Journal of Regional Research
Investigaciones Regionales

ISSN: 1695-7253 e-ISSN: 2340-2717
investig.regionales@aecr.org
AECR - Asociación Española de Ciencia Regional
www.aecr.org
España – Spain

Does the location of company headquarters affect regional trade flows? Evidence from Spanish regions

Francisco Morillas-Jurado, Paz Rico-Belda, Bernardí Cabrer-Borrás

Does the location of company headquarters affect regional trade flows? Evidence from Spanish regions
Investigaciones Regionales - Journal of Regional Research, 64, 2026/1
Asociación Española de Ciencia Regional, España

Available on the website: https://investigacionesregionales.org/numeros-y-articulos/consulta-de-articulos

Additional information:

To cite this article: Morillas-Jurado, F., Rico-Belda, P., & Cabrer-Borrás, B. (2026). Does the location of company headquarters affect regional trade flows? Evidence from Spanish regions. Investigaciones Regionales – Journal of Regional Research, 2026/1(64), 67-89. https://doi.org/10.38191/iirr-jorr.26.001

Investigaciones Regionales – Journal of Regional Research (2026/1) 64: 67-89
https://doi.org/10.38191/iirr-jorr.26.001

Journal of Regional Research
Investigaciones
Regionales

Articles

Does the location of company headquarters affect regional trade flows? Evidence from Spanish regions

Francisco Morillas-Jurado, Paz Rico-Belda**, Bernardí Cabrer-Borrás****

Received: 02 April 2024
Accepted: 09 December 2025

Abstract:

This paper examines trade flows between Spanish regions to assess whether the location of company headquarters affects regional trade flows. To achieve this, various gravity models are used to assess whether economic and geographical factors influence the intensity of trade flows. This study utilises European regional data, provided by the EUREGIO database, focusing specifically on Spanish regions. The results show that factors such as inertia, territorial contiguity, economic attraction between regions, and the location of company headquarters play a significant role in determining the intensity of GVA trade flows between Spanish regions.

Keywords: Trade flows; Input-Output table; gross value added; gravity model; spatial autocorrelation and distance.
JEL Classification: C67; O10; R50.

¿Influye la ubicación de la sede central de una empresa en los flujos comerciales regionales? Datos de las regiones españolas

Resumen:

En este trabajo se obtienen y analizan los flujos comerciales entre las regiones españolas con el objetivo de verificar si la localización de las sedes centrales de las empresas influye en la intensidad de dichos flujos. Para ello, mediante modelos de gravedad, se evalúa si factores económicos y geográficos influyen en la intensidad de los flujos comerciales. Este estudio utiliza datos regionales europeos, proporcionados por la base de datos EUREGIO, y se centra específicamente en las regiones españolas. Los resultados muestran que factores como la inercia, la contigüidad territorial, la atracción economica entre regiones y el efecto de la localización de la sede central de las empresas influyen en la intensidad de los flujos comerciales del VAB entre las regiones españolas.

Palabras clave: Flujos comerciales; tabla de insumo-producto; valor añadido bruto; modelo de gravedad; autocorrelación espacial y distancia.
Clasificación JEL: C67; O10; R50.

* Departament d'Economia Aplicada, Facultat d'Economia, Universitat de València, Spain. Francisco.Morillas@uv.es
** Departament d'Análisis Econòmica, Facultat d'Economia, Universitat de València, Spain. Paz.Rico@uv.es
*** Departament d'Análisis Econòmica, Facultat d'Economia, Universitat de València, Spain. Bernardi.Cabrer@uv.es
Corresponding author: Paz.Rico@uv.es

1. Introduction

The momentum observed in trade flows of goods and services, driven by globalisation and production relocation, has both positive and negative repercussions for the economies of the regions. The development of trade flows offers great opportunities that lead to economic growth (Frankel and Romer, 1999; Winters et al., 2004). However, knowing the mechanisms of their development is important in order to be able to intervene, where necessary, and achieve economic and/or social improvements. Given that the production and distribution of goods and services directly impact the location and/or relocation of production centres, these also indirectly affect the territorial distribution of income between the different local Economic Activity Units (EAU) of the companies. Better understanding of the interrelationship of interregional flows would allow the design and implementation of economic policies aimed at mitigating potential interregional imbalances.

