Spatial heterogeneity in pro-independence vote in Catalonia: analysis of local voting and its relationship with potential economic impacts

1. Introduction

In recent times, the Catalan nationalist movement has experienced substantial advances, shifting from supporting pro-autonomy to claiming independence. In the period 2006–2014, public opinion polls to Catalan citizens have shown that votes for an independent state tripled from 14% to around 45% (Muñoz & Tormos, 2015).

The perception that an independent Catalonia would perform better economically as a result of fiscal autonomy seem to be a strong driving force for independence (Serrano, 2013; Muñoz and Tormos, 2015; Cuadrás-Morató & Raya, 2016). In this respect, and in addition to other issues of culture, demography, landscape, "national" identity, partisanship or sovereignty (Nogué and Vicente, 2004; Prat i Guilanyà, 2012; Boylan, 2015; Serrano & Bonillo, 2017), there is evidence that the current economic role of Catalonia within Spain and the expectations regarding the economic power that it could achieve as an independent nation may explain a part of the rise in support towards independence (Dowling, 2017). Indeed, Catalonia has the highest Gross Domestic Product (GDP) among all the Spanish regions and accounted for approximately 20% of the national GDP in 2018 according to the Spain's National Institute of Statistics (INE). Furthermore, in those Catalan municipalities above 20,000 inhabitants, the average annual disposable income was about 10% higher than the national average income in 2017. In terms of trade, its relevance is even greater: more than a quarter of the Spanish exports and imports are of Catalan origin. Catalan exports accounted for 25% of all foreign sales from Spain in 2018. In addition, Catalonia´s unemployment rate in 2018 was 11.5%, mainly concentrated on women and youth. Although this value remains below the national average of 15.3%, it is above the 6.9% registered by the EU (Eurostat, 2019).

Regarding the likely economic effects of the independency of Catalonia, there is a high degree of uncertainty with respect to the economic consequences of the separation (Castells, 2014). As a result, there is no consensus on the desirability of a secession and experts convey opposing views on the economic consequences of secession. Whilst a part of the literature has argued in favour of the independence (Bosch and Espasa, 2014; Comissió d'Economia Catalana, 2014), other authors have stated the harmful economic consequences Catalonia may face (Amat, 2012; Benitez-Aurioles, 2019; Comerford, Myers, and Rodríguez, 2014; Feito Higueruela, 2014; Polo, 2014).

Therefore, it is important to assess the potential economic impact of the possible independence of Catalonia from Spain and know to what extent these expected economic consequences are related to the local support for secession among Catalan citizens. More specifically, this paper explores the relationship between electoral support for pro-independence parties and employment loss caused by the hypothetical secession in order to understand the reasons for the pro-independence vote in Catalonia.

Several scholars conducted a similar study to analyse the electoral behaviour in another secession phenomenon, the "Brexit" referendum of 2016 (Los, McCann, Springford & Thissen, 2017). These authors claim that regional differences in economic prosperity, the so-called, economy geography, emerged as a central factor for the vote to leave the EU. Consequently, those British regions with higher levels of unemployment tended to feel more threatened by immigration and international trade and hence they voted to leave the EU in greater proportions. This pattern reveals a "geography of discontent" (McCann, 2016; Dijkstra, Poelman & Rodríguez-Pose, 2019) resulting from the interaction of local economic and individual-specific characteristics. In this paper, we explore this line of study, focusing on whether specific local economic conditions may be playing a role driving the pattern of voting on independence.

In Catalonia, relevant spatial inequalities in income exist mainly between the municipality of Barcelona and its metropolitan area, that concentrates all the 13 richest Catalan 20,000-inhabitant municipalities (INE, 2020). In contrast, municipalities of Girona and Tarragona represent 70% of the 10 poorest Catalan municipalities with more than 20,000 inhabitants. In the whole region, the income of the wealthiest population is up to 5.5 times higher than that of the poorest. In 2019, 4 municipalities of the province of Barcelona (Sant Cugat del Vallés; Castelldefels; Barcelona and Cerdanyola del Vallés) also showed the lowest unemployment rates out of the 15 cities with the lowest values in Spain. This paper exploits these divergences by studying the link between electoral behaviour and the economic consequences of secession at the municipality level in an attempt to relate spatial economic differences to secessionist support.

In this study, we first analyze the spatial distribution of the electoral results of the elections to the Parliament of Catalonia in 2012, 2015 and 2017 in all the municipalities of the region by clustering votes in relation to the positioning of political parties and candidacies regarding the independence question. Furthermore, we estimate the impact of the potential secessionism in terms of potential job at risk in Catalonia as a consequence of a hypothetical interruption in the trade relationships of Catalonia with other regions of Spain and the EU. To do this, we frame our analysis on the basis of Multi-Regional Input-Output (MRIO) tables estimated for the NUTS 2 regions of the EU for 2010 (see Thissen et al., 2013). The main goal of this article is not only the prediction of the impacts that could derive from secession, but also to analyze the geographical areas within Catalonia that present the highest risk of a negative economic impact. In addition, we aim to investigate whether the pro-independence votes are in line with the possible job loss in each municipality.

The remaining of this paper is organized as follows. Section 2 provides a historical background and gives an overview of the results of the elections in 2012, 2015 and 2017 by analysing the spatial distribution of the pro-independence vote. Section 3 describes the methodology and data, while Section 4 describes the main results. Finally, Section 5 offers some concluding remarks.

2. The spatial distribution of the pro-independence vote in Catalonia

2.1. A brief historical background

Although separatism in Catalonia may seem like a recent phenomenon, nationalism is not. The tension between the Central Government of Spain and Catalonia has existed since the War of Spanish Succession and the union of regions of Spain by the Treaty of Utrecht in 1713. In this context, the *Nueva Planta* decrees were signed as an attempt to make Spain more homogeneous, both institutionally and culturally (González, 1997). However, this implied some changes for the Catalans, such as the prohibition of Catalan language and institutions, as well as the centralization of the administration (Conversi, 1997). As a consequence, the beginning of the nationalist ideas dates back to the early 19th century, with the foundation of a cultural movement called *Renaixença*, which sought to revive the Catalonian identity mainly through literature (Judd, 2014). After the oppression of Primo de Rivera's dictatorship, the Spanish Second Republic (1931-1936) granted some degree of self-rule of Catalonia, but the Spanish Civil War (1936-1939) and Francisco Franco's victory ended the possibilities of deepening self-government. (Payne, 1973). Francisco Franco's dictatorship ended with his death in 1975 and, after a long democratisation process, a new Constitution was published in 1978, which recognized and guaranteed the right to self-government of the nationalities and regions that constituted Spain (The Spanish Constitution, section 2, 1978). In 1979 the Catalan Statute of Autonomy, which stated the Catalonia's inalienable right to self-government a reality (Constitutional Law 4/1979, 1979), was ratified by the Spanish Parliament. Since the ratification, the *Generalitat*[1] has continued to make moves toward greater levels of autonomy.

