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Spain, split and talk: quantifying regional independence

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ABSTRACT

We quantify the economic impact of a potential secession of Catalonia from Spain. Using a novel dataset of trade flows between 17 Spanish subnational regions and 142 countries, we estimate the effects of different levels of borders on trade flows and uncover heterogeneity in regional, national and EU border effects. We use a general equilibrium analysis of trade with fiscal transfers to understand the consequences of a potential secession with political uncertainty. In counterfactual experiments, we impose new borders on Catalan regional and international trade, potentially within or outside the European Union, resulting in a welfare decline for Catalonia and Spain.

KEYWORDS

international trade; regional trade; border effects; regional independence

JEL F10, F13, F14, H77, R12

HISTORY Received 15 November 2023; in revised form 19 November 2024

1. INTRODUCTION

In December 2019, during a heated rivalry football match between FC Barcelona and Real Madrid, Catalan pro-independence supporters unveiled banners with the rallying prompt 'Spain, sit and talk'. The slogan was intended to encourage the Spanish central government to sit around the negotiating table and talk about the potential secession of the region from Spain. The match ended in a 0–0 draw, symbolising the political impasse that has gripped Catalonia since the independence referendum in October 2017. After the referendum, the Spanish government stripped the Catalan government of power, leaving the region in political limbo until the regional elections in December 2017 elected another pro-independence leader. Catalan independence has remained on the political agenda in Catalonia, with pro-independence parties gaining a majority of the votes until the recent election of a non-secessionist Catalan President in 2024.[1]

In this paper, we analyse the potential economic consequences of Catalan independence. We quantify the effects of Catalan secession, had it taken place in the period from 2001 to 2017, while focusing on two years: 2012, when the process reignited with the massive independence demonstration in Barcelona; and 2017, the year of the referendum. These insights shed light on the consequences one may expect if the independence process becomes successful one day. We place our analysis into an international trade setting and acknowledge that, in the present status quo, Catalonia's trade is subject to different levels of borders (regional, international or EU borders), which would change if it became an independent state within or outside the EU. This border change alongside changes in net-transfer payments is what we use in our analysis to model different independence scenarios.[2]

Our contribution to the literature is twofold. First, international border effects are widely observed and reduce international trade compared with trade among regions within a country. For a review of different studies on international border effects, see Havranek and Irsova (2017). In our context, borders refer to trade barriers that result in higher levels of domestic than international or interregional trade. To estimate different levels of border effects, we construct a novel dataset that nests the 17 Spanish regions' international, interregional and domestic trade flows into the International Trade and Production Database for Estimation (ITPD-E Release 2) dataset with international and domestic trade flows from which we use 142 countries worldwide. Having data on domestic trade at the regional and country levels allows us to estimate different levels of border effects (region–region, region–country, country–country borders, as well as borders within the EU) and

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to uncover sizeable heterogeneity. Focusing on Catalonia's border over the period 2001–17 reveals that its border with other Spanish regions became thicker, especially in the aftermath of Spain's economic collapse following the financial crisis of 2007–08. At the same time, Catalonia's international border became thinner, in line with recent evidence, such as Almunia et al. (2021). This suggests that Catalonia became more integrated internationally, decreasing the cost of independence from Spain, which implies thicker borders (i.e., more costly trade) with the remaining Spanish regions.

The second contribution is quantifying the potential economic consequences of a hypothetical secession of Catalonia from Spain using the theoretical properties of the structural gravity equation of international trade in a general equilibrium (GE) analysis, including fiscal transfers within Spain. We expand the scant previous work in this area (e.g., Comerford & Rodríguez Mora, 2019) by accounting for the political uncertainty regarding the conditions under which Catalonia would become independent. Particularly regarding its EU membership, we consider different counterfactual scenarios, such as Catalonia remaining in the EU or being no longer part of the EU. We also consider a scenario in which Catalonia is outside the EU and not a World Trade Organization (WTO) member. We also explicitly take into account fiscal transfers between the Spanish regions, given that an independent Catalonia no longer has to pay net fiscal transfers. Our approach allows us to shed light on the potential economic consequences of regional independence and thereby add to the political discussion on regional, specifically Catalan, independence. The findings suggest increasingly high losses for the decreasingly integrated scenarios, for both consumers and producers in Catalonia, while the loss is lower and similar across the different scenarios for the rest of Spain. This implies that the Spanish central government may have greater leverage than Catalonia in hypothetical political negotiations.

The rest of the paper is organised as follows. Section 2 offers some background on the relevant literature. Section 3 outlines the theory and methods. Section 4 describes the data. Section 5 reports the regression results. Section 6 presents the GE counterfactual experiments. Section 7 concludes.

2. RELATED LITERATURE

Researchers from different disciplines, such as legal scholars and political scientists, have extensively studied regional independence. We focus on our contribution to two strands of the economics literature. On the one hand, there are studies examining the partial effects of regional independence and state fragmentation on regional growth. These studies (e.g., Monastiriotis & Zilic, 2020; Rodríguez-Pose & Stermšek, 2015; Reynaerts & Vanschoonbeek, 2021) report mixed results and generally conclude that the economic impact of independence depends not only on the mere occurrence of secession but also on how it takes place. For Catalonia, this means that the economic impact of its secession will depend on whether it maintains its economic ties to other countries, which we model in our counterfactual experiments.

The other strand of literature takes a perspective on international trade. Within the international trade literature, there have been extensive studies of international disintegration, particularly on the effects of the recent UK's exit from the EU (Breinlich et al., 2020; Dhingra et al., 2017; McGrattan & Waddle, 2020; Thissen et al., 2020). Using examples of individual countries, some studies focus on the trade effects of regional secession such as Quebec (Helliwell, 1996), the Republics of the Soviet Union (Fidrmuc & Fidrmuc, 2003) and Scotland (Huang et al., 2021).

The Catalan independence has been studied by Comerford et al. (2014), who use a three-country model with data on Catalonia, the rest of Spain and the rest of the world and find a 3% decrease in income for an independent Catalonia in the EU, using Portugal as a benchmark. Comerford and Rodríguez Mora (2019) compute the border effect of the 'Head–Ries Index' (Head & Ries, 2001) for subnational and international trade data. They find a 12.5% loss in welfare for an independent Catalonia that has the same trade frictions with Spain as Portugal.[3]

While our approach is similar to that of Comerford and Rodríguez Mora (2019), the analysis differs in several respects. First, we apply the latest developments in the estimation of structural gravity models to a multi-country, multi-region setting. Our novel dataset nesting all of the 17 individual Spanish regions' trade flows into trade flows of 142 countries from 2001 to 2017 allows us to differentiate between regional and international borders, as well as EU borders. We estimate the effects of these different border levels and use the estimates in our GE analysis, implementing different scenarios of Catalan independence, such as Catalonia remaining in or leaving the EU or the WTO. Second, we include fiscal transfers into our model, which appears to be an important aspect for independence supporters, given that Catalonia is a net contributor to the Spanish fiscal common pool. Third, we do not limit our study to the consequences for Catalonia and also quantify the effect on the remaining Spanish regions and countries worldwide. This is relevant in light of policy uncertainty: by analysing the rest of Spain, we obtain insights into the political economy of regional independence, that is, the leverage of the Spanish central government in political negotiations. Fourth, our analysis allows us to compute effects on consumer and producer prices along with overall real gross domestic product (GDP) effects. Fifth, while Comerford and Rodríguez Mora (2019) use Catalan data from 2005 and Spanish data from 2006 for goods only, we expand the time period and the sectors, allowing us to gain insights into the economic rationale for regional secession. That is, we capitalise on more up-to-date data, as we use data for the period 2001–17 (with a detailed focus on 2012 and 2017). Furthermore, our data include higher quality for the domestic trade flows based on raw data, which is crucial for identifying border effects.

Our analysis is also related to the literature on border effects, spurred by McCallum (1995) and Anderson and van Wincoop (2003). Some recent studies highlight regional border effects, which reduce regional trade relative to regional domestic sales (Coughlin & Novy, 2021; Santamaría et al., 2023). We contribute to this literature by combining worldwide international trade flows and Spanish regional trade data with domestic sales at both levels and employing the most recent developments in the trade gravity literature. Several papers have studied the border effects of Spanish regions. Gallego and Llano (2014) used a previous version of the region-to-region database applied in the present paper to estimate the border effect among Spanish regions and between Spanish regions and regions from other European countries. Gil-Pareja et al. (2005) and Ghemawat et al. (2010) compared Catalonia's trade with other Spanish regions relative to other European countries. We contribute to this literature by extending their analysis to non-European countries with worldwide international trade flows and Spanish regional trade data with domestic sales at both levels and employing the most recent developments in the trade gravity literature (outlined in Yotov et al., 2016).

3. THEORETICAL FOUNDATION AND EMPIRICAL STRATEGY

Our empirical specification for quantifying border effects and our counterfactual analysis rely on the structural gravity model of trade.

Following the recommendations for gravity equation estimation, as, for example, described in Yotov et al. (2016), we estimate the following equation:

$$X_{ij} = \exp(\mathbf{T}_{ij}\beta + \rho_i + \phi_j) \times \epsilon_{ij}, \quad (1)$$

where the dependent variable X_{ij} are trade flows from country or region i to j, $\mathbf{T}_{ij}$ is the vector collecting all bilateral explanatory variables approximating trade costs (such as geographical distance or trade agreements), β is the corresponding parameter vector, ρ_i denotes exporter fixed effects, and ϕ_j denotes importer fixed effects. Trade flows are related to the explanatory variables via an exponential function motivated by gravity theory suggesting a multiplicative relationship. ϵ_{ij} is a remainder error term with conditional expectation equal to 1.[4]

To quantify the border effects, which are part of the explanatory variables of the trade costs $\mathbf{T}_{ij}$, we construct several different variables, which utilise the features of our data. First, a variable *BRDR_ALL* captures any border, that is, it distinguishes between domestic sales and sales crossing any border, be it either trade between Spanish regions, between a Spanish region and another country, or between two countries. Our dataset allows us to split the general *BRDR_ALL* into three different border levels: (1) international borders between countries (not including the border between countries and Spanish regions), *INTL_BRDR*, (2) international borders between a country and a Spanish region, *INTL_SPAIN*, and (3) borders between Spanish regions, *INTER_REGION*. The distinction of these three different border variables is possible because we split Spain into regions and we have domestic sales for countries as well as for Spanish regions. In some specifications, we split the *INTL_BRDR* and *INTL_SPAIN* dummies further into *INTL_BRDR_EU*, indicating an international border between EU member countries; *INTL_BRDR_noEU*, indicating an international border between two non-EU member countries or an EU member country and a non-EU member country; and, similarly for *INTL_SPAIN_EU* and *INTL_SPAIN_noEU*, indicating trade between a Spanish region and an EU member country and between a Spanish region and a non-EU member country, respectively. In our analysis, we even split the variables further to allow for country- and region-specific border effects. Besides the border variables, we also control for the standard gravity variables used in cross-section gravity specifications.

