourism-related projects.

Lastly, public opinion and local community engagement play a crucial role. Municipalities are, after all, serving their local communities. If there's a strong public push towards specific projects or initiatives, municipalities might adjust their spending patterns accordingly. For instance, a widespread public demand for better healthcare facilities or green spaces can lead to increased allocation of funds in these areas across various municipalities.

While the Principle of Relatedness provides a robust framework for understanding municipal expenditure patterns, it's essential to consider the multifaceted influences that shape these patterns.

3.4. Conclusions

Within the intricate landscape of economic complexity and municipal expenditure patterns, the study focusing on Chilean municipalities, guided by the Principle of Relatedness, has established a distinctive position. This research has delved into unraveling the intricacies influencing municipal expending behaviors.

The introduction of the ESE and ESB, stand as pivotal elements of this investigation. Their deployment has shed light on some unforeseen dynamics, especially the intriguing

behavior of the ESE. These revelations not only challenge established notions but also emphasize the importance of adopting a comprehensive approach in dissecting expenditure patterns. The contrasting behaviors of the ESE and ESB underscore the intricate balance of factors influencing municipal expenditure.

Moreover, this research has expanded the analytical horizon by emphasizing both geographical and non-geographical determinants. Traditional emphasis on geographical proximity has been re-evaluated, with the findings pointing towards a more layered scenario. The lack of clear geographical clusters, combined with socio-political and economic influences, suggests that municipal spending is a subject shrouded in complexity.

The study also prompts a deeper introspection into the influence of global events, such as economic shifts or pandemics, on municipal finances. While their immediate repercussions are evident, the enduring ramifications on policy formulation, expenditure trends, and regional strategies necessitate further scrutiny.

Additionally, the study's findings have implications for the broader field of economic complexity. The Principle of Relatedness, while traditionally applied to industries and products, has found a new application in the context of municipal expenditures. This opens avenues for further research, exploring the interconnectedness and relatedness principles across various domains and scales. For instance, while our exploration of the municipality and category networks was primarily for visualization, it's evident that understanding the unique characteristics of each cluster is vital for a deeper comprehension of municipal public spending.

Certain aspects, like the variation in the time window for dependent and independent variables, the exploration of expense spikes as seen in Figure (2.1a) or the analysis of municipal expenditures while considering an alternate hierarchical structure for the categories, either derived from the eight-digit UNSPC code itself or the category network clustering (see Appendix .6), continue to be unexplored areas. The influence of political

variables, especially in light of the observed significance of coalition memberships, also presents a promising avenue for future research.

In wrapping up, this research stands as a testament to the intricate interplay of factors that shape municipal expenditure patterns. It not only offers a fresh perspective but also sets the stage for future inquiries, ensuring that our understanding of municipal spending remains dynamic, comprehensive, and ever-evolving.

REFERENCES

Aschhoff, B., & Sofka, W. (2009). Innovation on demand—can public procurement drive market success of innovations? *Research policy*, *38*(8), 1235–1247.

Balassa, B. (1965). Trade liberalisation and "revealed" comparative advantage. *The Manchester School*, *33*(2), 99-123. Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1467-9957.1965.tb00050.x doi: https://doi.org/10.1111/j.1467-9957.1965.tb00050.x

Baskaran, T. (2011). Fiscal decentralization, ideology, and the size of the public sector. *European Journal of Political Economy*, *27*(3), 485-506. Retrieved from https://www.sciencedirect.com/science/article/pii/S0176268011000292 doi: https://doi.org/10.1016/j.ejpoleco.2011.03.003

Baskaran, T., Feld, L. P., & Schnellenbach, J. (2016). Fiscal federalism, decentralization, and economic growth: A meta-analysis. *Economic Inquiry*, *54*(3), 1445-1463. Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1111/ecin.12331 doi: https://doi.org/10.1111/ecin.12331

Boschma, R., Coenen, L., Frenken, K., & Truffer, B. (2017). Towards a theory of regional diversification: combining insights from evolutionary economic geography and transition studies. *Regional Studies*, *51*(1), 31-45. Retrieved from https://doi.org/10.1080/00343404.2016.1258460 doi: 10.1080/00343404.2016.1258460

Bove, V., Efthyvoulou, G., & Navas, A. (2017). Political cycles in public expenditure: butter vs guns. *Journal of Comparative Economics*, *45*(3), 582-604. Retrieved from https://www.sciencedirect.com/science/article/pii/S0147596716300038 doi: https://doi.org/10.1016/j.jce.2016.03.004

ChileCompra. (2023). *Datos abiertos.* Retrieved from https://datos-abiertos.chilecompra.cl/ (Accessed: 2023-04-25)

Connolly, J. M., & Mason, D. P. (2016). Ideology and local public expenditure priorities. *Political Research Quarterly*, *69*(4), 830-841. Retrieved from https://doi.org/10.1177/1065912916665702 doi: 10.1177/1065912916665702

Corvalan, A., Cox, P., & Osorio, R. (2018). Indirect political budget cycles: Evidence from chilean municipalities. *Journal of Development Economics*, *133*, 1-14. Retrieved from https://www.sciencedirect.com/science/article/pii/S0304387818300014 doi: https://doi.org/10.1016/j.jdeveco.2018.01.001