Reuveny and Li (2003) evaluate the effects of trade in terms of income imbalances and conclude that trade reduces this imbalance. Thissen et al. (2019) consider that economic development is interregional by nature, with the regional dimension of economic development being increasingly at the centre of political and academic debates. These authors emphasise that economic growth is determined by physical and technological proximity, which is facilitated by interregional and national cross-border interactions in trade, investment and knowledge. Similarly, economic disparities can generate social unrest and feelings of comparative grievance between regions (He and Duchin, 2009), which can be the source of conflicts. Therefore, knowing how interregional trade flows develop and evolve is crucial. A better knowledge of interregional trade flows will aid in formulating more appropriate economic policy decisions.

This paper analyses the gross value added (GVA) flows of Spanish regions to examine how the location of company headquarters affects these flows. We propose a methodology to obtain and analyse regional GVA flows, focusing on interregional flow matrices derived from the equilibrium models of Leontief (1953) and Ghosh (1958). The application of this methodology focuses on quantifying trade flows between Spanish regions, using the EUREGIO database which contains annual data for the period 2000-2010 for European regions (see Thissen et al., 2018). From this database, the GVA flows are derived, allowing for a characterisation of regions based on their dependence, orientation and intensity of flows. Once the GVA flows are obtained, the analysis proceeds using two complementary approaches.

The first approach carries out a descriptive study of the GVA flows. This provides a global idea of the interdependence between the regions, evaluating the exchanges between two regions: region *r*, of origin, and region *s*, of destination.

The second approach analyses the flows using a gravity model that incorporates geographical location factors, in line with the work of Santamaría et al. (2023). In economic literature, gravity models are widely used to explain trade flows between regions (Evenett and Keller, 2002). These models typically use (i) trade flows between regions as the endogenous variable, and (ii) explanatory variables characterising the asymmetric distribution of trade flows. Thus, some regressors take into account characteristics such as inertia, distance, contiguity, and income. The sample period covers the years 2000-2010, resulting in a sample of 3,179 observations.

This paper seeks to contribute to the current literature in several ways. Firstly, in this study, the accounting method is considered the most appropriate method for obtaining the regional GVA flow matrix, since this method adequately accounts for the GVA imputed to each region when company headquarters are located outside the production centres. Secondly, a gravity model is used to assess whether economic and geographic factors affect interregional flows, emphasising the effect of the location of company headquarters.

Following this introduction, the paper is structured as follows. Section 2 presents the theoretical framework. Section 3 includes the description and analysis of the database used. Section 4 presents the gravity model. Section 5 shows the empirical application of the gravity model to Spanish regions. The final section offers the conclusions of the study.

2. Theoretical framework

Traditional gravity models (Evenett and Keller, 2002; Baldwin and Taglioni, 2006; Anderson, 2010; Head and Mayer, 2014; Head and Mayer, 2021) are rooted in an adaptation of Newton's law of gravitation, which relates to the force of attraction between two objects, depending on their masses and the distance separating them. Similarly, the gravity model is a tool used in a wide range of empirical fields (Baldwin and Taglioni, 2006; Kabir et al., 2017) to measure trade between countries. The Tinbergen (1962) model, one of the earliest macroeconomic models, suggests that trade between two countries depends mainly on two factors: the economic size of the countries and the distance between them. Building on this and inspired by the spatial econometrics proposed by Anselin (1988, 2003), an additional factor derived from substantive spatial autocorrelation or dependence is incorporated.

The gravity model has played an important role in research on international trade, as it provides a simple and empirical way to evaluate and predict trade flows between countries. While Tinbergen's original model was relatively simple, it has since been expanded and modified to include additional factors that affect trade, such as trade policies, tariff barriers, and the characteristics of the economies. Head and Mayer (2014) provide a comprehensive review of the literature that uses the gravity model to explain trade flows between countries. More recently, Kabir et al. (2017) and Shahriar et al. (2019) have conducted a thorough review of recent developments in the gravity model applied to trade flow analysis. The gravity model remains a widely used tool in contemporary research. For instance, Nitsch and Wolf (2013) demonstrate the persistence of the border effect in internal German trade following reunification. Similarly, Wrona (2018) uses the gravity model to measure intranational trade integration in Japan and examine the existence of a border effect. Mayer et al. (2019) evaluate the benefits of intra-European trade promoted by the economic integration of the European Union, as well as the potential impact of its disintegration. Serrano-Domingo et al. (2020) analyse the immigration flows between countries. Yotov (2021) argues that trade flows between regions within the same country have been insufficiently considered and analyses the importance of domestic trade flows in the estimation of the gravity model of trade. Finally, Santamaría et al. (2023) analyse regional trade patterns in Europe, where distance, borders, and political divisions are key determinants.