For our counterfactual analysis, we develop a GE endowment model with fiscal transfers between Spanish regions. Following the quantitative trade literature, we solve the model in changes (see Costinot & Rodríguez-Clare, 2014, for a survey). The framework allows us to perform counterfactual experiments by changing the trade cost vectors and fiscal transfers, more precisely by imposing different levels of borders for Catalan trade and terminating Catalonia's fiscal contributions to the Spanish central state. Taking fiscal transfers explicitly into account in our model and counterfactual analysis seems to be important, since transfers are often brought forward in the political debate as one motivation for Catalonia to become independent, given that Catalonia is a net payer in the transfer system. We then obtain counterfactual values for exports, consumer prices, producer prices, and real GDP (our measure of welfare). The reported results are the percentage changes between baseline and counterfactual values.[5]

4. DATA

To construct our novel dataset, which nests Spanish regions into worldwide country-level trade data (i.e., we replace Spain's country trade flows with all regional trade flows), we use two main data sources. First, we use country-to-country international trade flows from the ITPD-E Release 2 dataset of the US International Trade Commission (USITC), described by Borchert et al. (2021). Second, we use trade flows for the 17 Spanish regions (NUTS-2 level) within regions, between regions, as well as between regions and countries in the ITPD-E data from the C-Intereg project.[6] Previous waves of this dataset are thoroughly described by Llano et al. (2017, 2010). The C-Intereg dataset is unique as its construction is not based on gravity and is hence suitable for gravity estimation.[7] It merges freight datasets by transport mode (roads, railway, sea and air) and type of products with product-specific price vectors and imposes output and trade constraints at the national and regional levels. The

international trade flows of Spanish regions are based on the official files published yearly by the Spanish Tax Agency (AEAT), which we scale to match the ITDP-E flows of 2001.

The international control variables come from the Dynamic Gravity Dataset of the USITC (Gurevich & Herman, 2018), as well as from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) dataset (Conte et al., 2022). Distance between regions is taken from Llano et al. (2010) and is averaged and weighted using the population of origin and destination, corresponding to the most representative distance, being road deliveries (the largest share of deliveries observed in Spain). We manually adjust contiguity and common language for the Spanish regions. We merge the ITPD-E and the Spanish datasets at the four-digit industry level and aggregate them at the regional/country level. We use the C-Intereg broad R5 industry classification of agriculture, consumer goods, equipment goods, intermediates and energy, which we match with ITPD-E.

The data for regional income and expenditure come from the Spanish System of Territorialised Public Accounts, which is available for the period 2011–14.[8] To compute the regional fiscal transfers, we follow the methodology proposed by Fuente et al. (2014), which is described in the supplemental data online. The data show that in 2012, Catalonia's share of GDP paid into the common pool of Spanish fiscal transfers is about 34.8%. Ten regions have higher shares (up to 41%) and five regions have lower shares (minimum of 29%). In total amounts, Catalonia has the highest payment (i.e., tax income) into the common pool. Catalonia receives 16.4% of the common pool as a transfer (i.e., public expenditure). This is the second-highest share and it follows Andalucia (16.8%). Madrid has the third-highest share with 13.2%. Catalonia is a net contributor of transfers, paying a net 3.8% of its GDP to the common pool, after adjusting for the total fiscal deficit.[9]

Table 1 shows descriptive statistics of our trade data, subdivided by region-to-region trade and region-to-country (EU and not EU) trade. On average, the remaining Spanish regions trade 2.4 times more among themselves than with EU countries and 35 times more than with non-EU countries. Catalonia follows the same pattern, but with lower numbers: Catalonia trades 1.3 times more with other Spanish regions than with EU countries and 21 times more than with non-EU countries. Catalonia also displays a higher variability than the average of the remaining Spanish regions, and larger maximum trade values, except for non-EU trade.

Figure 1 shows the top 20 Catalan trading partners. The top importer of Catalan exports is France, followed by Aragón, Valencia and Germany. Of these top importers, 12 of them are Spanish regions.

Table 1. Summary Statistics.

	Remaining Spanish regions			Catalonia		
	Mean	Maximum	SD	Mean	Maximum	SD
Region-to-region trade	139	4433	277	479	4875	650
Region-to-EU country trade	59	9582	256	371	12,679	886
Region-to-non-EU country trade	4	6770	50	23	4881	135

Note: Domestic trade excluded; data are in US$ millions.

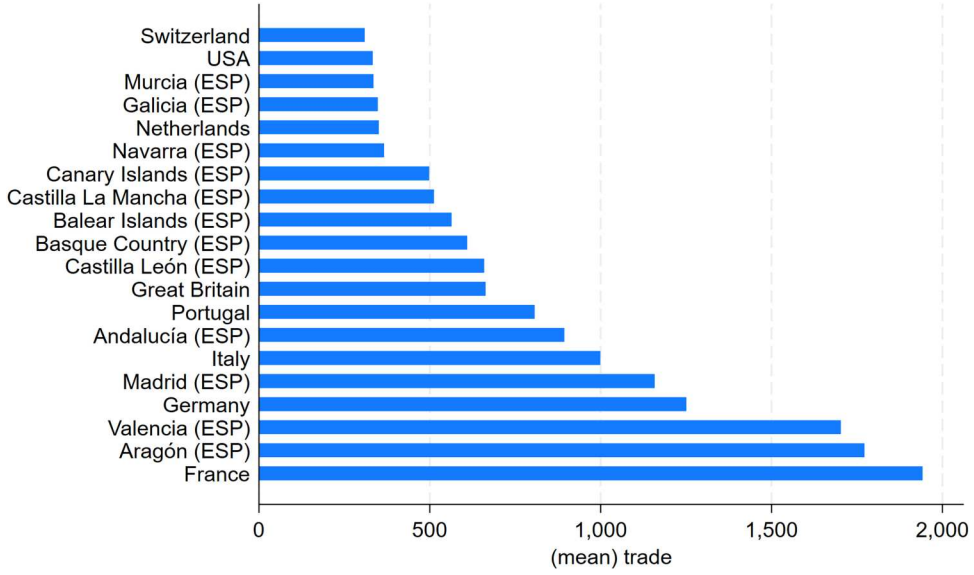

Figure 1. Catalan top 20 trading partners (Catalan exports).
Note: The horizontal axis represents the average volume of Catalan exports in million USD over the period 1995–2017.

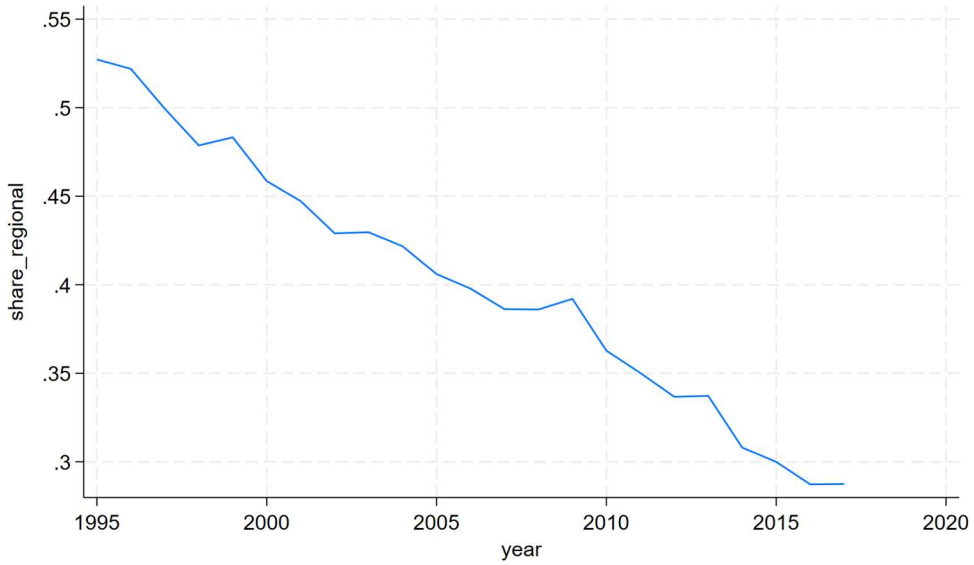

Figure 2. Catalan regional trade share (Catalan exports and imports).
Note: The vertical axis represents the share of Catalan regional trade (exports plus imports) over total Catalan trade.

Figure 2 depicts the evolution of the Catalan regional trade share over time (as the sum of regional imports and exports over international trade). The share of regional Catalan trade (i.e., the share of exports to and imports from other Spanish regions over international trade) has declined over the last decades. Catalan trade with other Spanish regions represented half of its total trade in the mid-1990s. In the mid-2010s, regional trade represented one-third of Catalan trade.

Our dataset covers the period between 2001 and 2017, with 2001 representing a time of Spanish economic growth and 2017 marking the post-independence referendum era. We utilise cross-sectional estimates of trade costs, particularly the effects of borders, in various scenarios of our GE analyses for these different years. By doing so, we can assess and compare the costs of independence for Catalonia and the remaining Spanish regions over the period 2001–17. Given that the Catalan independence process reignited in 2011, culminating in the massive demonstration in September 2012, our main illustrations focus on 2012, when Spain was in a recession following the financial crisis of 2007–08. We compare our results with those obtained for 2017 (the year of the referendum) as a robustness check.

5 ESTIMATION RESULTS

5.1. Estimating different trade border levels

Table 2 reports the results of estimating equation (1) when splitting the borders into different levels.[10] Column (1) reports estimates of the international border effect obtained using a sample of 143 countries in 2012, where Spain is considered as a single entity instead of being split into its regions. In column (2), Spain is split into its regions and the dataset comprises region-with-country trade flows instead of Spain-with-country trade and region-with-region or domestic regional trade flows instead of Spanish domestic trade. A Wald test reveals that the overall border effect is not statistically different from the estimate in column (1). The observation that the average border becomes a little thinner in column (2) can be explained by the fact that we are creating borders within Spain, counting region-with-region trade as trade across a border, whereas it counts as Spain's domestic trade in column (1). While the border effects estimated in columns (1) and (2) capture overall borders, in column (3) we differentiate between country-to-country, region-to-country[11] and region-to-region borders. All border coefficients are negative and highly significant. The border between Spanish regions and other countries is comparable to the border among other countries, suggesting that Spanish regions are integrated to a similar extent as the other countries. Accordingly, two countries trade about 97.96% less with each other than domestically ($(\exp(-3.893)-1)\times 100 \approx -97.96$), while a Spanish region and a country trade about 98.16% less with each other than domestically. Although regional borders are thinner, they are still significant and substantial, suggesting that regions trade about 73.58% less with each other than domestically. This reveals that Spanish regions are not fully integrated, in line with previous findings in the literature on the border effect in Spain (Gil-Pareja et al., 2006). When using these estimates to answer our research question, a counterfactual scenario of Catalan independence could involve expanding the Spanish regional borders for Catalonia by about 25 percentage points from 73.58% to 98.16%. In column (4), we split the country-to-country and region-to-country borders into EU and non-EU borders. The results confirm that EU borders are thinner than non-EU borders, but nonetheless significant and sizeable.[12] In all specifications, the coefficient estimates of the further gravity control variables are as expected.

Table 2. Country borders, regional borders, EU borders.