Curado, A., Damásio, B., Encarnação, S., Candia, C., & Pinheiro, F. L. (2021, dec). Scaling behavior of public procurement activity. *PLOS ONE*, *16*(12), e0260806. Retrieved from https://doi.org/10.1371%2Fjournal.pone.0260806 doi: 10.1371/journal.pone.0260806

Darby, J., Li, C.-W., & Muscatelli, V. (2004). Political uncertainty, public expenditure and growth. *European Journal of Political Economy*, *20*(1), 153-179. Retrieved from https://www.sciencedirect.com/science/article/pii/S0176268003000685 (Special Section: Mini-symposium on Professional Prejudice and Discrimination in the History of Economic Thought) doi: https://doi.org/10.1016/j.ejpoleco.2003.01.001

Edler, J., & Georghiou, L. (2007). Public procurement and innovation—resurrecting the demand side. *Research policy*, *36*(7), 949–963.

European Commission, D.-G. f. R., & Policy, U. (2018). *Public procurement: guidance for practitioners on the avoidance of the most common errors in projects funded by the european structural and investment funds.* Publications Office. Retrieved from https://data.europa.eu/doi/10.2776/886010

Fazekas, M., & Wachs, J. (2020). Corruption and the network structure of public contracting markets across government change. *Politics and Governance*, *8*(2), 153–166.

Francisca Pacheco, R. S., & Villena, M. G. (2021). Estimating local government efficiency using a panel data parametric approach: the case of chilean municipalities. *Applied Economics*, *53*(3), 292-314. Retrieved from https://doi.org/10.1080/00036846.2020.1808171 doi: 10.1080/00036846.2020.1808171

Hausmann, R., & Klinger, B. (2007, 01). The structure of the product space and the evolution of comparative advantage.

Hidalgo, C., Balland, P.-A., Boschma, R., Delgado, M., Feldman, M., Frenken, K., ... Zhu, S. (2018, 07). The principle of relatedness: Proceedings of the ninth international conference on complex systems. In (p. 451-457). doi: 10.1007/978-3-319-96661-8_46

Hidalgo, C., Castañer, E., & Sevtsuk, A. (2020, 08). The amenity mix of urban neighborhoods. *Habitat International*, *106*, 102205. doi: 10.1016/j.habitatint.2020.102205

Hidalgo, C. A., & Hausmann, R. (2009). The building blocks of economic complexity. *Proceedings of the National Academy of Sciences*, *106*(26), 10570-10575. Retrieved from https://www.pnas.org/doi/abs/10.1073/pnas.0900943106 doi: 10.1073/pnas.0900943106

Hidalgo, C. A., Klinger, B., Barabási, A.-L., & Hausmann, R. (2007). The product space conditions the development of nations. *Science*, *317*(5837), 482–487.

Hidalgo, C. A., Klinger, B., Barabási, A.-L., & Hausmann, R. (2007). The product space conditions the development of nations. *Science*, *317*(5837), 482-487. Retrieved from https://www.science.org/doi/abs/10.1126/science.1144581 doi: 10.1126/science.1144581

Instituto Nacional de Estadísticas. (2023). *Proyecciones de población.* Retrieved from https://www.ine.gob.cl/estadisticas/sociales/demografia-y-vitales/proyecciones-de-poblacion (Accessed: 2023-04-25)

Jara-Figueroa, C., Jun, B., Glaeser, E. L., & Hidalgo, C. A. (2018). The role of industry-specific, occupation-specific, and location-specific knowledge in the growth and survival of new firms. *Proceedings of the National Academy of Sciences*, *115*(50), 12646-12653. Retrieved from https://www.pnas.org/doi/abs/10.1073/pnas.1800475115 doi: 10.1073/pnas.1800475115

Kleider, H., Röth, L., & Garritzmann, J. L. (2018). Ideological alignment and the distribution of public expenditures. *West European Politics*, *41*(3), 779–802. doi:

10.1080/01402382.2017.1395634

Kristoufek, L., & Skuhrovec, J. (2012). Exponential and power laws in public procurement markets. *Europhysics Letters*, *99*(2), 28005.

OECD. (2019). *Government at a glance 2019*. OECD Publishing. Retrieved from https://doi.org/10.1787/8ccf5c38-en doi: 10.1787/8ccf5c38-en

United Nations Global Marketplace. (2023). *Unspsc*. Retrieved from https://www.ungm.org/Public/UNSPSC (Accessed: 2023-04-25)

Uyarra, E., & Flanagan, K. (2010). Understanding the innovation impacts of public procurement. *European planning studies*, *18*(1), 123–143.

Veiga, F., & Veiga, L. (2007, 03). Political business cycles at the municipal level. public choice, 131(1-2), 45-64. *Public Choice*, *131*, 45-64. doi: 10.1007/s11127-006-9104-2

Wachs, J., Fazekas, M., & Kertész, J. (2021). Corruption risk in contracting markets: a network science perspective. *International Journal of Data Science and Analytics*, *12*, 45–60.

Walker, H., & Phillips, W. (2009). Sustainable procurement: emerging issues. *International Journal of Procurement Management*, *2*(1), 41–61.