Under the democratic era, the first elections to the Parliament of Catalonia were held in 1980. Jordi Pujol from *Convergència i Unió* (CiU) won the election and was re-elected for five consecutive terms. The main change in Catalan nationalism in recent times has been a shift in priorities: from a cultural and ethnic approach to an institutional one (Colomer, 2018). Indeed, a proposal to reform the Catalan Statute of Autonomy was approved in 2006, aimed at increasing Catalan political and fiscal autonomy, but without making reference to self-determination or secession. Thus, the judiciary and fiscal competences were assigned to the *Generalitat* (Bieri, 2014). Nevertheless, in 2010 the Spanish Constitutional Court issued a ruling that abolished several key passages of the Statute, including the definition of Catalonia as a "nation" (Muñoz and Guinjoan, 2013; Calzada, 2019). This disagreement, together with the eruption of the economic crisis of 2008, occurred in parallel to a marked upsurge in support for pro-independence positions among the Catalan population (Barrio, Barberá & Rodríguez-Teruel, 2018; Bel, Cuadras-Morató & Rodon, 2019; Cuadras-Morató and Rodon, 2019).

On 27 October 2017, Catalonia's former president Carles Puigdemont unilaterally declared independence from Spain. It followed a referendum in the region, deemed illegal (unconstitutional) by the Spanish government and courts (Paasi, 2016), which triggered the application of section 155[2] of the Spanish Constitution by the Spanish Government that took control of Catalan institutions, removed Carles Puigdemont from office and called for new

[1] The *Generalitat* is the institutional system in which Catalonia is politically organized.

[2] The Article 155 of the Spanish Constitution of 1978 states that "if a self-governing community does not fulfil the obligations imposed upon it by the constitution or other laws, or acts in a way that is seriously prejudicial to the general interest of Spain, the government may take all measures necessary to compel the community to meet said obligations, or to protect the above-mentioned general interest".

regional elections (Rodon, 2020). Nine leaders of the separatist movement have since been jailed, and Carles Puigdemont has gone into exile in Belgium. Although the secession has not yet actually happened, the force that this movement has gained into the political arena is undeniable and the political uncertainty over independence could have started to have some economic consequences (Benitez-Aurioles, 2019).

2.2. Elections and candidacies

As previously mentioned, to study the spatial distribution of the pro-independence vote in Catalonia, electoral outcomes of the 2012, 2015 and 2017 elections to the Catalan Parliament were considered, whereas the total of municipalities were chosen as the unit of observation.

Catalonia has been characterized for the dual voting of its citizens. In other words, national and regional elections have been won by different types of candidacies (Font and Montero, 1991). Citizens feel that different parties defend better their interests according to the competences they have. Thus, in the national elections, trends show a preference for the right-left dimension, whereas the nationalist dimension prevails in elections to the Parliament of Catalonia (Riba, 2000). Taking into account the aim of this study, i.e., to analyse the spatial distribution of the pro-independence votes and their potential relation to the economic impacts generated by a secession from Spain, the electoral results for the Catalonia Parliament were chosen. We opted for analysing regional and not national or local elections for several reasons. First, we disregard the voting behaviour to the national parliament of Spain, because this could bias the analysis towards non-secessionist voters, given that pro-independency parties choose not to make much effort in these elections or do not participate directly (as in the case of the CUP party). Local elections were not considered either, because local dynamics and "personal charisma" of the local candidates could affect the results more than pure political motivations, especially in small municipalities. As a consequence, we focus on the last three regional elections, which is particularly convenient for the purpose of this study, as the Catalan political scene has undergone a great transformation in the last decade, with the birth of new political parties, as well as with the dissolution and change of the position of relevant candidates (Bartomeus, 2015).

The 2012 elections to the Catalan Parliament were held two years ahead of schedule and a total of 17 candidacies were submitted. Compared to the election of 2010, voter turnout in 2012 increased by almost ten points up to 67.8% of eligible voters (Serrano and Bonillo, 2017). The 2015 elections took place a year ahead of schedule with 11 candidacies and a turnout rate of over 77% of electors (Cetrà and Martí, 2016). Finally, the elections for the Catalan Parliament in 2017 were held again before the end of the previous term, due to the measure of Spanish government to apply the section 155 of the Spanish Constitution. Thirteen total candidacies were running at these elections and the turnout rate was about 82%.

On those elections the Catalan political scene was composed by several political parties with candidacies and coalitions that have varied through the years and in which conflicting views on the independence issue coexist (see Appendix 1). The creation of new political parties and new coalitions has altered a decades-long scheme in Catalonia. Some remarkable examples are the

case of *Ciutadans-Partido de la Ciudadanía's* (C´s) that, although it was formed just over a decade ago, it now holds over a quarter of the votes to the Parliament of Catalonia, or the dissolution of the 30-year old coalition of CDC and UDC, CiU. For the sake of simplicity, political parties and their candidacies are separated in two groups according to their support for the independence of Catalonia in Appendix 1.

Table 1 presents the classification of the main movements and parties according to their support for independence in each one of the three elections. Electoral results for all 947 municipalities of Catalonia in the 2012, 2015 and 2017 elections to the Regional Parliament were obtained from the IDESCAT (Statistical Institute of Catalonia) and classified as pro-independence or non-pro-independence vote.

Table 1. Distribution of candidacies according to their support for independence of Catalonia at the 2012, 2015 and 2017 elections.

Elections Year	Pro-independence group	Non-independence group
2012	CiU ERC CUP SI	PSC; PPC; ICV-EUiA; C's; PxC; EB; PACMA; UPyD; PIRATA.CAT; FARTS.cat; VD; U.C.E.
2015	JxSí CUP	PSC; PPC; C´S; PACMA; RECORTES 0-EV; PIRATA.CAT/XD; GANEMOS; CSQP; unio.cat (UCD)
2017	JuntsxCat ERC CUP	PSC; PPC; C's; CatComú-Podem; PACMA; RECORTES 0-EV; PUM+J

Source: self-elaborated based on the electoral program of each candidacy.

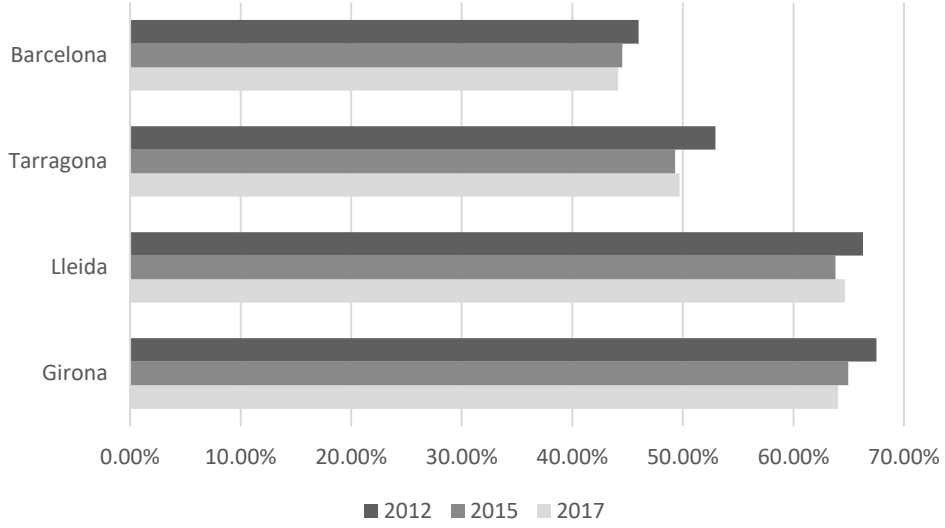
The classification of candidacies is shown in Table 1. It is necessary to mention that some of the candidacies that were presented in the elections to the Parliament of Catalonia are branches of national political parties and, therefore, cannot be considered as pro-independence regardless of their nationalist ideology (Muñoz and Tormos, 2015). Furthermore, although some of them are regional parties, they do not have a strong enough position to be considered pro-independence, either because they are focused on a specific political objective or because they do not have a clear position on the issue. Therefore, the political parties and candidacies that are defined in favour and have committed to achieve Catalonia´s independence from Spain will be considered as part of the *Pro-independence group.* Thus, the *Non-independence group* is composed by those political parties that defend the unity of Spain, based on section 2 of the Spanish Constitution. Particularly, this group is formed by those parties that do not directly address the issue and those branches of state-level parties.