	(1)	(2)	(3)	(4)
LN_DIST	−0.372***	−0.386***	−0.361***	−0.361***
	(0.049)	(0.048)	(0.049)	(0.049)
CONTIG	0.590***	0.681***	0.672***	0.681***
	(0.100)	(0.105)	(0.103)	(0.103)
COM_LANG	0.333***	0.359***	0.329***	0.339***
	(0.069)	(0.069)	(0.069)	(0.070)
RTA	0.253***	0.189**	0.241***	0.234***
	(0.075)	(0.075)	(0.076)	(0.076)
EU	0.218**	0.158*	0.195**	
	(0.093)	(0.090)	(0.092)	
COM_REL	1.054***	1.124***	1.068***	1.051***
	(0.140)	(0.138)	(0.139)	(0.139)
COM_LEG	−0.018	−0.024	−0.035	−0.042
	(0.065)	(0.062)	(0.064)	(0.064)
ISLAND	0.414**	0.452***	0.452***	0.454***
	(0.163)	(0.162)	(0.164)	(0.164)
LAND	−0.830***	−0.738***	−0.762***	−0.758***
	(0.142)	(0.132)	(0.129)	(0.129)
BRDR_ALL	−3.830***	−3.775***		
	(0.139)	(0.140)		
INTL_BRDR			−3.893***	
			(0.143)	
INTL_SPAIN			−3.996***	
			(0.180)	
INTER_REGION			−1.331***	−1.335***
			(0.180)	(0.179)
INTL_BRDR_EU				−3.715***
				(0.165)
INTL_BRDR_noEU				−3.889***
				(0.143)
INTL_SPAIN_EU				−3.574***
				(0.187)
INTL_SPAIN_noEU				−4.250***
				(0.181)
Observations	19,807	24,607	24,607	24,607
R^2	0.983	0.983	0.983	0.983
Importer, exporter fixed effects	Yes	Yes	Yes	Yes
Spain region	No	Yes	Yes	Yes

Note: Robust standard errors are shown in parentheses. Column (1): cross-country estimation with Spain included as a country (with Spanish domestic and international trade); column (2): estimation with Spain split up into regions (with regional domestic, region-to-region and international trade); column (3): dissect the border: country-to-country (*INTL_BRDR*), region-to-country (*INTL_SPAIN*), region-to-region (*INTER_REGION*); and column (4): dissect the border further: non-EU country-to-country (*INTL_BRDR_noEU*), non-EU region-to-country (*INTL_SPAIN_noEU*), EU country-to-country (*INTL_BRDR_EU*), EU region-to-country (*INTL_SPAIN_EU*) and region-to-region (*INTER_REGION*). *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

Overall, Table 2 reveals highly significant and large negative border coefficients, which are in line with the 'border puzzle' literature. Since border effects quantify the difference between domestic and cross-border trade, proper identification of borders requires the dataset to include sales in the home market. Our dataset allows us to identify border effects both at the country level and at the regional level since it includes domestic sales for both levels.[13] Similar to our large estimates in Table 2, Borchert et al. (2021) report sizeable effects.[14] Others, such as Bergstrand et al. (2015), use panel estimates with bilateral fixed effects. In this case, the level of the

border is captured by the bilateral fixed effects. Only if interacted with a time dummy, the change in border effects over time (relative to the omitted base category) can be quantified. When estimating these interaction terms, the magnitudes of the coefficients are substantially smaller and capture the relative importance of borders over time, also associated in the literature with globalisation. As we are not concerned about globalisation, but rather interested in differences in the thickness of different types of borders, we stick to a cross-section analysis in our main specifications, where the estimated border effects are in levels. Since we focus on the difference between the various level-effect estimates, general differences in domestic sales versus cross-border flows that are captured by our border dummies are differenced out.

The sizeable border effects invoke the question of whether the border between an independent Catalonia and the remaining Spanish regions would actually expand by the differences in the effects for the different border levels, as illustrated by the results in column (3). In response, it is important to note that the estimates so far only capture partial effects and abstract from any GE adjustments (such as price and income effects, or trade diversion due to relative trade cost changes) that may occur after Catalan independence. This is a reason why we use a GE analysis to quantify the effects of Catalan independence. When modelling our counterfactual experiments, we change the Catalan regional border to a Catalan country border. We can do this by estimating Catalonia-specific borders (such as the Catalan region-to-region border or its region-to-country border) and then using these for our counterfactual experiments. Hence, we dissect all borders shown in the specifications of Table 2 into country- or region-specific borders and graphically present coefficient estimates along with 95% confidence intervals.

Figure 3 displays the country- and region-specific coefficients when dissecting the EU and non-EU borders from column (4).[15] It shows that Catalonia's region-to-region border is the thinnest among all region-to-region borders, followed by Madrid. This strongly suggests that other Spanish autonomous regions are still the most important trading partners for Catalonia, which is reflected by the overall lower absolute level of border effects of region-to-region borders (see also Castells, 2014). Hence, Catalonia would be strongly affected by higher trade costs when trading with other regions. Turning to the EU and non-EU region-to-country borders, Catalonia's borders are

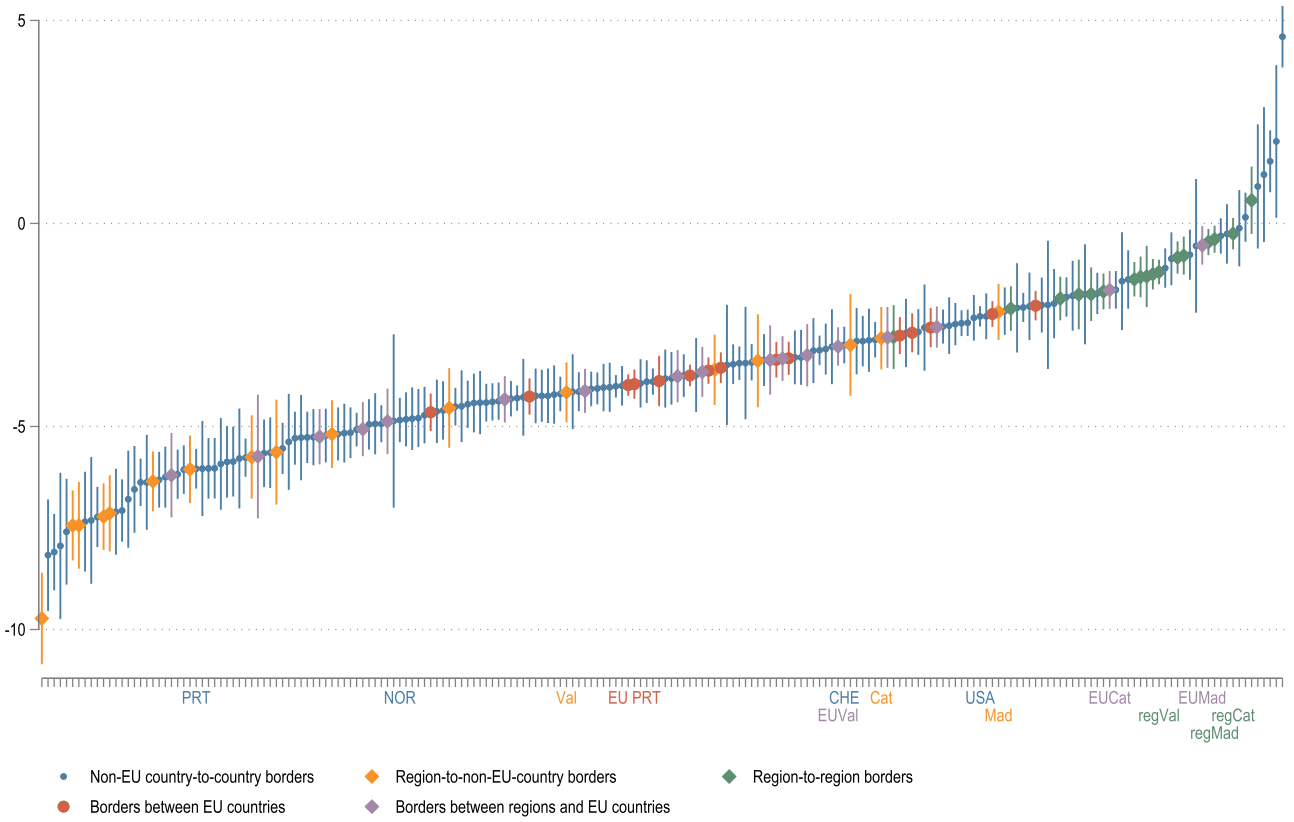

Figure 3. EU versus non-EU country and region borders.
Note: Coefficient estimates and 95% confidence intervals of country- and region-specific borders, dissected from the specification shown in column (4) of Table 2. The labels highlight a selection of non-EU country borders (where PRT is Portugal, NOR is Norway, ESP is Spain, CHE is Switzerland and USA is the United States), of EU country borders (where EU PRT is Portugal), of region-to-non-EU country borders (where Val is Valencia, Cat is Catalonia and Mad is Madrid), of region-to-EU country borders (where EUVal is Valencia, EUCat is Catalonia and EUMad is Madrid), and of region-to-region borders (where regVal is Valencia, regMad is Madrid and regCat is Catalonia).

the second thinnest among the Spanish regions, after Madrid, which has the thinnest country borders among all regions. The different levels of Catalonia's borders are of the expected order, where the regional border is the thinnest with an insignificant estimated coefficient, followed by the EU country border, and the non-EU country border is the thickest. We employ these Catalonia-specific estimates in our counterfactual experiments. In a scenario in which Catalonia stays in the EU, the Catalan regional border (i.e., the border between Catalonia and Madrid or between Catalonia and any other Spanish region) are assigned the estimate we obtained for the Catalan EU country border. In a scenario in which Catalonia leaves the EU, we accordingly use the estimate of a non-EU border. As Catalonia has a thinner EU border, which would become substantially thicker if it leaves the EU, independence may harm trade and welfare in Catalonia (see also Granell, 2014; Puig, 2014). The quantitative implications are explored in our following GE analysis.

The heat map in Figure 4 displays the geographical distribution of the country-specific borders (obtained by dissecting the country-to-country border in the specification shown in column (1) of Table 2). As may be anticipated, a positive association exists between GDP and border coefficients, resulting in Sub-Saharan African countries having the thickest borders while Western countries and China have the thinnest.

Similarly, the heat map in Figure 5 shows the geographical distribution of the region-to-country borders of the Spanish regions (obtained by dissecting the region-to-country border in the specification shown in column (3) of Table 1). It reveals that, among all Spanish regions, Catalonia has the thinnest border, together with the Basque Country and Madrid, while Extremadura and Castilla-La Mancha belong to the regions with the thickest borders. The latter regions are among the most rural and poorest in terms of GDP per capita. The regions with the thinnest borders are among the most developed regions in Spain. The observed pattern of thinner borders with increased development is in line with the pattern observed above for the country-to-country border effects, depicted in Figure 4.

When comparing the border estimates for 2012 with estimation results for 2017, the year in which the Catalan independence referendum took place, all international borders are thinner in 2017 than in 2012, while the regional borders are thicker in 2017 than in 2012. The overall and relative magnitudes are similar in both years. A table with estimation results as well as plots of the country- and region-specific borders for 2017 are shown in the supplemental data online.