APPENDIX

Category	Code
Live Plant and Animal Material and Accessories and Supplies	10
Mineral and Textile and Inedible Plant and Animal Materials	11
Chemicals including Bio Chemicals and Gas Materials	12
Resin and Rosin and Rubber and Foam and Film and Elastomeric Materials	13
Paper Materials and Products	14
Fuels and Fuel Additives and Lubricants and Anti corrosive Materials	15
Mining and Well Drilling Machinery and Accessories	20
Farming and Fishing and Forestry and Wildlife Machinery and Accessories	21
Building and Construction Machinery and Accessories	22
Industrial Manufacturing and Processing Machinery and Accessories	23
Material Handling and Conditioning and Storage Machinery and their Accessories and Supplies	24
Commercial and Military and Private Vehicles and their Accessories and Components	25
Power Generation and Distribution Machinery and Accessories	26
Tools and General Machinery	27
Structures and Building and Construction and Manufacturing Components and Supplies	30
Manufacturing Components and Supplies	31
Electronic Components and Supplies	32
Electrical Systems and Lighting and Components and Accessories and Supplies	39
Distribution and Conditioning Systems and Equipment and Components	40
Laboratory and Measuring and Observing and Testing Equipment	41
Medical Equipment and Accessories and Supplies	42
Information Technology Broadcasting and Telecommunications	43
Office Equipment and Accessories and Supplies	44
Printing and Photographic and Audio and Visual Equipment and Supplies	45
Defense and Law Enforcement and Security and Safety Equipment and Supplies	46
Cleaning Equipment and Supplies	47
Service Industry Machinery and Equipment and Supplies	48
Sports and Recreational Equipment and Supplies and Accessories	49
Food Beverage and Tobacco Products	50
Drugs and Pharmaceutical Products	51
Domestic Appliances and Supplies and Consumer Electronic Products	52
Apparel and Luggage and Personal Care Products	53
Timepieces and Jewelry and Gemstone Products	54
Published Products	55
Furniture and Furnishings	56
Musical Instruments and Games and Toys and Arts and Crafts and Educational Equipment and Materials and Accessories and Supplies	60
Farming and Fishing and Forestry and Wildlife Contracting Services	70
Mining and oil and gas services	71
Building and Facility Construction and Maintenance Services	72
Industrial Production and Manufacturing Services	73
Industrial Cleaning Services	76
Environmental Services	77
Transportation and Storage and Mail Services	78
Management and Business Professionals and Administrative Services	80
Engineering and Research and Technology Based Services	81
Editorial and Design and Graphic and Fine Art Services	82
Public Utilities and Public Sector Related Services	83
Financial and Insurance Services	84
Healthcare Services	85
Education and Training Services	86
Travel and Food and Lodging and Entertainment Services	90
Personal and Domestic Services	91
National Defense and Public Order and Security and Safety Services	92
Politics and Civic Affairs Services	93
Organizations and Clubs	94

Table .4. UNSPSC names and 2 digit code.