This paper specifies a gravity model, following the approach of Santamaría et al. (2023), which includes the effect of the location of company headquarters. Head and Mayer (2019) refine traditional gravity models by including a new type of friction, highlighting the challenges of selling in markets geographically distant from a company's headquarters. Similarly, Wang (2021) examines how the location of corporate headquarters affects international trade dynamics. Using Chinese customs data, Wang finds that the headquarters effect accounts for approximately 20% of China's exports in 2000, and he argues that ignoring this effect could introduce bias into quantitative analyses of trade between the USA and China.

3. Database and descriptive analysis

This study uses the EUREGIO database, see Thissen et al. (2018), which provides information on interregional flows between the NUTS II regions of the EU as well as a supra-regional entity labelled "rest of the countries of the world", encompassing a total of 248 regions. The database covers the period from 2000 to 2010 and includes data on 14 production sectors.

To analyse the Spanish regional economy the information provided by EUREGIO must first be reorganised through successive aggregations. Specifically, the 248 regions are grouped into 21 and all 14 sectors are aggregated into a single sector. The 21 regions include the seventeen Spanish regions, together with the two Spanish autonomous cities Ceuta and Melilla, plus two other supra-regions; the first supra-region encompasses the rest of the EU's NUTS II, and the second supra-region includes the rest of the countries in the world that the database includes. This gives the matrices of interregional flows of intermediate consumption of goods and services (Matrix **Z**) and the matrix of interregional flows of final demand for goods and services (Matrix **F**) for the 21 regions (see Tormo et al., 2023).

The GVA matrix is not generally accessible and must be estimated. For its estimation, the EUREGIO database provides the flows of intermediate goods and services matrix, **Z**, and the flows of final goods and services matrix, **F**. Using the accounting method, based on the Leontief (1953) model, the production flow matrix **X** is obtained as the sum of **Z** and **F**. Subsequently, the GVA flow matrix, **V**, is calculated as the difference between $\mathbf{X}'$ and **Z**.

The multi-regional input-output Leontief model is expressed by the following equation[1]:

$$z_{ij}^{rs} + f_{ij}^{rs} = x_{ij}^{rs} \tag{1}$$

where the superscripts denote regions *r* and *s*, and subscripts denote sectors *i* and *j*.

This relationship can be expressed in matrix terms by the equation **(1.a)**:

$$\mathbf{Z} + \mathbf{F} = \mathbf{X} \tag{1.a}$$

where[2]:

Z is a square matrix of interregional flows of intermediate consumption **Z**=$[z^{rs}]$.

F is a square matrix of interregional flows of demand for final goods **F** = $[f^{rs}]$

X is a square matrix of interregional flows of production **X** = $[x^{rs}]$

Similarly, from the supply perspective, the Ghosh (1958) model is used to express by the equation **(2)**:

$$z^{rs} + v^{rs} = x^{rs} \tag{2}$$

This relationship can be expressed in matrix terms as the equation **(2.a)**:

$$\mathbf{Z} + \mathbf{V} = \mathbf{X}' \tag{2.a}$$

where **V** is a square matrix of interregional flows of value added **V**=$[v^{rs}]$.

From the equation **(1.a)** the matrix of production **X** is obtained. Similarly, from the equation **(2.a)** the GVA[3] flow matrix is obtained, matrix **V**.

In summary, the process described provides four matrices of interregional flows for each year of the period 2000 to 2010: a total of 44 square matrices of interregional flows of dimension 21 x 21[4].

The matrices of interregional flows enable the characterisation of regions based on the intensity of the interregional flows. Intensity is defined as the volume of flows originating in region *r* and destined for one or more other regions.