5.2. Catalonia's borders over time

We estimate border effects for each cross-section from 2001 to 2017, allowing us to compare countries' and regions' levels of integration for different years. To this end, we estimate the same specifications as in Table 2 for all years between 2001 and 2017 individually and plot the respective coefficients, along with 95% confidence intervals. Within a type of border, we find no significant differences in the estimated coefficients over time. In Figure 6, which shows results corresponding to the specification shown in column (4) of Table 2, we observe a significant difference between the regional and international borders, supporting our previous findings that regional borders are much thinner than international borders. There seems to be a larger difference between the region-to-country EU borders and region-to-country non-EU borders than between the country-to-country EU borders and country-to-country non-EU borders. This suggests that being part of the EU market is rather important for Spanish regions and might have implications for Catalonia's independence, whose welfare implications could depend on whether or not it stays in the EU.[16]

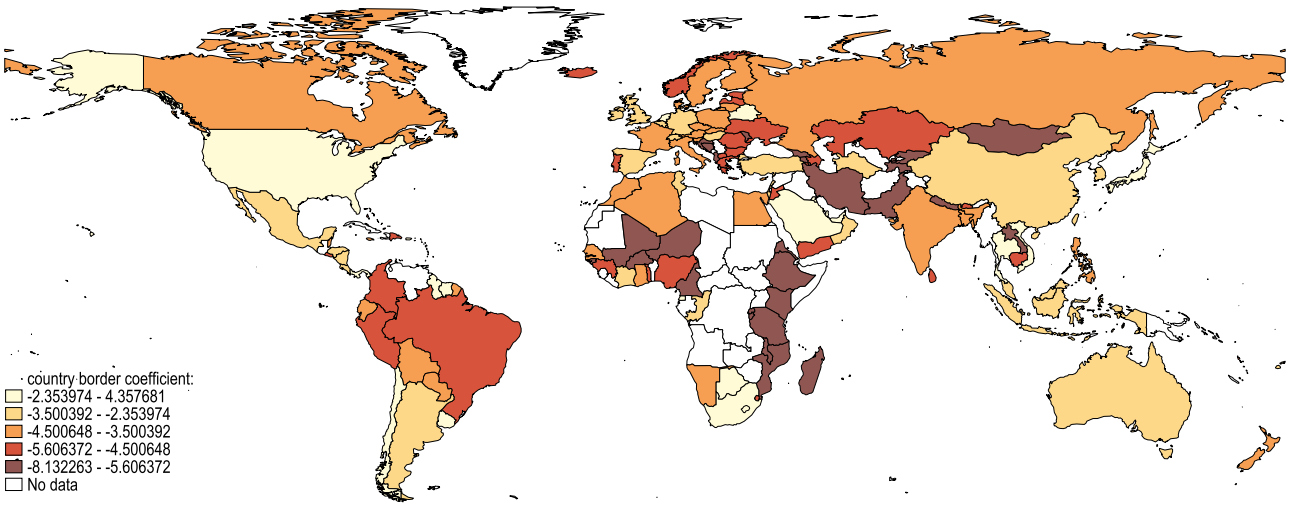

Figure 4. Border coefficients, heat map.
Note: Coefficient estimates of country-specific borders, dissected from the specification shown in column (1) of Table 2.

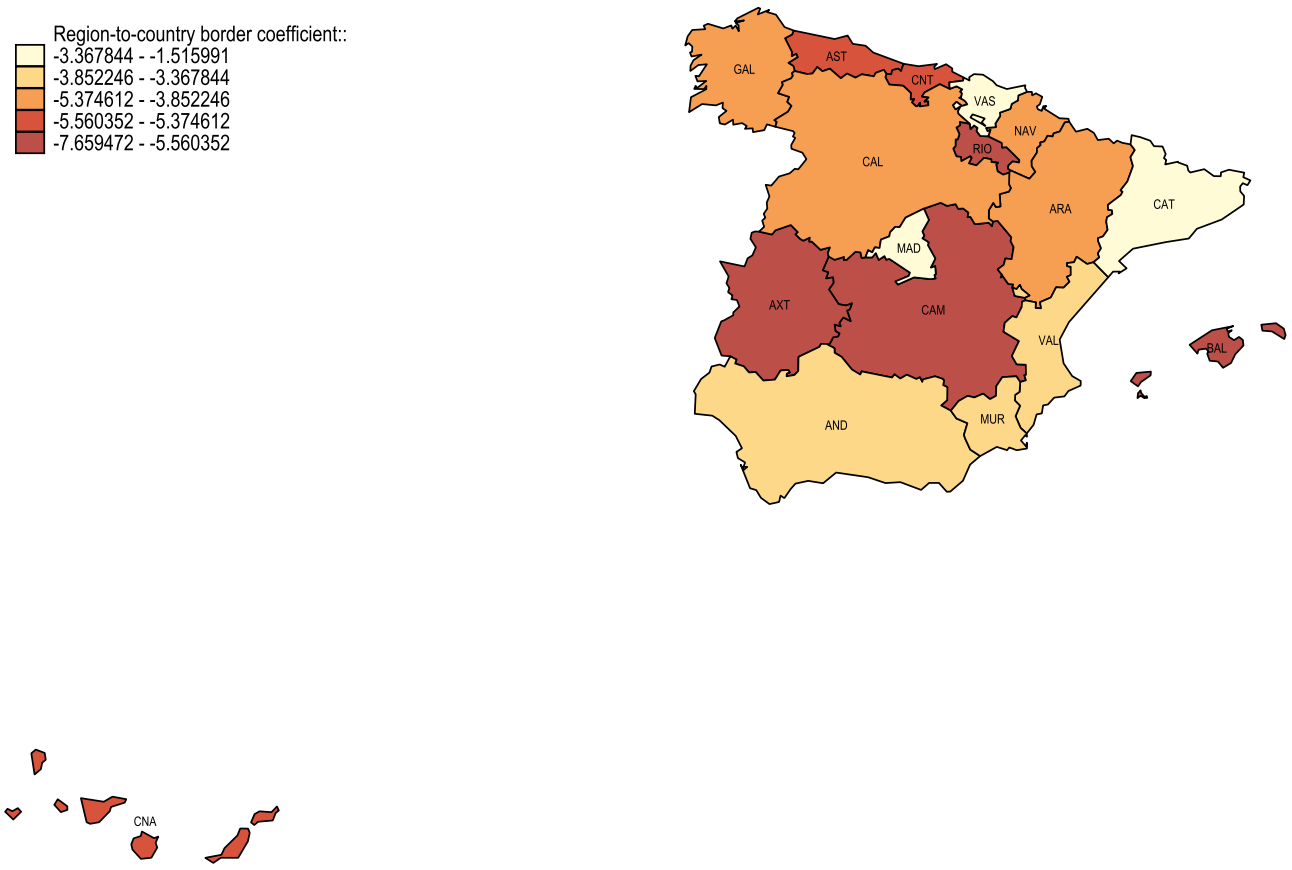

Figure 5. Region-to-country border coefficients, heat map.
Note: Coefficient estimates of region-specific borders, dissected from the specification shown in column (3) of Table 2.

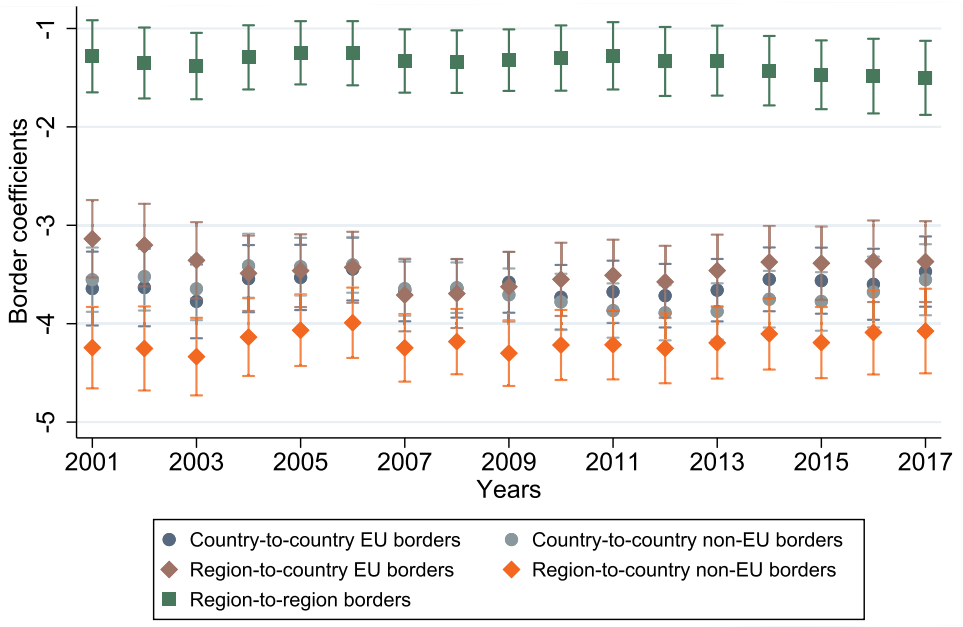

Figure 6. EU versus non-EU country and region borders, 2001–17.
Note: Coefficient estimates and 95% confidence intervals from the specification shown in column (4) of Table 2 over time.

To assess how Catalonia's different borders evolved over time, we estimate Catalonia's regional border, its EU country border, and its non-EU country border for each cross-section from 2001 to 2017. We calculate the cumulative change over time in the absolute value of the respective type of border and plot the change in Figure 7.