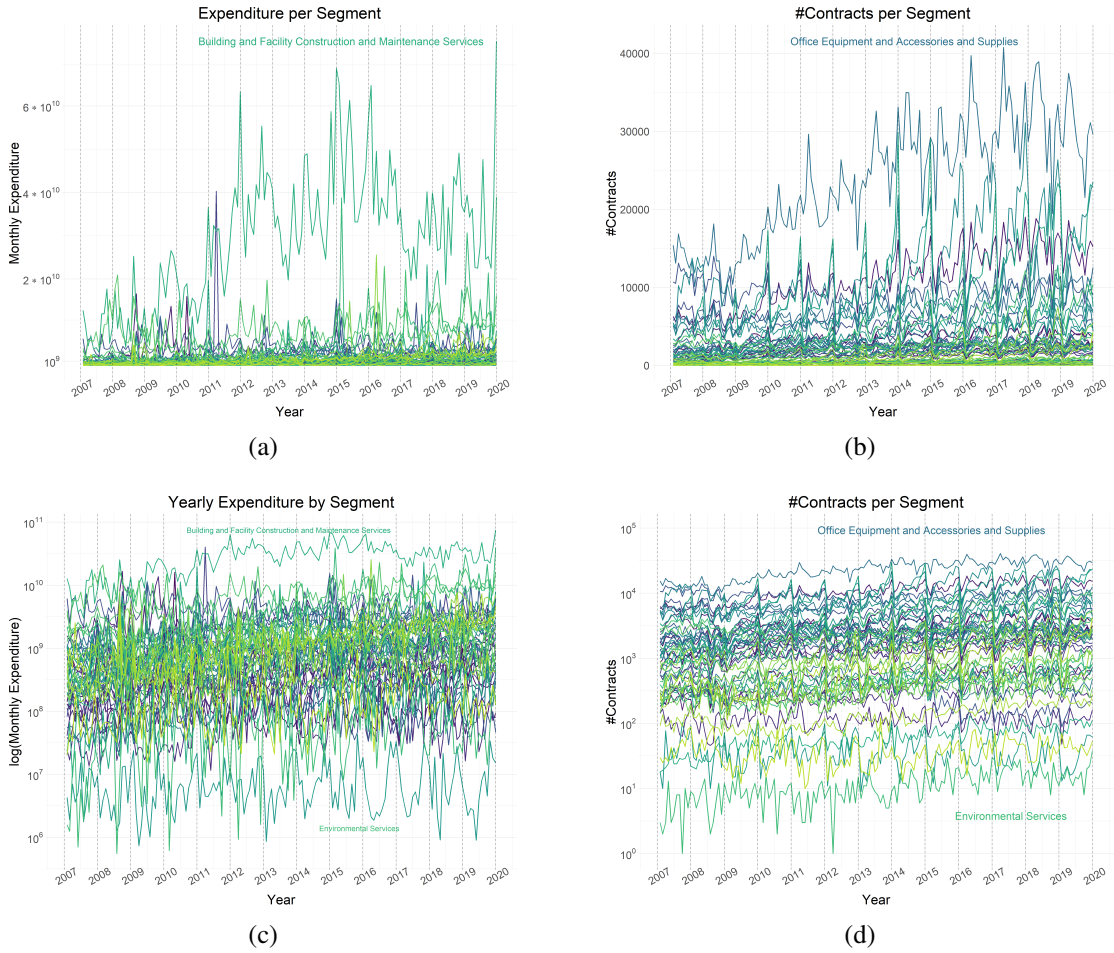


Figure .4. Temporal behaviour of the procurement data. Each line represents an UNSPSC segment. (a) Total monthly expenditures made by municipalities between 2007 and 2019. (b) Total number of monthly expenditures made by municipalities between 2007 and 2019. (c) Total (log) monthly expenditures made by municipalities between 2007 and 2019. (d) Total (log) number of monthly expenditures made by municipalities between 2007 and 2019.

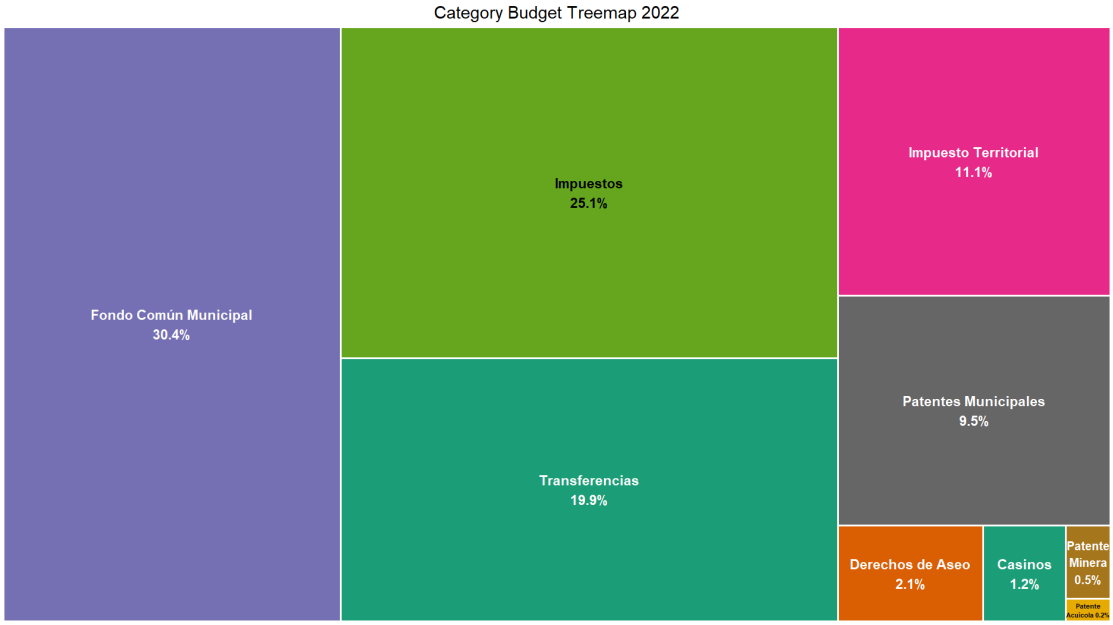


Figure .5. Treemap for the budget categories. Below the name of each category lies the share percentage of the total budget for the year 2022.

	Dependent variable:									
	log(Expending lead)									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
log(expending)	0.367***									
	(0.002)									
log(ubiquity)		0.138***								
		(0.019)								
log(diversity)			0.007							
			(0.006)							
log(ESE)				0.226***						
				(0.006)						
log(ESB)					0.304***					
					(0.007)					
density						1.187***				
						(0.015)				
rca							0.287***			
							(0.002)			
log(population)								0.641***		
								(0.060)		
log(budget)									0.089***	
									(0.016)	
pol. affinity										−0.005**
										(0.002)
Full R Squared	0.724	0.668	0.668	0.67	0.671	0.678	0.698	0.668	0.668	0.668
Projected R Squared	0.169	0	0	0.007	0.009	0.03	0.092	0.001	0	0
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Category FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	201,254	201,254	201,254	201,254	201,254	201,254	201,254	201,254	200,538	201,254
Residual Std. Error	0.401	0.440	0.440	0.439	0.438	0.434	0.420	0.440	0.440	0.440
Note:										*p<0.1; **p<0.05; ***p<0.01

Table .5. Three ways fixed effects model, single variables.