With respect to the results obtained for the GVA flow matrix using the accounting method, the interpretation of an Input-Output Table from the supply perspective is carried out by studying, by columns, the flow matrices **Z**, **V** and $\mathbf{X}'$. The concept is as follows: to produce a unit of a good or service requires primary inputs from the region itself and from other regions. These inputs configure an interregional square matrix of primary input flows, whose generic element is z^{rs}. The production of these goods and services in a region may originate in the same region or in other regions. The flows of the goods and services produced configure the square matrix of interregional production flows, whose generic element is x^{rs}. The difference between the matrix of interregional production flows and the matrix of interregional flows of primary inputs defines the matrix of GVA flows, **V**, whose generic element is v^{rs}.

---

[1] The standard input-output notation is used, where bold capital letters denote matrices (X) and bold lowercase letters denote vectors (x).
[2] In this paper, sectors are aggregated into a single sector, so the analysis focuses exclusively on regions.
[3] There are different techniques to estimate GVA. Among these are the expenditure method, the income method, and the value-added method (see Appendix A).
[4] Data can be provided by the authors upon request.

This process of deriving the GVA flow matrix from the intermediate consumption flow matrix and the production matrix is referred to as the accounting method.

It is important to emphasise that some elements of the GVA flow matrix, **V**, have a negative sign[5]. The negative sign in a GVA flow would indicate, for a given region *r*, that the flow of production of goods and services, x^{rs}, coming from this region *r* is lower than the flow of primary inputs z^{rs}, from the same origin. The negative value of an interregional flow of the GVA v^{rs} (when analysing the matrix **V**, interregional purchases, by columns) would be to the detriment of the purchasing region *r* (since its GVA ultimately decreases) and to the benefit of the selling region *s*. In this case, using the accounting method, an underestimation of the GVA of region *r* would occur.

From an economic point of view, GVA is an economic macromagnitude obtained from the difference between production and primary inputs. Furthermore, the GVA is basically configured by the sum of the remuneration of the capital factor, the gross operating surplus, and the remuneration of the labour factor.

Table 1 presents the GVA trade flow matrix for the year 2009 obtained using the accounting method using equation **(2.a)**. Analysing the matrix by rows and focusing on negative values reveals the GVA received from other regions. The regions that benefit most from interregional GVA flows are the following: Community of Madrid, Catalonia, and the Basque Country. The sum of the negative elements by column indicates the amount of GVA that each region gives to the others. The most disadvantaged in percentage terms are Extremadura, the Region of Murcia and the Canary Islands.

Figure 1 confirms that the regions that benefit the most are the Community of Madrid, followed by Catalonia and the Basque Country, regions where the largest number of company headquarters are concentrated. The regions most negatively affected by interregional GVA flows are Extremadura, the Region of Murcia and the Canary Islands, followed by Castilla-La Mancha, La Rioja, Castilla-León, the Balearic Islands, and Cantabria.

In conclusion, the presence of both positive and negative interregional flows of GVA between regions implies that some regions benefit from trade flows, while others are disadvantaged. Furthermore, it is important to note that negative GVA flows entail, from an accounting point of view, an underestimation (overvaluation) of the regional GVA, and consequently an underestimation (overvaluation) of its own GDP[6].

These results invite further study of the possible causes of these imbalances, which include, among others, the *effect of territorial contiguity*, the company *headquarters effect*, *temporal inertia,* and *spatial inertia*.

To measure the behaviour of a region through its trade flows, the statistical coefficient, CP^{rs} (Pavía-Miralles and Cabrer-Borrás, 2004), is used. The coefficient CP^{rs} is expressed as:

$$CP^{rs} = \frac{1}{2}\left(\frac{x^{rs}}{\sum_s x^{rs}} + \frac{x^{rs}}{\sum_r x^{rs}}\right)$$

This coefficient distinguishes the links between regions according to the origin of each trade flow and quantifies the relative importance of interregional flows by weighting each trade flow by the total flows of the regions. The CP^{rs} coefficients highlight, within the total set of flows, those flows that are of special importance for the sending region, the receiving region or both.

---

5 The possibility that the GVA flow in a production sector (region) presents a negative value is considered in: EUROSTAT (1995); Hernández García (1997) and the Official Journal of the European Union (2013).

6 The GDP is obtained after adding to the GVA the indirect taxes that are levied on production and subtracting the subsidies that companies receive.