2.3. Review of electoral results

With a little less than 50% of Catalans voting for secessionist parties in the three elections, polls suggested that Catalans are evenly divided on whether or not to stay as a part of Spain. The pro-independence vote pattern for the Catalan Parliament remained almost constant in all the

provinces during the last three elections with a slight decrease over the years (see Figure 1 and 2).

Figure 1. Pro-independence vote by province in the 2012, 2015 and 2017 elections.

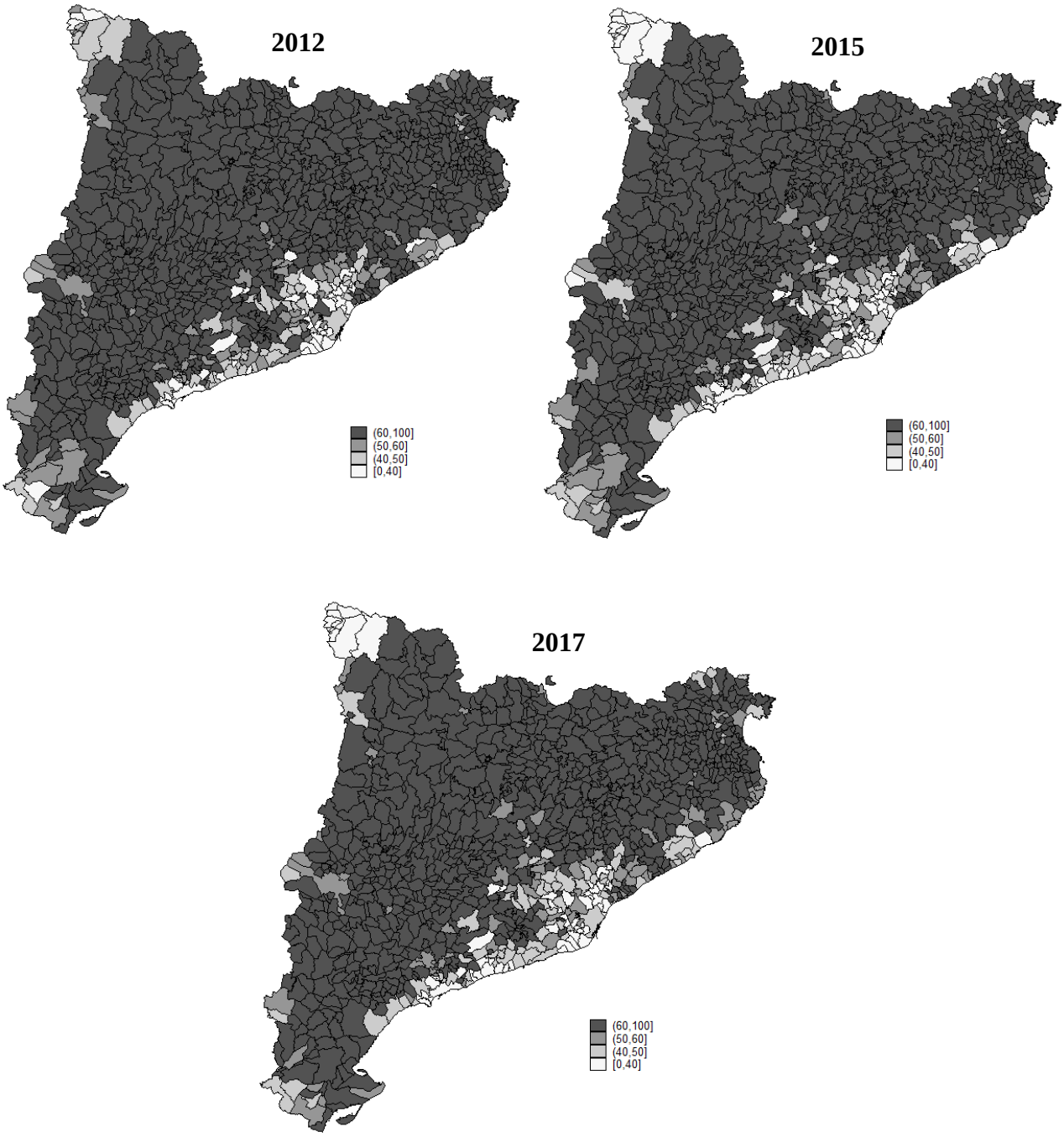


Source: self-elaborated with data of electoral results obtained from IDESCAT.

Figure 2 shows the spatial distribution of pro-independence votes at the 2012, 2015 and 2017 elections of Catalan municipalities. This illustration suggests a strong geographic pattern in their distribution, thus revealing the presence of homogeneous clusters in the pro-independence vote rate (Rodon and Guinjoan, 2018). The highest pro-independence vote rates correspond to the provinces of Girona and Lleida. In particular, some areas in the North-western part of Girona displays a constant pattern of high pro-independence vote in the three elections, as Lepic, M. (2017) also observed. Some of the municipalities with a high pro-independence rate in Lleida belongs to the north Pyrenean and the central areas of the province. However, pro-independence support in these geographical areas has declined gradually during the analysed period (see Figure 2).

On the opposite, the less pro-independent zones are mostly located along the coast, especially near the municipalities of Barcelona and Tarragona. Nevertheless, some zones in the north and central Barcelonese regions of Berguedà and Bages and the north area of Tarragona presented a high rate of pro-independence vote in 2012 and 2015.

Figure 2. Percentage of pro-independence votes in the 2012, 2015 and 2017 elections of Catalan municipalities.



Note: darkest grey shading represents higher rates of pro-independence vote.

Source: self-elaborated with data of electoral results obtained from IDESCAT.

We obtained similar results when a more localized analysis on the province capitals was performed. The highest rates of pro-independence vote -on average across the three elections- correspond to Girona and Lleida with more than 63% and 49% respectively (see Table 2). Tarragona followed the same trend as the whole Catalonia (48.5% voted on average for

independence) and pro-independence vote went up to 37.4%. Table 2 also shows that only Lleida and Girona, obtained a rate higher than 50% in the elections of 2012 and 2017 among those most populated Catalan municipalities. For the remaining ones, the pro-independence vote rates were under the 50% barrier.

Table 2. Pro-independence vote in the province capitals and the 2011 ten most populated municipalities of Catalonia in the 2012, 2015 and 2017 elections.