	Dependent variable:					
	log(Expending lead)					
	(1)	(2)	(3)	(4)	(5)	(6)
log(ESE)	−0.004	0.182***	0.428***	0.102***	0.043***	−0.001
	(0.006)	(0.006)	(0.009)	(0.007)	(0.006)	(0.006)
log(expending)	0.318***					
	(0.002)					
log(ubiquity)		−0.004				
		(0.020)				
log(diversity)			−0.328***			
			(0.010)			
log(ESB)				0.170***		
				(0.009)		
density					1.000***	
					(0.017)	
rca						0.257***
						(0.002)
log(population)	0.495***	0.698***	0.634***	0.725***	0.747***	0.719***
	(0.066)	(0.070)	(0.070)	(0.070)	(0.070)	(0.068)
log(budget)	0.032**	0.079***	0.071***	0.081***	0.082***	0.077***
	(0.017)	(0.018)	(0.018)	(0.018)	(0.018)	(0.017)
pol. affinity	−0.007***	−0.005**	−0.007***	−0.005**	−0.005**	−0.005**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Full R Squared	0.714	0.672	0.674	0.673	0.679	0.696
Projected R Squared	0.132	0.005	0.012	0.007	0.024	0.076
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Category FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	182,378	182,378	182,378	182,378	182,378	182,378
Residual Std. Error (df = 181965)	0.404	0.433	0.432	0.433	0.429	0.417
Note:						*p<0.1; **p<0.05; ***p<0.01

Table .6. Three-way fixed effects model with a focus on the ESE coefficients. The data presented in this table, along with the subsequent ones, suggest a positive bias in the ESE. This bias is significant to the extent that when potential omitted variables are included, the impact of ESE on expenditure reverses, changing from positive to negative.

	Dependent variable:														
	log(Expending lead)														
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
log(ESE)	−0.003	−0.046***	−0.014**	−0.037***	−0.035***	0.428***	0.102***	−0.062***	−0.0004	0.422***	0.329***	0.252***	−0.119***	−0.132***	−0.003
	(0.006)	(0.009)	(0.007)	(0.006)	(0.006)	(0.009)	(0.007)	(0.007)	(0.006)	(0.014)	(0.009)	(0.009)	(0.008)	(0.007)	(0.006)
log(expending)	0.319***	0.321***	0.318***	0.309***	0.275***										
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)										
log(ubiquity)	−0.189***					−0.027	0.007	−1.453***	−0.179***						
	(0.019)					(0.020)	(0.020)	(0.027)	(0.019)						
log(diversity)		0.054***				−0.329***				−0.325***	−0.395***	−0.339***			
		(0.009)				(0.010)				(0.011)	(0.010)	(0.009)			
log(ESB)			0.022**				0.170***			0.006			0.306***	0.268***	
			(0.009)				(0.009)			(0.011)			(0.009)	(0.009)	
density				0.278***				1.850***			1.076***		1.127***		0.021
				(0.017)				(0.023)			(0.017)		(0.017)		(0.019)
rca					0.079***				0.259***			0.258***		0.263***	0.256***
					(0.003)				(0.002)			(0.002)		(0.002)	(0.003)
log(population)	0.496***	0.503***	0.498***	0.514***	0.529***	0.634***	0.725***	0.807***	0.721***	0.636***	0.673***	0.652***	0.802***	0.762***	0.719***
	(0.066)	(0.066)	(0.066)	(0.066)	(0.066)	(0.070)	(0.070)	(0.069)	(0.068)	(0.070)	(0.069)	(0.068)	(0.070)	(0.068)	(0.068)
log(budget)	0.032*	0.033**	0.033**	0.035**	0.038**	0.071***	0.081***	0.085***	0.077***	0.071***	0.073***	0.069***	0.086***	0.080***	0.077***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.018)	(0.018)	(0.017)	(0.017)	(0.018)	(0.017)	(0.017)	(0.018)	(0.017)	(0.017)
pol. affinity	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.005**	−0.005*	−0.005**	−0.007***	−0.007***	−0.006***	−0.005**	−0.005**	−0.005**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Full R Squared	0.714	0.714	0.714	0.715	0.716	0.675	0.673	0.684	0.696	0.674	0.681	0.698	0.68	0.697	0.696
Projected R Squared	0.133	0.133	0.132	0.134	0.137	0.012	0.007	0.04	0.076	0.012	0.033	0.082	0.03	0.08	0.076
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Category FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378
Residual Std. Error (df = 181964)	0.404	0.404	0.404	0.404	0.403	0.432	0.433	0.426	0.417	0.432	0.427	0.416	0.428	0.416	0.417
Note:															*p<0.1; **p<0.05; ***p<0.01

Table .7. Three-way fixed effects model with a focus on the ESE coefficients (cont.).