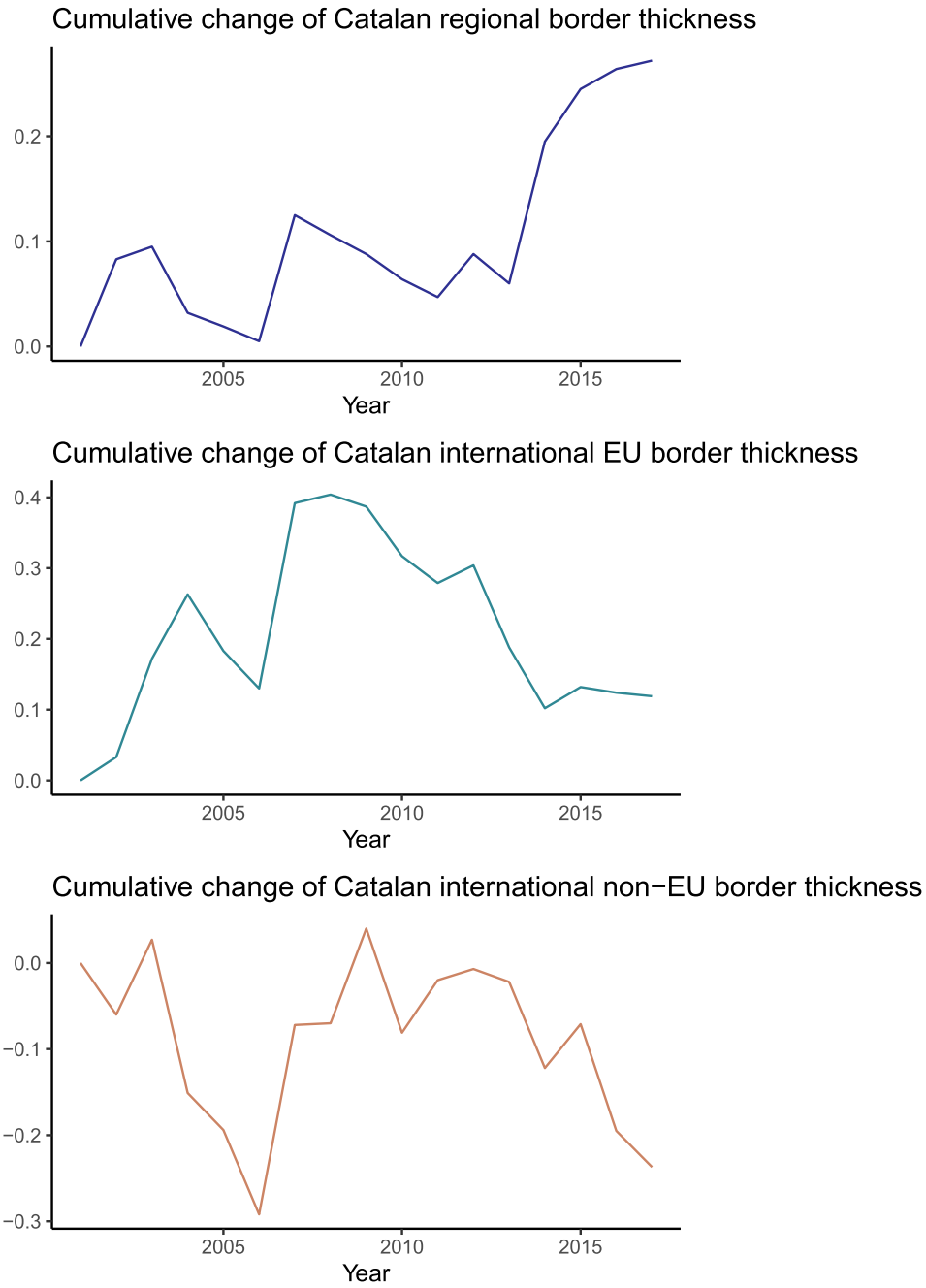

Figure 7. Catalonia's borders over time.
Note: The graphs show the cumulative change in the absolute value of the respective type of border for Catalonia, that is, an increase in the cumulative change implies that the border became thicker.

It shows that Catalonia's regional border became thicker while its international borders became thinner over time. Despite yearly changes in the border thickness, for example, just before and after the financial crisis, there is a tendency that Catalonia's regional border became thicker while its international borders became thinner over time, both in the EU and globally.

These findings align with recent results by Almunia et al. (2021), who show that Spanish firms increased their international exports in response to the recession in 2011–2012 during the aftermath of the financial crisis. The export increase was induced by an adjustment in unit labour costs, translating into lower wages for Spanish workers. The thinner international border and hence better international integration of Catalonia may imply that the costs of independence have decreased over time while also wages and welfare state benefits decreased. In 2001, independence and hence an increase in the relatively thin regional borders would have led to a more substantial rise in trade costs than in 2017.

5.3. Social connectedness

Social ties between regions and countries may impact the amount they trade with each other. Bailey et al. (2021)

use data from Facebook to construct pairwise social connectedness between 170 countries and 332 European regions. They show that two countries trade more when they are more socially connected and find a decline in the estimated effects of distance and borders on trade when controlling for social connectedness. Social ties

Table 3. Country borders, regional borders, EU borders, controlling for social connectedness.

	(1) Trade	(2) Trade	(3) Trade	(4) Trade
LN_DIST	0.013	0.011	0.020	0.020
	(0.042)	(0.041)	(0.042)	(0.042)
CONTIG	0.617***	0.684***	0.699***	0.705***
	(0.070)	(0.070)	(0.069)	(0.069)
COM_LANG	−0.085	−0.078	−0.086	−0.079
	(0.055)	(0.054)	(0.054)	(0.055)
RTA	0.292***	0.232***	0.279***	0.273***
	(0.063)	(0.062)	(0.063)	(0.063)
EU	0.088	0.083	0.067	
	(0.069)	(0.066)	(0.068)	
COM_REL	0.249**	0.268***	0.261**	0.257**
	(0.105)	(0.104)	(0.104)	(0.104)
COM_LEG	0.039	0.053	0.020	0.016
	(0.052)	(0.050)	(0.052)	(0.052)
ISLAND	0.102	0.109	0.146	0.149
	(0.131)	(0.129)	(0.130)	(0.130)
LAND	−0.513***	−0.371***	−0.466***	−0.465***
	(0.114)	(0.109)	(0.106)	(0.107)
LN_SCI	0.530***	0.527***	0.526***	0.525***
	(0.024)	(0.023)	(0.024)	(0.024)
BRDR_ALL	−2.073***	−2.046***		
	(0.127)	(0.118)		
INTL_BRDR			−2.147***	
			(0.127)	
INTL_SPAIN			−1.445***	
			(0.163)	
INTER_REGION			−0.254**	−0.260**
			(0.112)	(0.112)
INTL_BRDR_EU				−2.092***
				(0.137)
INTL_BRDR_noEU				−2.147***
				(0.127)
INTL_SPAIN_EU				−1.228***
				(0.165)
INTL_SPAIN_noEU				−1.652***
				(0.168)
Observations	17,722	22,266	22,266	22,266
R^2	0.988	0.987	0.988	0.988
Importer, exporter fixed effects	Yes	Yes	Yes	Yes
Spain region	No	Yes	Yes	Yes

Note: Robust standard errors are shown in parentheses. Trade cost variables include the social connectedness index (SCI). Column (1): cross-country estimation with Spain included as a country (with Spanish domestic and international trade); column (2): estimation with Spain split up into regions (with regional domestic, region-to-region and international trade); column (3): dissect the border: country-to-country (*INTL_BRDR*), region-to-country (*INTL_SPAIN*), region-to-region (*INTER_REGION*); and column (4): dissect the border further: non-EU country-to-country (*INTL_BRDR_noEU*), non-EU region-to-country (*INTL_SPAIN_noEU*), EU country-to-country (*INTL_BRDR_EU*), EU region-to-country (*INTL_SPAIN_EU*) and region-to-region (*INTER_REGION*). *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

may play a role in the trade between Spanish regions and countries worldwide. We therefore include the social connectedness index (SCI) of Bailey et al. (2021) as a trade cost component in our regressions.[17]

We compare the results in Table 3 with our baseline results for 2012, while for the results for 2017, see the supplemental data online. The coefficients on the natural logarithm of the SCI are positive and around 0.5 across specifications for 2012 and 2017. Social Connectedness is highly significant. Including SCI renders the estimate for distance insignificant in both years. Note that the correlation between *LN_DIST* and *LN_SCI* is −0.57. The negative border effects stay highly significant when adding SCI to the regressions, although their magnitude decreases. The relative magnitudes remain similar, with international borders being thicker than regional borders and non-EU borders being thicker than EU borders. In 2012, controlling for social connectedness, a Spanish region trades 23% less with other Spanish regions than domestically (column 4 of Table 3). Without social connectedness, it trades 74% less with other Spanish regions than domestically (column 4 of Table 2). Controlling for social connectedness, an EU country trades 88% less with other EU countries than domestically. Without social connectedness, it trades 98% less with other EU countries than domestically.

6. GENERAL EQUILIBRIUM ANALYSIS

In this section, we present and discuss the results of our various counterfactual experiments based on the structure of the theoretical model outlined in section 3 and using 2012 as our baseline year.

In a first counterfactual exercise, Catalonia secedes from Spain but stays in the EU. This would imply that the trade between an independent Catalonia and the remaining Spanish regions no longer crosses regional borders but instead crosses EU borders. We thus assign the same thickness to the counterfactual Catalan region-to-region borders as the Catalan region-to-EU country border (Figure 3). In this first scenario, we also highlight the role of including transfers into the model. We therefore present results for the model without transfers as an initial benchmark. These results are depicted in Figure 8 and Table E1 in Appendix E in the supplemental data online, showing effects on exports, consumer prices and producer prices (relative to the United States, our numéraire), as well as on welfare, which corresponds to real output in our model, for Catalonia and the remaining Spanish regions. In a model with transfers, an independent Catalonia would discontinue its payments into and no longer receive transfers out of the common pool. We assume the contributions to the common pool by all other Spanish communities to remain unchanged, while the payments received are adapted proportionally, such that the entire pool is distributed. Results are shown in Figure 9 and Table E3 in Appendix E in the supplemental data online.

In the model without transfers, Catalonia's total exports drop by 15.1% and its welfare declines by 6.5%, while in the model with transfers, Catalonia's total exports drop by 17.4% and its welfare declines by 6.1%. For the remaining Spanish regions, the welfare loss is between 0.1% and 7.3% in the model without transfers, resulting in an average loss of 1.9%, and between 0.4% and 7.4% in the model with transfers, resulting in an average loss of 2.1% for the rest of Spain. Hence, as may be expected, the remaining Spanish regions face (slightly) higher

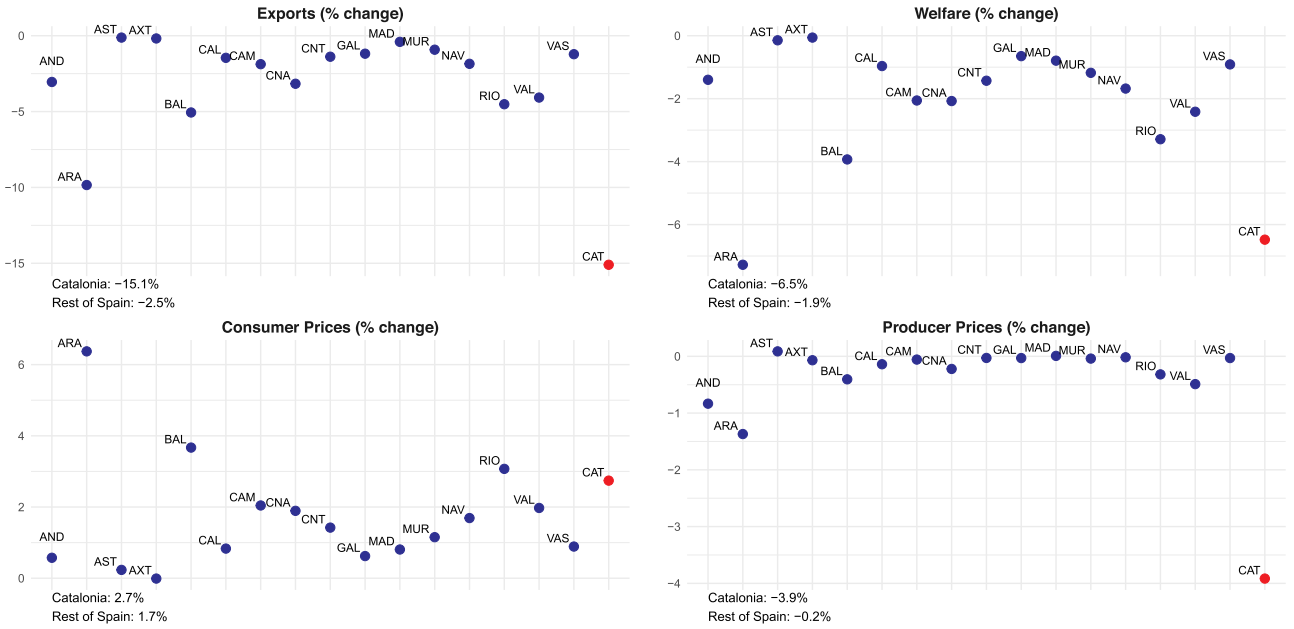

Figure 8. Catalonia's regional border as EU country border, without transfers.
Note: The graphs report the effects on total exports, consumer prices, producer prices (relative to the United States), as well as on welfare, for Catalonia and the remaining Spanish regions. The reported change for the rest of Spain is an average of the changes for the remaining Spanish regions. The model does not include transfers.