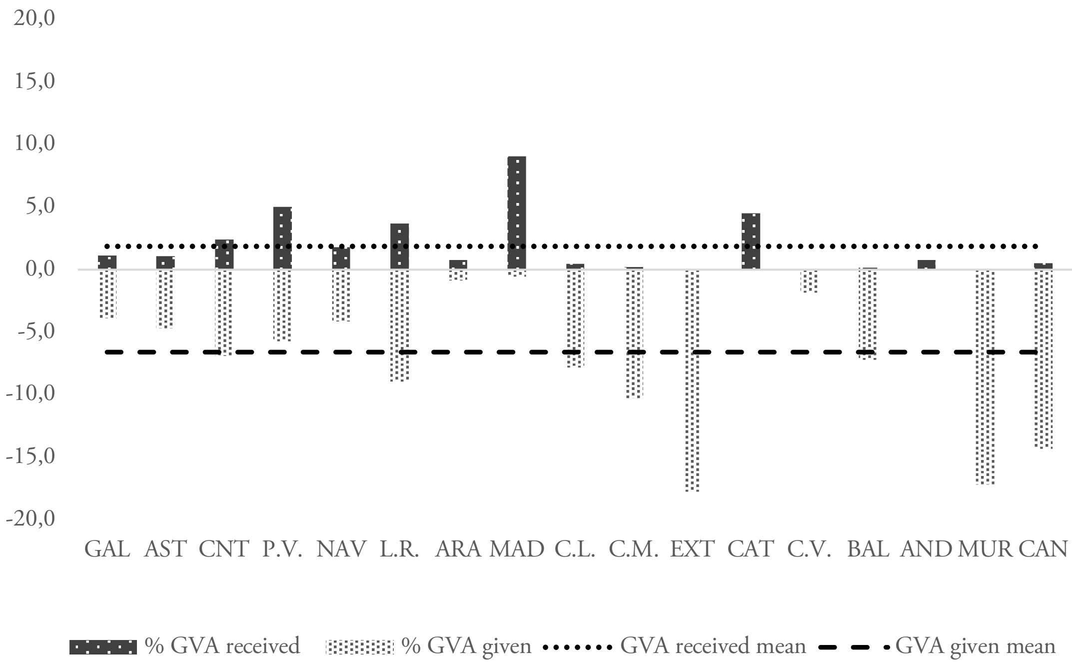
Table 1.
Matrix of GVA interregional flows. Year 2009. (Units million €)

	GAL	AST	CNT	P.V.	NAV	L.R.	ARA	MAD	C.L.	C.M.	EXT	CAT	C.V.	BAL	AND	MUR	CAN
GAL	50 971	-41	-160	976	-74	-175	266	5 141	220	-88	296	2 577	752	-56	1 373	279	772
AST	352	20 615	5	462	63	-92	319	2 318	218	122	334	1 305	594	-32	1 001	-111	189
CNT	328	85	10 355	387	55	-33	163	1 030	260	155	-53	936	500	99	691	-197	323
P.V.	-71	-68	-122	54 103	-272	14	-251	6 137	-446	-579	-546	2 699	654	-226	978	-627	306
NAV	350	42	-7	807	13 986	70	330	1 258	200	88	-109	1 337	552	51	782	-163	354
L.R.	272	134	61	280	163	5 876	297	285	214	151	18	450	337	71	264	-255	135
ARA	371	-20	-87	807	-43	-61	26 507	1 761	157	-39	33	2 458	874	223	1 052	23	362
MAD	-1 925	-817	-84	-3 218	19	138	-34	131 581	-3 043	-1 996	-866	5 267	-1 307	-640	1 246	-1 594	-1 222
C.L.	717	281	85	1 661	183	-44	598	6 134	51 680	306	641	2 727	1 456	-151	1 581	819	-25
C.M.	767	209	35	1 481	213	-41	792	5 297	599	32 836	742	2 916	1 653	205	1 536	828	439
EXT	753	554	885	1 573	966	626	1 332	3 689	730	1 130	15 130	3 752	1 548	1 255	2 461	403	1 119
CAT	-161	-207	-146	-455	-274	-34	-507	-1 030	-606	-612	-927	123 276	-422	-601	1 674	-1 145	-204
C.V.	808	172	77	1 172	310	57	749	6 397	148	191	183	3 987	84 377	539	2 170	1 404	1 225
BAL	601	183	-13	669	130	-30	359	2 383	572	289	78	2 220	781	20 604	1 265	348	436
AND	77	-101	-100	1 098	46	-30	289	4 247	82	-139	-297	1 599	479	850	100 109	-282	19
MUR	1 059	1 081	1 069	1 777	1 148	756	1 605	4 936	394	1 349	977	4 751	1 680	1 350	2 987	25 182	1 548
CAN	475	210	-94	615	-27	-79	277	3 545	938	362	127	1 851	731	93	1 490	500	31 784
Total GVA	55 794	22 326	11 773	64 243	16 628	6 934	33 134	185 313	52 370	33 586	15 787	164 287	95 340	23 698	122 738	25 452	37 604
% GVA	5.77%	2.31%	1.22%	6.64%	1.72%	0.72%	3.43%	19.16%	5.42%	3.47%	1.63%	16.99%	9.86%	2.45%	12.69%	2.63%	3.89%
% GVA given	-3.87%	-4.69%	-6.91%	-5.72%	-4.14%	-8.93%	-0.86%	-0.56%	-7.82%	-10.28%	-17.72%	0.00%	-1.81%	-7.20%	0.00%	-17.18%	-14.31%
% GVA received	1.11%	1.08%	2.41%	5.02%	1.77%	3.68%	0.79%	9.05%	0.47%	0.18%	0.00%	4.49%	0.00%	0.18%	0.77%	0.00%	0.00%
Production	113 431	42 930	21 190	121 891	30 849	10 995	58 129	227 697	105 927	65 811	26 044	144 325	160 703	41 439	120 289	48 907	1 699
% Prod.	8.05%	3.05%	1.50%	8.65%	2.19%	0.78%	4.12%	16.15%	7.51%	4.67%	1.85%	10.24%	11.40%	2.94%	8.53%	3.47%	4.67%
% GVA / Prod.	37.30%	39.10%	40.60%	37.10%	38.00%	41.10%	38.90%	48.30%	39.30%	39.70%	39.40%	79.60%	44.60%	43.80%	77.60%	34.50%	44.30%