	Dependent variable:																			
	log(Expending lead)																			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
log(ESE)	−0.044***	−0.011	−0.089***	−0.034***	−0.105***	−0.055***	−0.031***	−0.070***	−0.071***	−0.041***	0.424***	0.274***	0.255***	−0.289***	−0.130***	−0.031***	0.195***	0.131***	0.247***	−0.152***
	(0.009)	(0.007)	(0.006)	(0.006)	(0.013)	(0.009)	(0.009)	(0.008)	(0.007)	(0.006)	(0.014)	(0.009)	(0.009)	(0.009)	(0.007)	(0.007)	(0.014)	(0.013)	(0.009)	(0.008)
log(expending)	0.322***	0.319***	0.297***	0.275***	0.322***	0.310***	0.274***	0.306***	0.271***	0.275***										
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)										
log(ubiquity)	−0.187***	−0.188***	−0.766***	−0.218***							−0.027	−1.652***	−0.204***	−1.647***	−0.165***	−0.431***				
	(0.019)	(0.019)	(0.026)	(0.019)							(0.020)	(0.027)	(0.019)	(0.027)	(0.019)	(0.029)				
log(diversity)	0.052***				0.091***	0.024**	−0.005				−0.326***	−0.484***	−0.342***				−0.317***	−0.264***	−0.345***	
	(0.009)				(0.011)	(0.010)	(0.010)				(0.012)	(0.010)	(0.009)				(0.011)	(0.011)	(0.009)	
log(ESB)		0.018**			0.066***			0.065***	0.075***		0.005			0.404***	0.266***		0.146***	0.134***		0.282***
		(0.009)			(0.010)			(0.009)	(0.009)		(0.011)			(0.009)	(0.009)		(0.011)	(0.011)		(0.009)
density			0.752***			0.269***		0.311***		0.073***		2.060***		2.131***		0.339***	1.122***		0.106***	0.145***
			(0.023)			(0.017)		(0.017)		(0.019)		(0.023)		(0.024)		(0.029)	(0.017)		(0.019)	(0.020)
rca				0.081***			0.079***		0.083***	0.074***			0.260***		0.265***	0.239***		0.261***	0.251***	0.254***
				(0.003)			(0.003)		(0.003)	(0.003)			(0.002)		(0.002)	(0.003)		(0.002)	(0.003)	(0.003)
log(population)	0.505***	0.499***	0.554***	0.531***	0.521***	0.517***	0.528***	0.528***	0.544***	0.532***	0.636***	0.725***	0.655***	0.888***	0.764***	0.739***	0.714***	0.689***	0.656***	0.771***
	(0.066)	(0.066)	(0.066)	(0.066)	(0.066)	(0.066)	(0.066)	(0.066)	(0.066)	(0.066)	(0.070)	(0.069)	(0.068)	(0.069)	(0.068)	(0.068)	(0.070)	(0.068)	(0.068)	(0.068)
log(budget)	0.033**	0.033**	0.038**	0.038**	0.035**	0.035**	0.038**	0.036**	0.040**	0.038**	0.071***	0.074***	0.069***	0.090***	0.080***	0.078***	0.077***	0.072***	0.069***	0.080***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.018)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
pol. affinity	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.006***	−0.005**	−0.005**	−0.005*	−0.007***	−0.006**	−0.006***	−0.005**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Full R Squared	0.714	0.714	0.716	0.716	0.714	0.715	0.716	0.715	0.716	0.716	0.675	0.688	0.698	0.687	0.697	0.696	0.682	0.698	0.698	0.697
Projected R Squared	0.133	0.133	0.138	0.137	0.133	0.134	0.137	0.134	0.137	0.137	0.012	0.053	0.083	0.049	0.081	0.077	0.034	0.083	0.083	0.081
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Category FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378
Residual Std. Error (df = 181963)	0.404	0.404	0.403	0.403	0.404	0.404	0.403	0.404	0.403	0.403	0.432	0.423	0.416	0.423	0.416	0.417	0.427	0.416	0.416	0.416
Note:																				*p<0.1; **p<0.05; ***p<0.01

Table .8. Three-way fixed effects model with a focus on the ESE coefficients (cont. 2).

	Dependent variable:														
	log(Expending lead)														
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
log(ESE)	−0.098***	−0.061***	−0.028***	−0.160***	−0.069***	−0.081***	−0.147***	−0.118***	−0.034***	−0.086***	0.069***	0.139***	0.234***	−0.214***	0.111***
	(0.013)	(0.009)	(0.009)	(0.008)	(0.007)	(0.006)	(0.013)	(0.013)	(0.009)	(0.008)	(0.014)	(0.013)	(0.009)	(0.008)	(0.014)
log(expending)	0.323***	0.294***	0.275***	0.291***	0.271***	0.278***	0.310***	0.274***	0.274***	0.270***					
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)					
log(ubiquity)	−0.181***	−0.789***	−0.219***	−0.841***	−0.214***	−0.606***					−1.711***	−0.192***	−0.650***	−0.629***	
	(0.019)	(0.026)	(0.019)	(0.026)	(0.019)	(0.028)					(0.027)	(0.019)	(0.029)	(0.029)	
log(diversity)	0.086***	−0.040***	−0.008				0.078***	0.048***	−0.010		−0.369***	−0.271***	−0.386***		−0.265***
	(0.011)	(0.010)	(0.010)				(0.011)	(0.011)	(0.010)		(0.011)	(0.011)	(0.010)		(0.011)
log(ESB)	0.060***			0.127***	0.072***		0.101***	0.097***		0.086***	0.221***	0.129***		0.322***	0.148***
	(0.010)			(0.009)	(0.009)		(0.010)	(0.010)		(0.009)	(0.011)	(0.011)		(0.009)	(0.011)
density		0.781***		0.864***		0.522***	0.302***		0.076***	0.110***	2.164***		0.597***	0.628***	0.152***
		(0.024)		(0.024)		(0.028)	(0.017)		(0.019)	(0.019)	(0.024)		(0.029)	(0.030)	(0.020)
rca			0.081***		0.085***	0.048***		0.082***	0.074***	0.076***		0.262***	0.224***	0.228***	0.251***
			(0.003)		(0.003)	(0.003)		(0.003)	(0.003)	(0.003)		(0.002)	(0.003)	(0.003)	(0.003)
log(population)	0.521***	0.550***	0.530***	0.585***	0.546***	0.557***	0.546***	0.555***	0.530***	0.550***	0.789***	0.689***	0.678***	0.807***	0.697***
	(0.066)	(0.066)	(0.066)	(0.066)	(0.066)	(0.066)	(0.066)	(0.066)	(0.066)	(0.066)	(0.069)	(0.068)	(0.068)	(0.068)	(0.068)
log(budget)	0.035**	0.038**	0.038**	0.041**	0.039**	0.040**	0.038**	0.041**	0.038**	0.040**	0.080***	0.072***	0.070***	0.083***	0.073***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
pol. affinity	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.006**	−0.006***	−0.005**	−0.006**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Full R Squared	0.715	0.716	0.716	0.716	0.716	0.716	0.715	0.716	0.716	0.716	0.689	0.698	0.699	0.698	0.698
Projected R Squared	0.133	0.138	0.137	0.139	0.138	0.139	0.134	0.137	0.137	0.137	0.055	0.084	0.085	0.083	0.084
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Category FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378	182,378
Residual Std. Error (df = 181962)	0.404	0.403	0.403	0.403	0.403	0.403	0.404	0.403	0.403	0.403	0.422	0.416	0.415	0.416	0.416
Note:															*p<0.1; **p<0.05; ***p<0.01