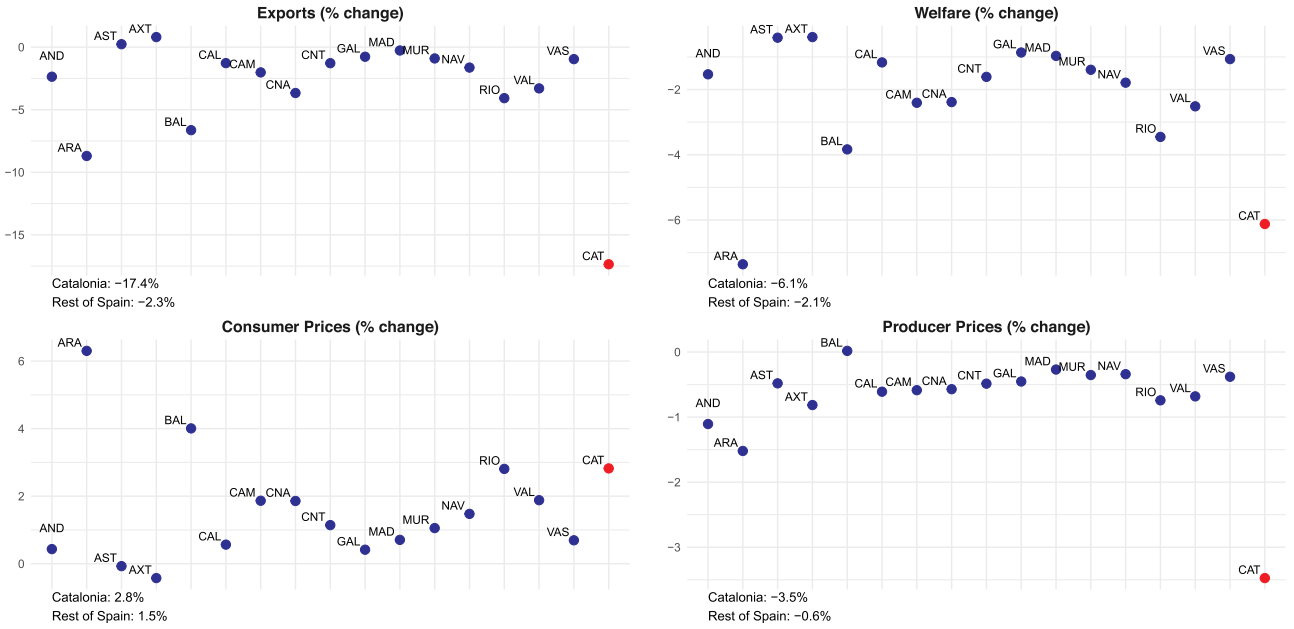

Figure 9. Catalonia's regional border as EU country border, with transfers.
Note: The graphs report the effects on total exports, consumer prices, producer prices (relative to the United States), as well as on welfare, for Catalonia and the remaining Spanish regions. The reported change for the rest of Spain is an average of the changes for the remaining Spanish regions. The model includes transfers. The transfers change in the counterfactual (i.e., Catalonia no longer contributes to the common pool and no longer receives transfers from the common pool).

welfare losses when Catalonia no longer pays into the common pool. Aragón has a stronger welfare decrease than Catalonia, which may be related to the fact that Catalonia is its most important trading partner and it spends about 32% of its total expenditure on goods from Catalonia. For Catalonia, in the setting with transfers, the stronger welfare decline in the remaining Spanish regions implies a reduced demand for its exports, such that its exports drop more strongly in the model with transfers than in the model without. As expected, the welfare loss for Catalonia is not as strong in the model with transfers, since it stops paying net transfers into the common pool. The fact that the 0.4 percentage point difference in the welfare losses between the counterfactuals is substantially smaller than the Catalan net transfer savings of 9.7% is due to the mitigating effect of Catalonia's spending on goods from other Spanish regions and the decreased demand for Catalan goods by the other regions. Overall, the trade-induced welfare loss is explained by a reduction in the consumer surplus due to higher domestic prices for consumers and lower income and a reduction in producer surplus due to lower domestic producer prices. Therefore, both consumers and producers share the burden of increased trade costs, while producer prices tend to fall more than consumer prices rise.

Although we focus on the impact of Catalan independence on exports, welfare, consumer prices, and producer prices for Catalonia and the remaining Spanish regions, our analysis does not isolate the Spanish regions. It also obtains results for the other 142 countries in our worldwide dataset. The welfare changes for the countries are depicted in the heatmap in Figure 10. While most countries are only affected very moderately (welfare effects between −0.01% and 0.18%), many countries in Europe encounter small positive changes in welfare, such as Portugal with an increase of 0.06%, benefiting from a 0.84% increase in trade.

The flexibility of our method surfaces in the wide variety of counterfactual experiments that we can design in light of the political uncertainty regarding the circumstances of a potential Catalan secession. The first counterfactual may underestimate the effects of Catalan independence, considering that Catalonia may not be granted EU membership.[18] Our second counterfactual thus considers a scenario in which Catalonia is no longer a member of the EU.[19] Given Catalonia's relatively high level of integration, it is possible that it would become an independent state outside the EU, similar to Switzerland (see Figure 3 for a comparison between the Swiss and Catalan non-EU country borders). To model this scenario, we therefore assign the Swiss border to Catalonia's regional and EU country borders. Note that this does not imply that Catalonia has the same treaties or institutions as Switzerland. It merely assumes the same thickness of borders, which could be achieved by various policy changes and differently from the way Switzerland established its borders. The results, reported in Figure 11 and Table E9 in Appendix E in the supplemental data online, show this is the worst scenario so far, with a Catalan welfare loss of 16.4%. In contrast, the average loss for the remaining regions is similar to the previous scenario, at 2.6%. Now, Catalonia is the Spanish region facing by far the strongest welfare impact, while Aragón is affected less. The heatmap in Figure E5 online shows that EU

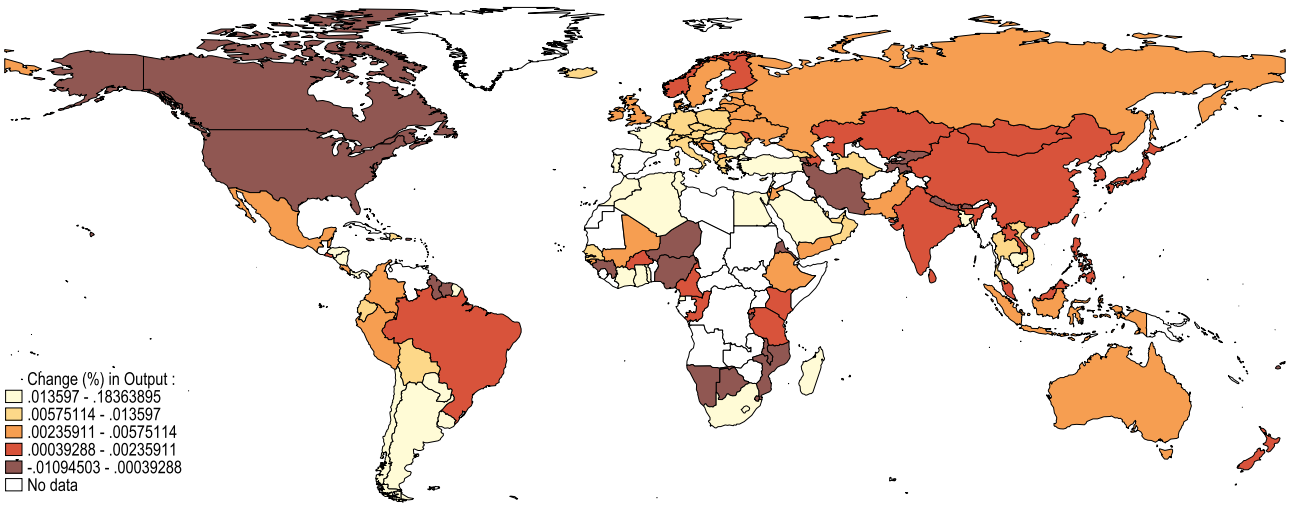

Figure 10. Catalonia's regional border as EU country border: change (%) of welfare for countries in the dataset.

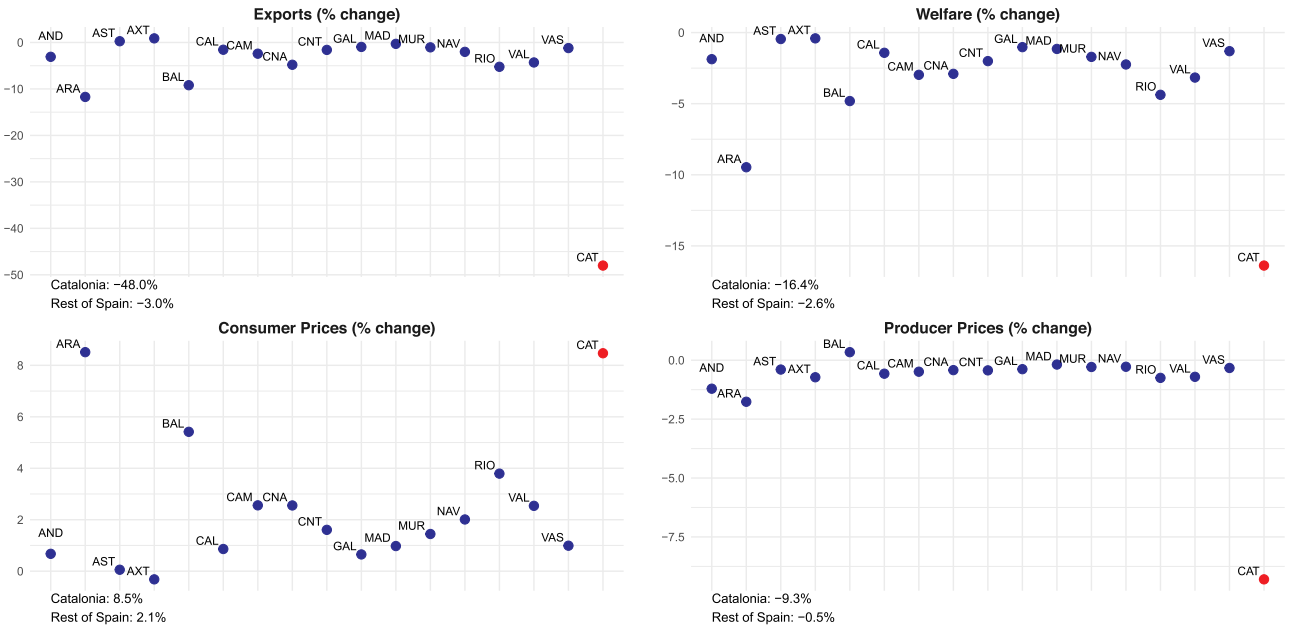

Figure 11. Catalonia outside the EU, same border as Switzerland, with transfers.
Note: The graphs report the effects on total exports, consumer prices, producer prices (relative to the United States), as well as on welfare, for Catalonia and the remaining Spanish regions. The reported change for the rest of Spain is an average of the changes for the remaining Spanish regions. The model includes transfers. The transfers change in the counterfactual (i.e., Catalonia no longer contributes to the common pool and no longer receives transfers from the common pool).

countries no longer slightly benefit from Catalan independence, as was the case in the previous scenario where Catalonia remained in the EU. For instance, Portugal faces a welfare loss of 0.14%, followed by Hungary and France with a loss of 0.04% each.