	Population	**2012**	**2015**	**2017**
Barcelona (B)	1,615,448	48.20%	47.45%	45.95%
Hospitalet de Llobregat (B)	256,065	25.35%	25.01%	25.90%
Badalona (B)	219,786	33.06%	31.18%	32.84%
Terrassa (B)	213,697	39.80%	40.15%	40.66%
Sabadell (B)	207,721	43.17%	41.87%	41.51%
Lleida (L)	138,416	50.09%	48.57%	50.71%
Tarragona (T)	134,085	39.23%	36.24%	36.71%
Mataró (B)	123,868	43.73%	42.11%	42.33%
Santa Coloma de Gramenet (B)	120,824	19.18%	19.30%	21.37%
Reus (T)	106,709	49.83%	45.04%	44.39%
Girona (G)	34,833	64.78%	63.08%	62.47%

Notes: () indicates the province. B: Barcelona, G: Girona, L: Lleida and T: Tarragona.
Source: self-elaborated with data of electoral results obtained at IDESCAT.

In Catalonia, population is very unevenly distributed throughout the territory. In fact, 70% of the Catalan population lives in the 45 municipalities with more than 20,000 inhabitants and the rest is distributed in more than 900 municipalities (INE). Therefore, to better capture the electoral behaviour in these small towns, Table 3 summarises the pro-independence vote rates in those municipalities with a population under 20,000 inhabitants in all three elections classified into 4 ranks within each Catalan province. The results are quite revealing: in all the municipalities with a population under 20,000 inhabitants, (except by the lowest range of municipalities in the province of Barcelona), the average of pro-independence vote weighted by the number of voters within each range is above 50%. Moreover, for all municipalities, the smaller the population range to which they belong, the higher the pro-independence vote. In fact, Table 3 exposes that the municipalities from Lleida and Girona tended to follow a more pro-independence trend than the ones from Barcelona and Tarragona. Therefore, population is an important factor to be taken into consideration when addressing the pro-independence vote, as León Ranero (2017) asserts.

In summary, our results point out that the support for independence in Catalonia was not uniform across provinces and municipalities in the three elections under study. Indeed, there were some marked differences related to economic performance and population. The analysis of the data indicates that those municipalities and provinces with fewer inhabitants and poorer economies in the rural interior of Catalonia presented the highest ratios of pro-independence votes.

Table 3. Pro-independence vote in municipalities with a population under 20,000 in the 2012, 2015 and 2017 elections.

Population range		2012	2015	2017	Weighted average
Barcelona	0-2,000	60.20%	71.84%	68.08%	67.06%
	2,001-5,000	62.06%	65.79%	65.30%	64.66%
	5,001-10,000	55.56%	58.12%	57.53%	57.27%
	10,001-20,000	49.77%	49.75%	49.40%	49.62%
Girona	0-2,000	67.45%	78.02%	76.84%	74.71%
	2,001-5,000	65.97%	74.12%	73.48%	71.80%
	5,001-10,000	62.42%	65.10%	64.28%	64.14%
	10,001-20,000	58.83%	65.18%	63.92%	63.11%
Lleida	0-2,000	66.19%	74.74%	75.36%	72.42%
	2,001-5,000	63.16%	70.37%	71.40%	68.74%
	5,001-10,000	62.11%	66.25%	66.42%	65.23%
	10,001-20,000	59.00%	65.10%	65.21%	63.47%
Tarragona	0-2,000	61.09%	68.55%	68.50%	66.38%
	2,001-5,000	57.38%	56.82%	57.20%	57.11%
	5,001-10,000	54.07%	52.30%	52.69%	52.87%
	10,001-20,000	50.71%	52.59%	54.70%	52.98%

Source: self-elaborated with data of electoral results obtained at IDESCAT.

3. Economic impact of Catalonia secession: Methodology and data

In order to study the impacts of the potential independence of Catalonia from the rest of Spain on the local employment, we focus on the trade flows between the regional economies of interest. Our analysis is based on a Multi-Regional Input-Output (MRIO) table which contains information on linkages within and across NUTS 2 regions from Catalonia, Spain and the EU and some other countries from the Rest of the World. The details about the type of multi-regional modelling that can be applied based on a MRIO table are reported on Appendix 2. The methodology is applied on the EUREGIO database (Thissen et al., 2013) that contains a time-series (2000-2010) of MRIO tables that distinguish 15 economic sectors for 256 regional economies in the EU at the level of the so-called NUTS2 classification and 17 countries from the Rest of the World (RoW). For the purpose of this study, we use the most updated EUREGIO table for the year 2010.

The modelling applied here allows the construction of scenarios that would give quantitative indications of the extent to which employment in Catalonia is exposed to the final demand from the rest of Spain and of the EU. More specifically, two scenarios are simulated. Scenario 1 assumes a complete cease of the commercial relationships between Catalonia and the rest of Spain, but the trade with the EU and the Rest of the World remains unaffected. Scenario 2 assumes that the trade flows between Catalonia and the EU also cease as a consequence of the independence from Spain, which would imply that Catalonia leaves de facto the EU. Total job loss is estimated in these two scenarios to proxy the economic implications of this independence. It is important to note two clarifying aspects of our modelling exercise. First, the plausibility of both situations is very low, since even in the eventual situation of independence

of Catalonia, trade flows with Spain or the EU countries are not expected to drop to zero. We simulate these two extreme cases to have a clear reference in these worst-case scenarios rather than making additional assumptions about the plausibility of other potential situations after the eventual independence. Second, "job loss" refers to job exposed or at risk under these two scenarios, rather than a prediction.

The "job loss" equations for both scenarios are derived from the MRIO model that compares the observed employment levels in the database (vector **e**) with the counterfactual employment produced by the modelling exercises (vectors $\mathbf{e}^{S_1}$ and $\mathbf{e}^{S_2}$, where superscripts $S_1$and S_2 stand for the two simulated scenarios) if the assumed situations took place. These simulated employment vectors capture the jobs in the economy of Catalonia that do not depend on the trade flows with the rest of Spanish and EU regions. As a consequence, the jobs in the Catalan that are put at risk if trade flows with the rest of Spain cease can be computed as:

$$\text{jobs} - \text{at} - \text{risk}^{S_1} = \mathbf{i}'\mathbf{e} - \mathbf{i}'\mathbf{e}^{S_1} \quad (1)$$

Similarly, the employment in Catalonia that is put at risk if exports from this region to the rest of EU regions cease (including other Spanish regions) is given by:

$$\text{jobs} - \text{at} - \text{risk}^{S_2} = \mathbf{i}'\mathbf{e} - \mathbf{i}'\mathbf{e}^{S_2} \quad (2)$$

This approach allows for a spatial disaggregation of the potential effects in terms of potential job loss by municipalities, since detailed data on employment by sectors and municipalities can be found in the most recent Housing and Population census, with reference date November 2011. The employment data for the Catalonian municipalities are not available for all cases, but only for those over 20,000 inhabitants. Municipalities with less than 20,000 inhabitants are classified into different groups as follows: up to 2,000 (type A), from 2,001 to 5,000 (type B), from 5,001 to 10,000 (type C) and from 10,001 to 20,000 (type D). Regarding sectoral classification, the Spanish and Population Census distinguishes 88 industries that we conveniently aggregate to make them consistent with the 15 industries included in the MRIO database.