Table .9. Three-way fixed effects model with a focus on the ESE coefficients (cont. 3).

	Dependent variable:					
	log(Expending lead)					
	(1)	(2)	(3)	(4)	(5)	(6)
log(ESE)	−0.189***	−0.110***	−0.046***	−0.153***	−0.132***	0.069***
	(0.013)	(0.013)	(0.009)	(0.008)	(0.013)	(0.014)
log(expending)	0.293***	0.274***	0.274***	0.271***	0.273***	
	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	
log(ubiquity)	−0.831***	−0.210***	−0.632***	−0.681***		−0.708***
	(0.026)	(0.019)	(0.028)	(0.028)		(0.029)
log(diversity)	0.031***	0.041***	−0.049***		0.047***	−0.293***
	(0.011)	(0.011)	(0.010)		(0.011)	(0.011)
log(ESB)	0.140***	0.091***		0.128***	0.107***	0.179***
	(0.010)	(0.010)		(0.009)	(0.010)	(0.011)
density	0.854***		0.552***	0.633***	0.109***	0.695***
	(0.025)		(0.028)	(0.029)	(0.019)	(0.030)
rca		0.083***	0.049***	0.048***	0.075***	0.222***
		(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
log(population)	0.592***	0.555***	0.552***	0.589***	0.561***	0.730***
	(0.066)	(0.066)	(0.066)	(0.066)	(0.066)	(0.068)
log(budget)	0.041**	0.040**	0.039**	0.042**	0.041**	0.074***
	(0.017)	(0.017)	(0.017)	(0.016)	(0.017)	(0.017)
pol. affinity	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.006***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Full R Squared	0.716	0.716	0.716	0.717	0.716	0.699
Projected R Squared	0.139	0.138	0.139	0.14	0.137	0.086
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Category FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	182,378	182,378	182,378	182,378	182,378	182,378
Residual Std. Error (df = 181961)	0.403	0.403	0.403	0.403	0.403	0.415
Note:						*p<0.1; **p<0.05; ***p<0.01

Table .10. Three-way fixed effects model with a focus on the ESE coefficients (cont. 4).