The third counterfactual is a worst-case scenario where Catalonia is neither an EU member nor in the WTO, which may not be utterly implausible, at least for a transition period, considering the above discussion. To model this scenario, we impose the Swiss border on Catalonia's regional and EU borders and discontinue all of Spain's Regional Trade Agreements for Catalonia.[20] As highlighted by the results reported in Figure 12 and Table E12 in Appendix E in the supplemental data online, this counterfactual is the worst for Catalonia with a welfare loss of 17.4%. Still, the impact on the remaining Spanish regions is very similar to the previous scenarios.

The political economy consequences behind our counterfactuals are interesting. First, while EU and WTO membership is crucial to Catalan welfare after independence, Spain would face a similar loss whether or not Catalonia joins the EU or the WTO. Therefore, the Spanish central government has little incentive to negotiate or vouch for a fast-track accession of Catalonia to the WTO or not to veto its entry into the EU. Therefore, the authorities of the Spanish central government can leverage EU and WTO membership in political negotiations. Second, fiscal transfers play a secondary role for

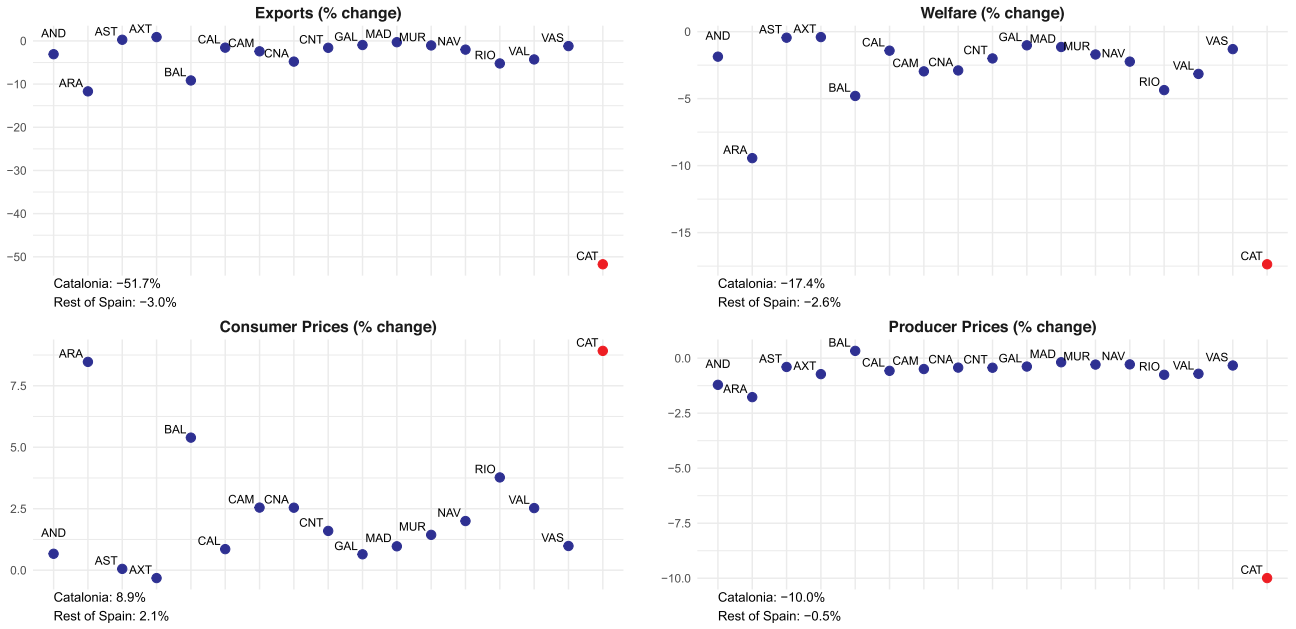

Figure 12. Catalonia outside the EU and the WTO, with transfers.
Note: The graphs report the effects on total exports, consumer prices, producer prices (relative to the United States), as well as on welfare, for Catalonia and the remaining Spanish regions. The reported change for the rest of Spain is an average of the changes for the remaining Spanish regions. The model includes transfers. The transfers change in the counterfactual (i.e., Catalonia no longer contributes to the common pool and no longer receives transfers from the common pool).

the welfare effects of Catalan independence. Moreover, Catalan gains from net transfer saving are substantially mitigated due to the trade relations with the remaining Spanish regions. Hence, the gains from net transfer saving are not expected to completely compensate the welfare loss resulting from Catalonia's thicker borders.

To assess whether the economic costs of independence have changed over time for Catalonia and the remaining

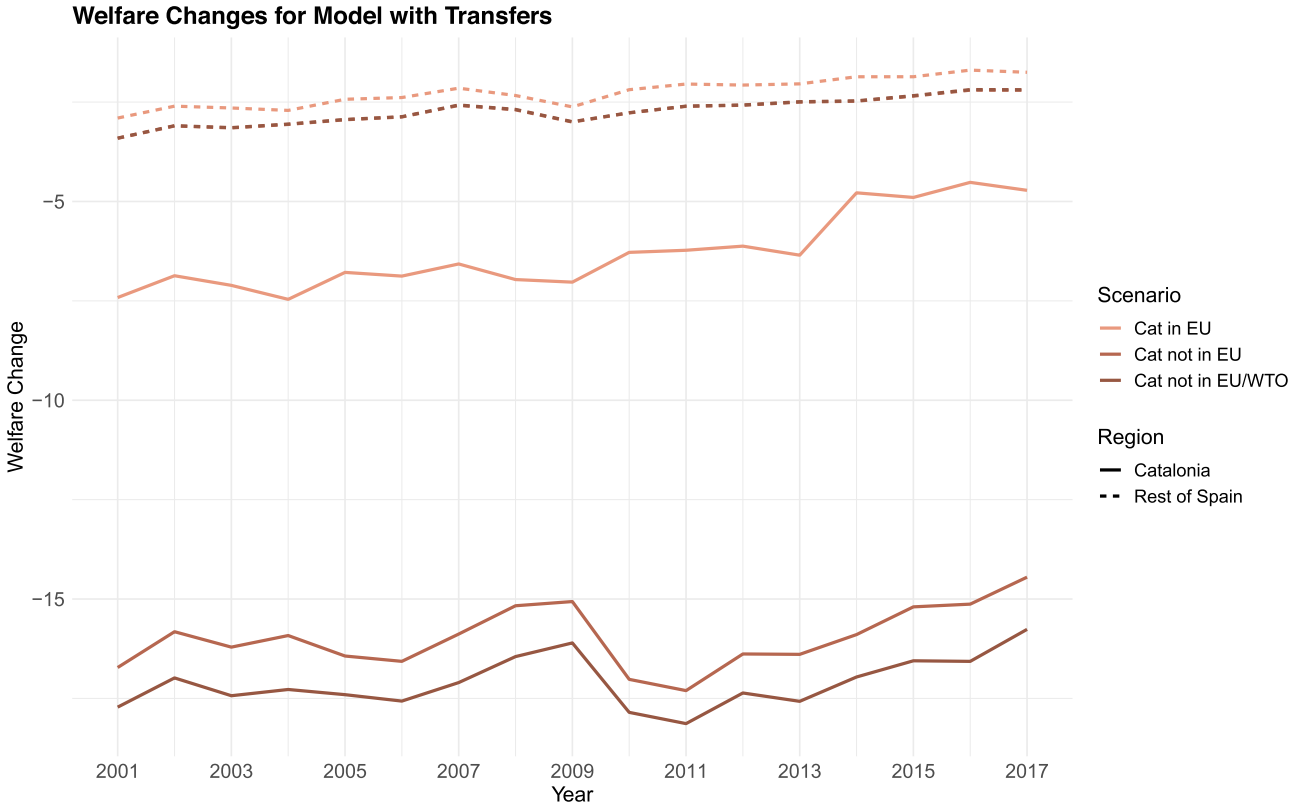

Figure 13. Change (%) of welfare after independence for Catalonia and the remaining Spanish regions over time for different scenarios, with transfers.

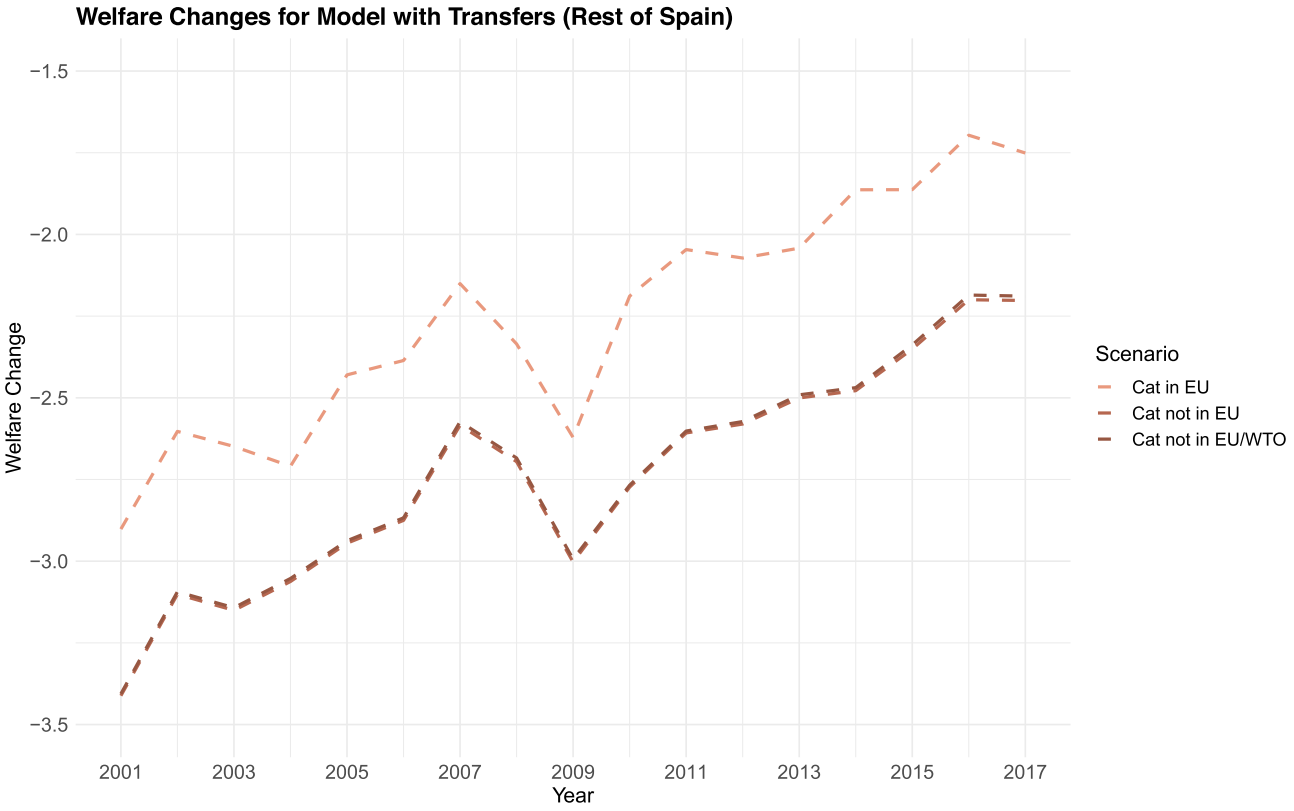

Figure 14. Change (%) of welfare after independence for the average of the remaining Spanish regions over time for different scenarios, with transfers.
Note: The results shown correspond with the results for the remaining Spanish regions in Figure 13, with a more detailed scale.