4. Results

In this section, we discuss the results obtained through the estimation of scenarios 1 and 2. As previously mentioned, in scenario 1 we explore the assumption that trade flows between Catalonia and the rest of Spain are interrupted. In scenario 2, the assumptions are even more extreme and simulate the effect of the end of trade relations between Catalonia and the remaining EU members on employment. Note that, in both cases, we simulate a "hard" secession of Catalonia both from Spain and the EU.

Table 4 presents the results for all the Catalan provinces and their municipalities with the highest and lowest rates of job loss both in scenario 1 and 2. Under scenario 1, 24.83% of the

jobs would be exposed on average in Catalonia (979.4 thousand jobs). Scenario 2 would exacerbate the impacts on regional employment and the rate of job loss would increase to 33.39% (1,317.5 thousand jobs). This reflects the importance of the economic relationship of Catalonia with the rest of the EU, even when some authors argued that the trade partners of this region are mainly located within Spain (Polo, 2012). The province of Barcelona would be the most affected by the secession, losing 738,061 thousand jobs under the first scenario (25.41%) and 982,148 thousand jobs (33.82%) under the conditions of the second scenario. In contrast, the provinces of Lleida and Girona would be the least affected economies in the first and the second scenarios, respectively, with a rate of 22.68% (51.35 thousand jobs) for Lleida and 31.32% (92.16 thousand jobs) for Girona.

In terms of municipalities, Sant Cugat del Vallès in Barcelona would have the highest rate of job loss (28.17%) if trade between Catalonian and the rest of Spain were interrupted. In the second scenario, the highest impact of job loss would take place in the Barcelonian municipality of Martorell with a rate of 36.06%.

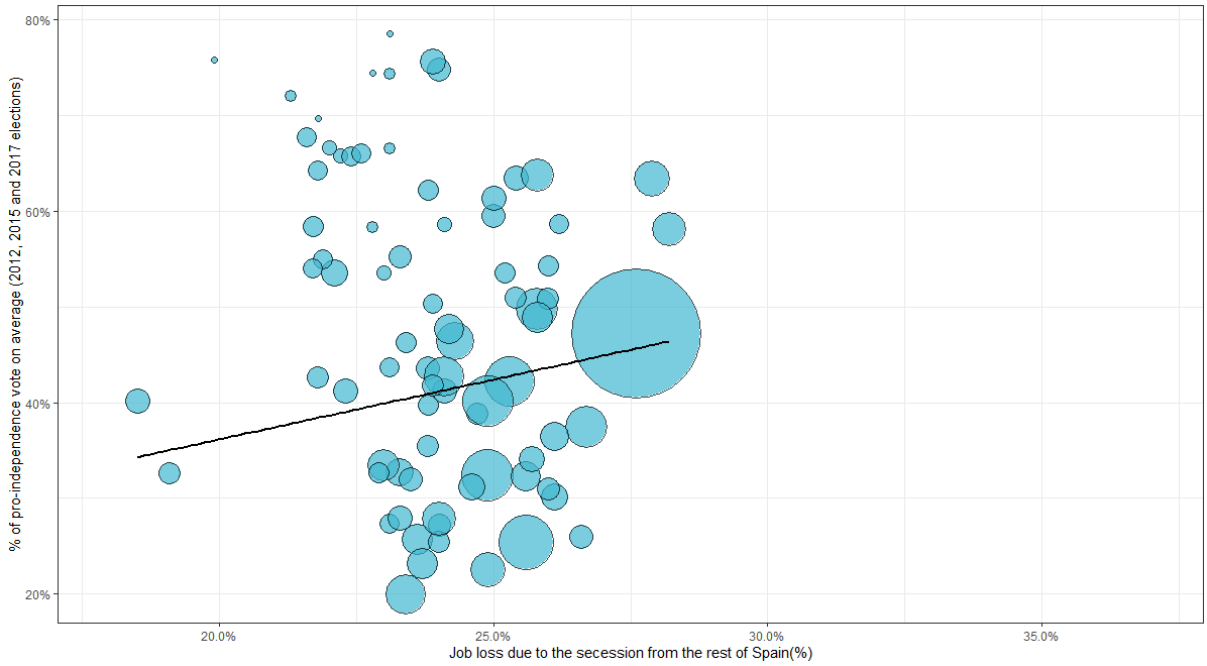
Table 4. Catalan municipalities with the highest and lowest rates of job loss by province in Scenarios 1 and 2 and average pro-independence votes.

Provinces	***Municipality***	***Total job loss in scenario 1 (%)***	***Total job loss in scenario 2 (%)***	***% of pro-independence vote on average (2012, 2015 and 2017 elections)***
Barcelona	Province of Barcelona	25.41%	33.82%	44.83%
	Sant Cugat del Vallès	28.17%	35.84%	58.11%
	Manlleu	21.61%	33.95%	67.65%
	Martorell	24.71%	36.06%	38.83%
	Pineda de Mar	21.80%	29.43%	42.57%
Girona	Province of Girona	23.08%	31.32%	60.52%
	Lloret de Mar	18.49%	22.89%	40.24%
	Girona	27.94%	34.82%	63.45%
	Sant Feliu de Guíxols	21.90%	28.00%	54.90%
Lleida	Province of Lleida	22.68%	33.16%	66.04%
	Lleida	25.85%	33.64%	49.79%
	Type A	19.86%	33.64%	75.83%
	Type D	22.56%	31.95%	66.04%
Tarragona	Province of Tarragona	23.55%	32.54%	49.25%
	Tarragona	26.68%	34.22%	37.39%
	Salou	19.14%	24.91%	32.56%
	Valls	23.81%	36.00%	62.21%
CATALONIA		**24.83%**	**33.39%**	**48.52%**

Notes: Type A: 0-2,000 inhabitants, Type B: 2,001-5,000 inhabitants, Type C: 5,001-10,000 inhabitants, Type D: 10,001-20,000 inhabitants.

In order to examine the interaction between the potential economic impacts of the secession and the pro-independence support, Figures 4 and 5 link the pro-independence votes in the Catalan municipalities with the level of job loss caused by the secession from Spain and the EU.

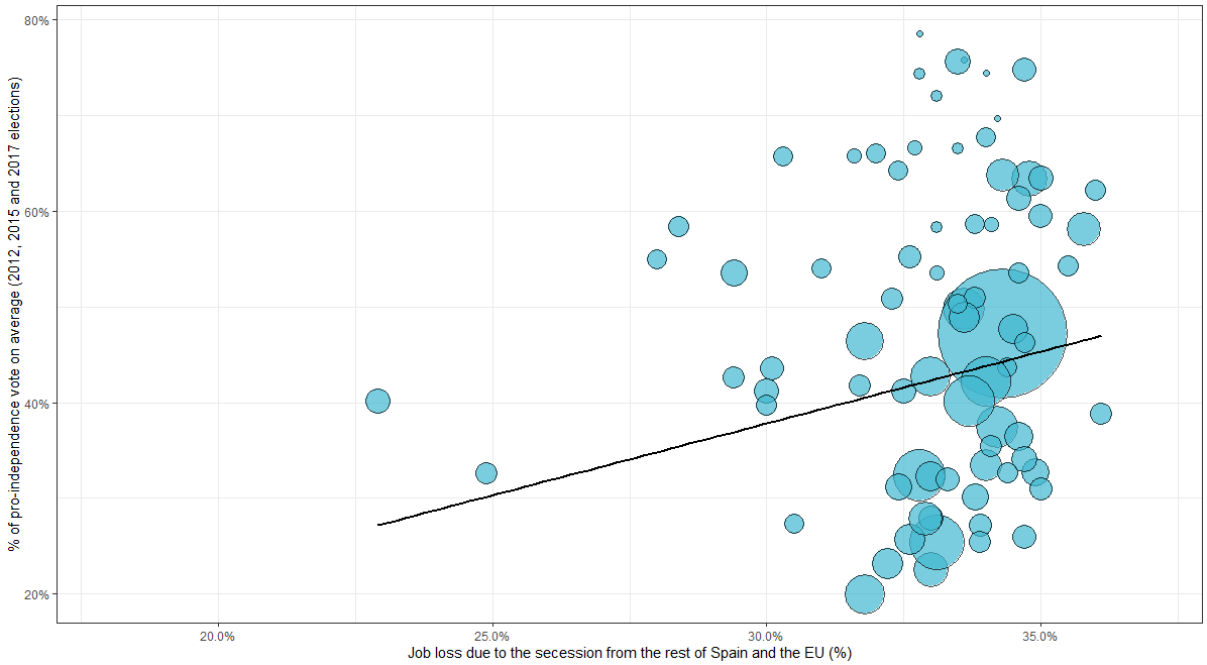
Figure 4. Relationship between the Catalan municipalities votes for independence and the job loss due to the secession from the rest of Spain, weighted by population.