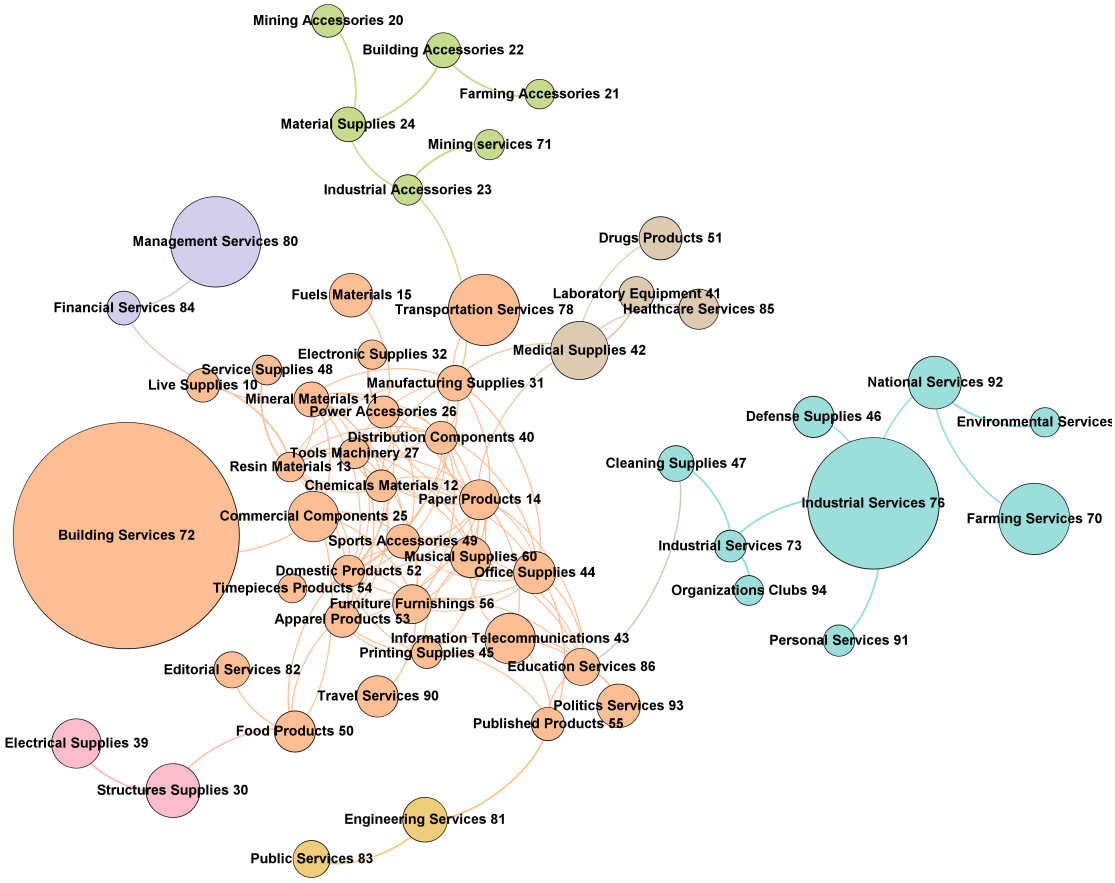


Figure .6. Network visualization for the categories similarity adjacency matrix for the period 2019-2022. Node color correspond to the assigned Louvain cluster and node size is proportional with the total expenses over that category for the considered period. Each node name is a shortened version of its full name accompanied with its corresponding two digit UNSPSC code.

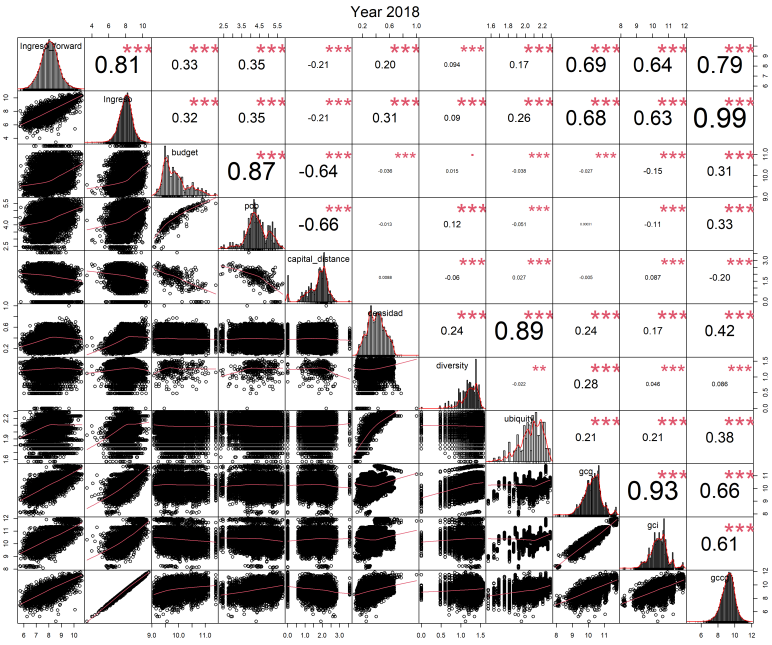


Figure .7. Correlogram (pearson) for the category pooled variables in the models. Time period of 2015-2018.

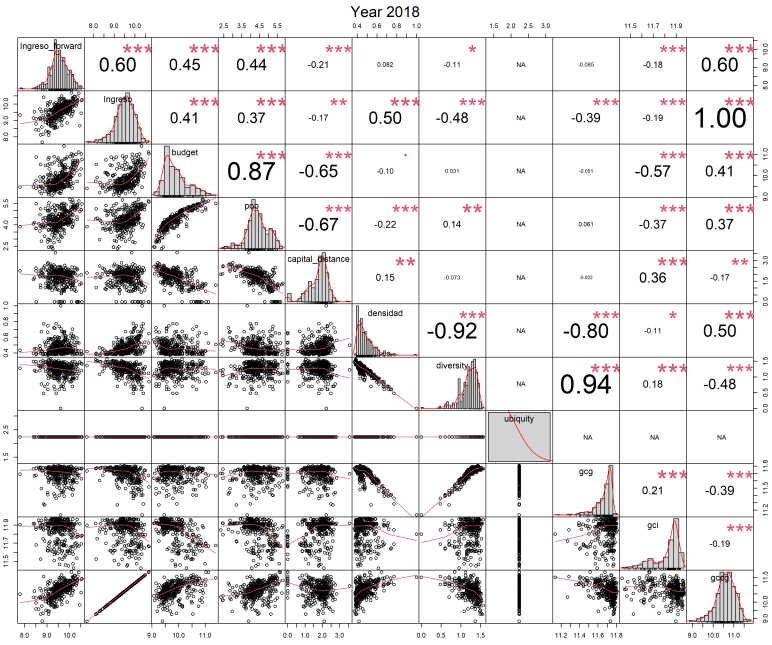


Figure .8. Correlogram (pearson) for the variables in the models with category equal to Building and Facility Construction and Maintenance Services. Time period of 2015-2018