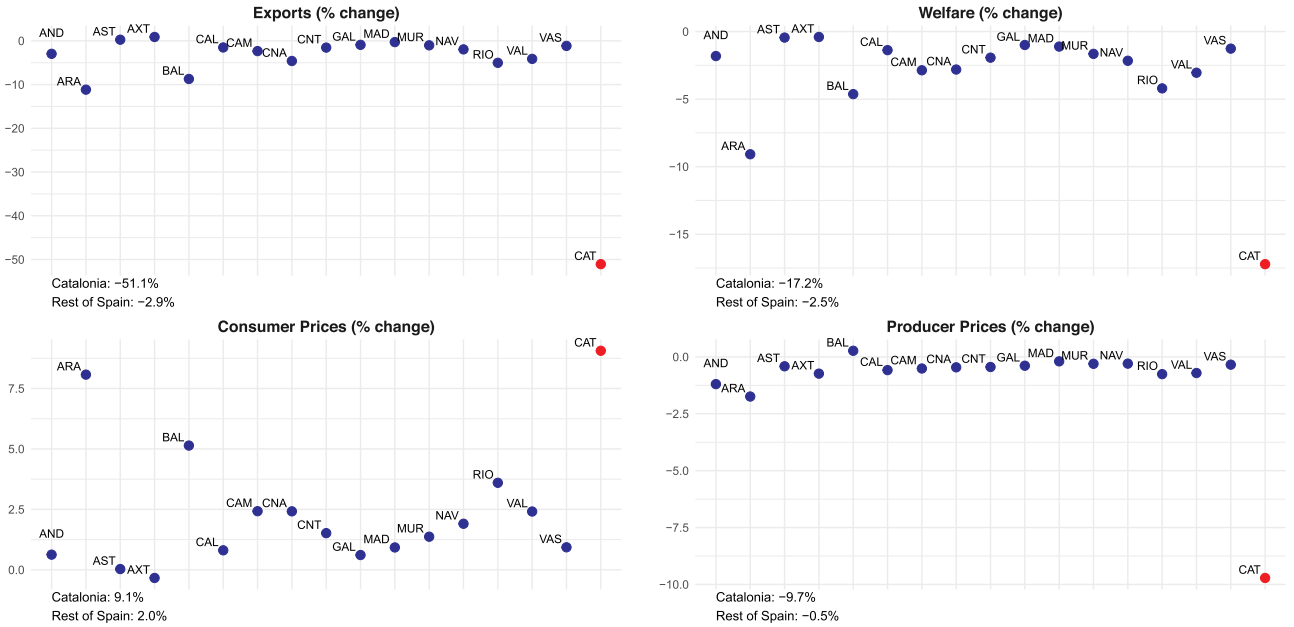

Figure 15. Catalonia outside the EU, same border as Switzerland, with transfers, model with social connectedness.
Note: The graphs report the effects on total exports, consumer prices, producer prices (relative to the United States), as well as on welfare, for Catalonia and the remaining Spanish regions. The reported change for the rest of Spain is an average of the changes for the remaining Spanish regions. The model includes transfers. The transfers change in the counterfactual (i.e., Catalonia no longer contributes to the common pool and no longer receives transfers from the common pool). Social Connectedness is the same in the baseline and counterfactual.

Spanish regions, we conduct our three counterfactual experiments individually for the period 2001–17. For our model with transfers, we plot the welfare change for Catalonia and the average of the remaining Spanish regions over time in Figure 13 and observe that Catalonia's cost of independence has decreased in recent years for all scenarios. The uppermost solid line represents the welfare change for Catalonia in the scenario where it remains in the EU. The costs of independence decreased after 2013. The development over time of Catalonia's welfare when it is outside the EU (second solid line from the bottom) and outside both the EU and the WTO (bottom line) are similar, while the levels for these more pessimistic scenarios are stronger, as expected. For these scenarios, we also observe that the cost of independence decreased after 2011. These findings are consistent with the finding that Catalonia became more integrated internationally, such that the change from a regional border to an international border leads to a weaker increase in trade costs over time.

For the remaining Spanish regions, the average welfare changes are lower than those for Catalonia and very similar for all scenarios. All dashed lines lie very close to each other, while the scenario for Catalonia in the EU has a slightly smaller welfare loss, shown in Figure 14 with a more detailed scale. This implies that the central government has significant bargaining power in possible negotiations. For example, the Spanish central government's veto on Catalonia's accession to the EU has essentially the same economic consequences for the rest of the Spanish regions as an amicable EU membership. We do not observe a strong change in the costs of independence for the regions, as the welfare loss only decreased by about 1.25 percentage points between 2001 and 2017.

As a robustness check, we use the results from our estimation including Social Connectedness in counterfactual experiments. Using our model with transfers and holding social connections constant, assuming that social ties between Catalonia and the other Spanish regions will not be eroded by its independence while changing the Catalan borders, we calculate results for our counterfactual experiments. Results for the scenario in which Catalonia is outside the EU are shown in Figure 15.[21] The pattern of the changes in exports, welfare, consumer and producer prices is very similar to the model without Social Connectedness. Similar patterns also arise in the other counterfactuals, suggesting that our results are robust.

7. CONCLUSIONS

Employing the empirical methods of the structural gravity model to a novel dataset that combines Spanish subnational and international trade data, we quantify the costs of Catalan regional independence using different levels of borders. This paper contributes to the literature on international economics and border effects. Specifically, we divide the international border dummy in the trade cost vector into more granular international, regional, and EU borders. We also emphasise the importance of using domestic country and regional sales to identify border effects accurately. Our analysis reveals substantial heterogeneity between country, regional, and EU border effects. Although regional borders within Spain and borders within the EU are thinner than international non-EU borders, they are negative and highly significant. Our findings highlight the substantial heterogeneity of regional border effects within Spain, which would not be evident if only country-level data were used to identify the Spanish border.

Our counterfactuals reveal adverse effects for an independent Catalonia and the remaining Spanish regions, with an expected welfare loss of between 6% and 17% for Catalonia and an average loss of roughly 2% for the rest of Spain. The analysis also reveals that fiscal transfers play a secondary role. These results shed light on the political economy involved in secession, with the Spanish government holding higher bargaining power.

Our findings can inform evidence-based policies and provide citizens with a better understanding of the economic consequences of trade border changes. Policymakers, therefore, should take into account that trade policies could have some influence on the independence process. Additionally, our findings help debunk the unsubstantiated political claims regarding regional fiscal redistribution, since fiscal and trade balances are intertwined.

The paper has, however, several limitations, which open exciting avenues for new research. First, it uses aggregate data at the country and regional levels to match the limitations of the sectors of the regional and international datasets. Second, it does not consider consumer boycotts as a reaction to the push for Catalan independence. For this analysis, new methods regarding directional trade borders should be developed. Third, the dynamics are limited to year-by-year analyses. An enhanced dynamic model including high-frequency data and movement of factors of production (i.e., capital and labour) might reveal additional insights. Fourth, the GE analysis is restricted to trade. Aspects such as employment and movement of firms and capital are further avenues for future research. Lastly, the data end in 2017 and only has regional-level data for Spain. With more recent data and potential regional trade data for more countries, one may investigate shocks such as Brexit and COVID-19, which we suggest as avenues for future research.

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DATA AVAILABILITY STATEMENT

The data are available upon request.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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NOTES

1. For further details about the background of the Catalan independence process, see the supplemental data online.
2. Our title 'Spain, split and talk' is inspired by the slogan 'Spain, sit and talk', but emphasises the quantification of a potential secession and the split of our data for Spain into its 17 autonomous regions.
3. Castells (2014) provides additional results and references on the effects of a potential Catalonian secession based on descriptive statistics or standard border effect estimates.
4. For details about the theoretical foundation and empirical strategy, see the supplemental data online.
5. Owing to space constraints, we had to delegate all further details on the theoretical model to the supplemental data online.
6. See https://www.c-intereg.es/.
7. There is neither an official source of administrative interregional trade data nor a consensus on constructing them. Some authors rely on data sources that use goods shipments to construct or complete regional trade flows (e.g., European Commission, 2014; Santamaría et al., 2023; Thissen et al., 2019).
8. See https://www.hacienda.gob.es/en-GB/CDI/Paginas/OtraInformacionEconomica/Sistema-cuentas-territorializadas.aspx/.
9. The fiscal balance data are quite parsimonious over time. For further details on the fiscal transfer data, see the supplemental data online.
10. Remember that border effects essentially estimate the difference between domestic and cross-border trade.
11. When referring to region-to-country borders, we also mean country-to-region borders, that is, we include all trade flows between Spanish regions and other countries, in both directions.
12. We did not include the EU variable in our gravity controls for this specification.
13. For example, Yotov (2012) shows the importance of domestic sales for distance elasticity estimates.
14. They use a dummy variable for trade within the same country, which can be transformed into our international border dummy.
15. We calculate country-specific border effects by assigning the country-specific border variable the value 0.5 whenever the country is the exporter or importer, such that the sum of the country-specific border variables is the overall border variable *BRDR_ALL*. In the setting of overall borders, the same results are obtained when assigning the country-specific border variable a value of 1 whenever the respective country is the exporter or, equivalently, whenever the country is the importer. For plots resulting from dissecting the borders from the remaining specifications shown in Table 2, see the supplemental data online.
16. For the figures for the remaining specifications shown in Table 2 over time, see the supplemental data online.
17. See https://data.humdata.org/dataset/social-connectedness-index/.
18. For another experiment to model the scenario in which Catalonia secedes from Spain but stays in the EU, by assigning it the same borders as Portugal's EU border, see the supplemental data online.
19. In this and the following scenario, we focus on the model with transfers, where Catalonia no longer contributes to nor receives payments from the common pool in the counterfactual. For the results for the model without transfers, see the supplemental data online.
20. Not being part of the WTO could also be modelled by switching a WTO dummy to 0. However, we model the worst-case scenario differently for three reasons: (1) we want to capture a very severe cut in preferable relationships and therefore discontinue all regional trade agreements; (2) as we focus on borders, we take a non-EU country border to capture a discontinuity of being an EU member; and (3) many countries were already WTO members in 2012 and 2017, the years of our cross-sectional regressions. Hence, the trade cost change implied by not being a WTO member anymore would be driven by the non-member countries that are presumably not the main trading partners of Catalonia.
21. For the results of our other counterfactual experiments, see the supplemental data online.

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