Note: r_{xy} = 0.204, R^2 = 0.042. The sizes of the dots are scaled to the sizes of the population in each municipality, i.e. bigger dots represent more populated municipalities.

The relation between the pro-independence vote and the potential job loss follows a similar and unexpected pattern in the two scenarios simulated. Scenario 1 reveals a weak and positive relationship (r_{xy}= 0.204, R^2 = 0.042), between the two variables (see Figure 4). That is, the lower the job loss in a municipality, the lower the pro-independence vote. By assuming the restrictions of Scenario 2, this positive relationship is stronger with r_{xy}= 0.215 and R^2 = 0.046: the larger the economic impact of the independence, the larger the pro-independence vote (see Figure 5). These results suggest that the pro-independence votes are not economically driven, but they are explained by an economically irrational behaviour supported, among others, by a national sentiment.

Figure 5. Relationship between the Catalan municipalities votes for independence and the job loss due to the secession from the rest of Spain and the EU (%), weighted by population.



Note: $r_{xy} = 0.215$, $R^2 = 0.046$. The sizes of the dots are scaled to the sizes of the population in each municipality, i.e. bigger dots represent more populated municipalities.

In summary, the relation between the two variables strengthens when the assumptions are more extreme (Scenario 2). Our final results are in line with the positive relationship between potential economic impact and the *Leave* vote found for the 'Brexit' referendum (Los, McCann, Springford and Thissen, 2017). In our case, those municipalities that are more economically interdependent with the Spanish and EU markets tended to have a higher proportion of pro-independence votes. By contrast, municipalities that are the least dependent on the Spanish and EU markets for their local prosperity are precisely those with the weakest pro-independence votes, specifically Barcelona and parts of Tarragona. However, it must be remarked that the relation is quite weak in both scenarios.

5. Discussion

The evidences from different studies suggest that there are various reasons for the pro-independence vote in Catalonia. However, the economic question is central to the decentralization debate in Catalonia and plays a key role in determining citizens' preference for secession.

This study aims to determine whether the pro-independence vote in Catalonia is consistent with the potential economic impacts of the secession on the regional employment. After analysing the spatial distribution of the pro-independence vote and the estimated local economic impact (measured by the number of jobs at risk) of the secession of Catalonia, we have found no clear evidence that the pro-independence votes in the last three elections to the Catalan Parliament were economically driven.

Our results are in line with similar studies regarding the Brexit referendum (Chen *et al*., 2017; Los *et al*, 2017). Although the goodness of the fit is low and the period of study is short (2012-2017), the analysis carried out allows us to uncover some patterns behind the pro-independence vote. In the two scenarios considered, the correlation between the estimated job loss and the pro-independence vote is weakly positive. Thus, we can conclude that there is no association between the potential economic impact of a hypothetical secession of Catalonia and the support for independence. In fact, our findings suggest that some of the Catalan municipalities that strongly supported the independence are also the same areas with the highest levels of dependency on Spanish and EU markets in terms of employment. This implies that other factors (such as identity, national sentiment, partisanship, population, age, place of birth, etc.) unrelated to the likely changing economic conditions may have a greater influence on Catalan citizens when voting for a pro-independence candidacy.

Although, the vote for independence in Catalonia has remained substantially stable through the three elections considered, geographically there is a clear pattern that distinguishes two different trends among Catalonian provinces that are clearly linked to the characteristics of their local economy. While the situation in the richest provinces, Tarragona and Barcelona, is tied between pro-independence and supporters of Spanish unity, Lleida and Girona are jointly the least economically developed and the most pro-independence prone areas. In fact, the highest rate of the Catalan pro-independence vote was registered in the province of Girona in the 2012 elections (67.52%), the same year in which the region presented the highest Catalan unemployment rate during the period of study (25.4%). In the next elections, when employment recovered slightly after the 2008 recession, the pro-independence vote in Girona declined. Although the level of employment followed a similar pattern in Lleida, the pro-independence vote in this province increased slightly in the 2017 elections. Consequently, the citizens of some Catalan municipalities, especially in Girona and Lleida, may perceive that they have not benefited from the rest of Spain and the EU economies as other areas such as Barcelona and some parts of Tarragona. This discontent, along with local economic conditions, may be another important factor behind the greater pro-independence votes in Girona and Lleida.

This territorial duality is associated with factors derived from historical, sociocultural and mainly economic differences such as urbanization, industrialization, migration, etc. These economic disparities can exacerbate the impact caused by the potential commercial ruptures and their consequent increases in trade cost in those Catalan provinces with higher rates of pro-independence votes. In this sense, a new rather satirical term called “Tabarnia” was recently introduced to define a movement that seeks for Tarragona and Barcelona to leave Catalonia and remain part of Spain (Maza, Villaverde and Hierro, 2019). Additionally, we also found a low pro-independence vote in the most populated municipalities, while the result was drastically opposite for those municipalities with fewer than 20,000 inhabitants. This suggests that pro-independence voting patterns in rural and urban areas are not similar.

As limitations, it must be taken into account that although the separation of Catalonia from Spain and the EU single market may entail legal and procedural complexities for trade negotiations with these economies, the consequences of secession are very uncertain and our

extreme assumptions can distort the results. In other words, considering that all trade relations with Catalonia will be cut off in the event of the independence from Spain is unrealistic, at least in the short term. Even if that were the case, Catalan citizens may have limited reliable information about the real implications of independence. As a consequence, their current vote in the elections may not represent the choice they might have if they had access to data regarding the real economic impact of secession in the long term. Therefore, the economic expectations of the Catalans could provide a relevant and additional explanation for individual preferences in terms of the independence.

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Appendix 1. Political parties at the Catalan 2012, 2015 and 2017 elections.

- *Partit Popular Català* (Catalan People´s Party – PPC-PP) is a branch of the Spanish People´s Party (PP) and is opposed to the independence (12.99% of votes at the 2012 elections; 8.50% of votes at the 2015 elections; 4.23% of votes at the 2017 elections).

- *Partit dels Socialistes de Catalunya* (Catalonia´s Socialists Party – PSC-PSOE), a branch of the Spanish Socialist Workers´ Party (PSOE). Although it claims to be in favor of a referendum agreed on by the Spanish government, the socialists reject secession (14.43% of votes at the 2012 elections; 12.72% of votes at the 2015 elections; 13.81% of votes at the 2017 elections).

- *Ciutadans - Partido de la Ciudadanía* (Citizens – C´s), a relatively recently born political party (2006), that evolved from a regional level into a state-wide party in 2013 (Lepic, 2017). It has advocated from its beginnings for the Constitutional unity of the Spanish territory (Ciudadanos, 2010) and thereby the party is opposed to the independence (7.56% of votes at the 2012 elections; 17.93% of votes at the 2015 elections; 25.26% of votes at the 2017 elections).

- *Convergència i Unió* (Convergence and Union – CiU) has pleaded for the right to self-determination since the 90s (Barrio, 2014). This candidacy was made of two parties: *Convergència Democràtica de Catalunya* (CDC) and *Unió Democràtica de Catalunya* (UDC). It ruled the *Generalitat* from the first elections to the Parliament of Catalonia in 1980 until 2003. Overall, CiU has traditionally been defined as a moderate nationalist force and their support of independence has been ambiguous. Nevertheless, at the 2012 elections to the Catalan Parliament CiU directly advocated for the right to self-determination and its electoral programme (Convergència i Unió, 2012) claimed that it was time for Catalonia to "start along the path to becoming an independent country". In June 2015, the CiU federation split over the issue of Catalan independence into the two original entities (CDC and UDC) (Barrio, 2009; Barrio, 2014; Bartomeus, 2015). (30.68% of votes at the 2012 elections). In 2018, the successor of the CDC, the Catalan European Democratic Party (PDeCAT), envisaged a new party called Junts per Catalunya, JxCat. (21.66% of votes at the 2017 elections).

- *Esquerra Republicana de Catalunya-Catalunya Sí* (Catalonia´s Republican Left – ERC), has been in favour of the secession of Catalonia from Spain from its birth in 1931 (Barrio, 2014). ERC formed part of the coalition Junts pel Si (JxSí) in the 2015 elections (13.70% of votes at the 2012 elections; 39.59% of votes at the 2015 elections; 21.38% of votes at the 2017 elections).

- *Iniciativa per Catalunya Verds* (Initiative for Catalonia Greens - ICV-EUiA) is an eco-socialist political party in Catalonia formed as a merger of *Iniciativa per Catalunya* and *Els Verds*. ICV formed part of the coalitions CatSíqueesPot (CSQP), in 2015 and CatComún-Podem in 2018 along with the state-level party Podemos (Catalunya Sí que es Pot., 2015). ICV tends to favour federalism, even though some of its members support independence as well (9.90% of votes at the 2012 elections; 8.94% of votes at the 2015 elections; 7.45% of votes at the 2017 elections).

- *Candidatura d´Unitat Popular-Alternativa d´Esquerres* (Popular Union Candidacy – CUP), a left-wing political party openly pro-independence (Barrio, 2014) (3.48% of votes at the 2012 elections; 8.21% of votes at the 2015 elections; 4.46% of votes at the 2017 elections).

Minority candidacies in the 2012 elections to the Catalan Parliament:

- *Plataforma per Catalunya* (Platform for Catalunya - PxC), a far right political party against the independence of Catalonia from Spain (1.68% of votes).
- *Solidaritat Catalana per la Independència* (Catalan Solidarity for Independence – SI), as its name states, this political party seeks Catalonia´s independence from Spain (1.3% of votes).
- *Escons en Blanc* (Seats in White – EB) is a political party that seeks a protest vote in the form of empty seats. Therefore, in the case of winning any seats, they would not be taken, nor any of the salary awards accepted (Escaños en Blanco, 2012) (0.79% of votes).
- *Partit Animalista contra el Maltractament Animal* (Animalist Party Against Mistreatment of Animals – PACMA) is a branch of the state-level PACMA. (0.57% of votes).
- *Pirates de Catalunya* (Pirates of Catalonia – PIRATA.CAT), based on the Swedish Pirate Party, a political party focused on copyright and information politics (Fredriksson, 2015) (0.51% of votes).
- *Unión, Progreso y Democracia* (Union, Progress and Democracy – UPyD), a branch of the state-wide party (0.41% of votes).
- *Hartos.org Ciutadans en Blanc (*FARTS.CAT) is a citizen candidature which aim is to change the Spanish democratic system (0.33% of votes).
- *Via Democràtica* - VD (0.17% of votes).
- *Unificació Comunista d´Espanya* (Communist Unification of Spain – U.C.E.) is a Marxist-Leninist political party at state level (0.07% of votes)

Minority candidacies in the 2015 elections to the Catalan Parliament:

- PACMA (0.73% of votes).
- RECORTES 0-EV (0.35% of votes).
- GANEMOS (0.03% of votes).
- PIRATA.CAT/XDT (0.01% of votes).

Minority candidacies in the 2017 elections to the Catalan Parliament:

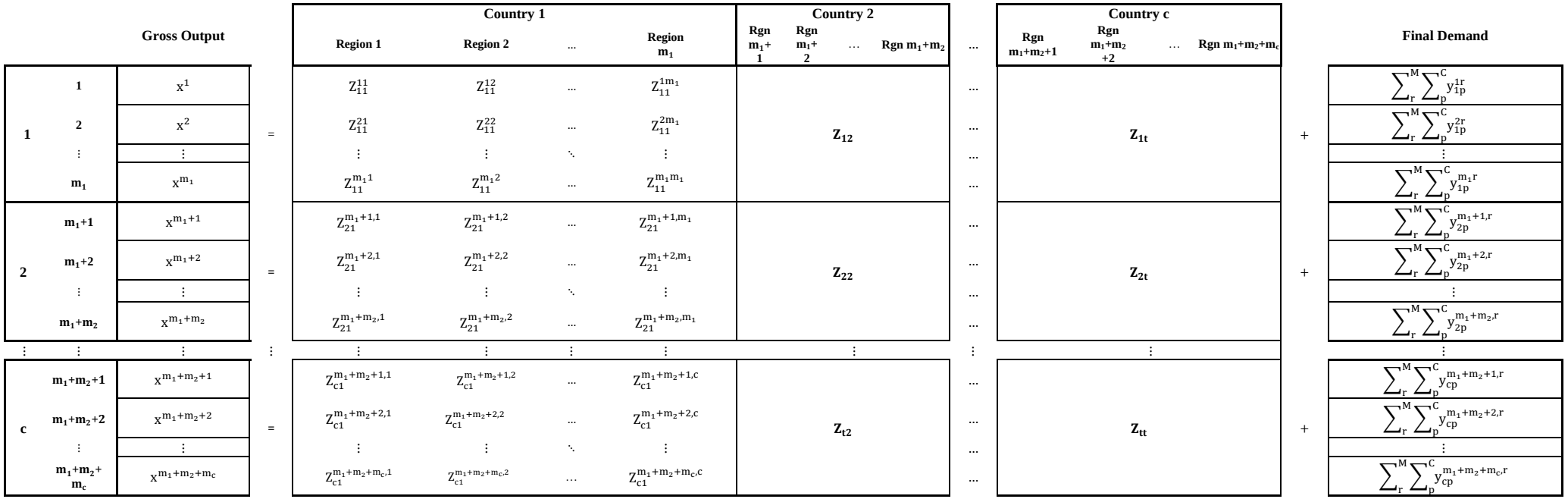
- PACMA (0.88% of votes).
- RECORTES 0-EV (0.23% of votes).
- PUM+J (0% of votes).

Appendix 2. The Multiregional Input Output (MRIO) model.

Our input-output tables are based on a multiregional framework that is comprised of *C* countries (c = 1, …, C) and *M* ($m_1 + m_2 + \ldots + m_c$) regions. Each country consists of a variables number of regions m_c and each region comprises of *N* sectors[3] identical across regions. The multiregional input-output analysis framework begins with the following accounting balance of monetary flows:

[3] The standard input-output notation is used in this paper. Matrices are named in bold capital letters, vectors in bold lower-case letter and scalars in italic lower-case letters. We denote by ^ a diagonal matrix with elements of the vector only in the main diagonal.

Figure A1. Multiregional input-output table with regional detail.



where **x** is the output matrix formed of *M* vectors x^s (*n x 1*) that represent the gross outputs of region *s* (*s = 1,…,m1,…, m1+m2,…, m1+m2+…+mc*) of country *q* (*q = 1,…,t*). Matrix **y** is formed of *M* vectors $\sum_r^M \sum_p^C y_{qp}^{sr}$ (*n x 1*), where y_{qp}^{sr} represents the final demand of region *r* (*r = 1,…,m1,…, m1+m2,…, m1+m2+…+mc*) of country *p* (*p = 1,…,t*) for products from region *s* in the same (*q = p*) or different country *q* (*q ≠ p*). Block matrix **Z** contains *M* diagonal matrices $\mathbf{Z}_{pp}^{rr}$ (*n* x *n*) that indicate the intermediate input flows among industries within the same region and $\sum_1^c [m_c(m_c - 1)]$ off-diagonal matrices $\mathbf{Z}_{pp}^{sr}$ (*n* x *n*) whose element $z_{pp_{ij}}^{sr}$ (*i, j = 1,…,n*) represent the value of sales by industry *i* in the region *s* to industry *j* in other region *r* of the same country *p* to which *s* belongs. Within the same matrix **Z**, matrices $\mathbf{Z}_{qp}^{sr}$ (*n* x *n*) contain the values of all transactions among industries in regions of different countries (*q ≠ p*).

Thus, the well-known static MRIO model can be expressed as:

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} = \mathbf{L}\mathbf{y} \tag{A1}$$

where the block matrix **A** contains the input coefficients $a_{qp_{ij}}^{sr} = z_{qp_{ij}}^{sr} / x_{p_j}^r$ that indicate how many cents of industry *i* from region *s* is required by industry *j* from region *r* in the same (*q = p*) or different country (*q ≠ p*) to produce one unit of industry *j*'s output. **L** is the global Leontief inverse matrix ($\sum_1^c nm_c$ x $\sum_1^c nm_c$) where its typical element $l_{qp_{ij}}^{sr}$ gives the gross output of industry *i* in region *s* required to produce one unit of final demand for the output of industry *j* from region *r* in the same (*q = p*) or different country (*q ≠ p*). **I** is an identity matrix of appropriate dimensions.

The MRIO model can be extended to estimate potential impacts on employment attributed to demand for final products in **y** by a specific region *r* in a particular country *p*. To do so, we pre-multiply (A1) by a diagonal matrix $\hat{\mathbf{v}}$ whose nonzero element $v_{p_j}^r = e_{p_j}^r / x_{p_j}^r$ is the employment coefficient per unit of output of industry *j* in region *r* from country *p*. This leads to:

$$\mathbf{e} = \hat{\mathbf{v}}\mathbf{x} = \hat{\mathbf{v}}(\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} \tag{A2}$$

where vector **e** represents total employment by industry *j* and region *r* from country *p*.

In this study, we are interested in the extent to which employment in Catalonia is exposed to the independence. This implies that only the employment corresponding to the Catalonian region is retained in matrix $\hat{\mathbf{v}}$, whereas other elements associated to the remaining regions are set to zero.

Equation (A2) is the basis to quantify the impacts of the secession on the Catalonian employment through two different scenarios. Scenario 1 assumes that Catalonia's trade flows to the rest of Spain are interrupted. That is, the final and intermediate demand for Catalan products from the rest of Spanish regions are set to zero. We assume that, given the Catalonia's

already deep integration in Spanish supply chains, independence might well result in an increase in trade barriers (rules of origin, market regulations, administrative procedures, etc.) that would extremely decrease trade levels between these two economies. Thereby, matrices $\mathbf{A}_{\mathrm{pp}}^{\mathrm{sr}}$ of intermediate inputs coefficients among between industries in the region *s* of Catalonia and industries from other regions *r* of Spain are zeroed[4] in matrix $\mathbf{A}$ to obtain $\mathbf{A}^{S_1}$. Also, those matrices $\mathbf{y}_{\mathrm{pp}}^{\mathrm{sr}}$ representing the final demand trade of goods between Catalonia and other Spanish regions are extracted from $\mathbf{y}$ ($\mathbf{y}^{S_1}$). Therefore, the part of employment in Catalonia that is not attributed to trade with the rest of Spain can be attained as follows:

$$\mathbf{e}^{S_1} = \hat{\mathbf{v}}\mathbf{x}^{S_1} = \hat{\mathbf{v}}(\mathbf{I} - \mathbf{A}^{S_1})^{-\mathbf{1}}\mathbf{y}^{S_1} \tag{A3}$$

Gaining independence may also mean leaving the EU[5] and the Euro and, as a third party in the European commercial relations, it would be charged the EU's Common External Tariffs. Therefore, in scenario 2, we assume a worst-case scenario of an intractable non-cooperation between the parties regarding the trade between Catalonia with the rest of Spain and the EU. In this hypothetical situation, the assumption of exports interruption is extended by also setting the final and intermediate demand from the rest of regions in the EU to be filled with zeros. As such, Catalonia (*s*) does not export or import neither intermediate ($\mathbf{A}^{S_2}$) nor final ($\mathbf{y}^{S_2}$) products to/from all regions (*r*) in the EU. The amount of Catalonian employment that is not exposed to the independence is now given by the difference between the original and the new employment:

$$\mathbf{e}^{S_2} = \hat{\mathbf{v}}\mathbf{x}^{S_2} = \hat{\mathbf{v}}(\mathbf{I} - \mathbf{A}^{S_2})^{-\mathbf{1}}\mathbf{y}^{S_2} \tag{A4}$$

[4] This is in the same spirit as the hypothetical extraction method (HEM) that measures the contribution of a sector to the economy by zeroing both the sector's input requirements (row of the technical coefficient matrix) as well as its supply links to other industries (column) (Dietzenbacher and Lahr, 2013).

[5] "If part of the territory of a Member State would cease to be part of that state because it was to become a new independent state, the Treaties would no longer apply to that territory. A new independent state would, by the fact of its independence, become a third country with respect to the EU and the Treaties would no longer apply on its territory" (President of the European Commission, José Manuel Durão Barroso, 2012).

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