Note: GAL= Galicia, AST= Asturias; CNT= Cantabria: P.V.= Basque Country; NAV= Navarre; L.R.= La Rioja; ARA= Aragon; MAD = Community of Madrid; C.L.= Castilla-León; C.M .= Castilla-La Mancha; EXT = Extremadura; CAT = Catalonia; C.V.= Valencian Community; BAL= Balearic Islands; AND= Andalusia; MUR= Region of Murcia; CAN= Canary Islands.
Source: compiled by the authors based on the matrices of GVA interregional flows for 2009, EUREGIO.

 ISSN: 1695-7253 e-ISSN: 2340-2717

FIGURE 1.
Regions benefitting from/disadvantaged by % GVA flows



Note: GAL= Galicia, AST= Asturias; CNT= Cantabria: P.V.= Basque Country; NAV= Navarre; L.R.= La Rioja; ARA= Aragon; MAD= Community of Madrid; C.L.= Castilla-León; C.M.= Castilla-La Mancha; EXT= Extremadura; CAT= Catalonia; C.V.= Valencian Community; BAL= Balearic Islands; AND= Andalusia; MUR= Region of Murcia; CAN= Canary Islands.
Source: compiled by the authors using data from Table 1.

Table 2 presents the estimates of the CP^{rs} coefficients for the year 2009, which have been calculated from the GVA trade flow matrix. The following results in Table 2 are of particular interest:

- The **CP** matrix presents negative values for some of the coefficients, CP^{rs}, affirming that they truly reproduce the direction of the "original" trade flows.
- The elements of greatest magnitude are found on the main diagonal of the matrix, which indicates that the most relevant GVA flows correspond to the internal flows of each region, produced within each of the regions.
- The analysis by columns of the **CP** matrix allows us to verify that there are several coefficients that stand out from the rest; those corresponding to the autonomous communities of Madrid and Catalonia. These results indicate that these are regions with a strong capacity to emit GVA flows.
- When analysing the elements of the **CP** matrix by row, the most important values are seen to be concentrated in the regions of Extremadura, Murcia, and Castilla-La Mancha, which indicates their high receiving capacity for GVA flows.

Figure 2 shows the main GVA flows between the different regions. The maps show that the most intense flows correspond to the regions closest to each other, and that the most relevant relative flows originate in the regions of Madrid and Catalonia. Therefore, these results corroborate the fact that the largest regions are those with greater intensity in trade flows.

TABLE 2.
Matrix of CP* calculated from the matrix of flows of GVA (Matrix V)

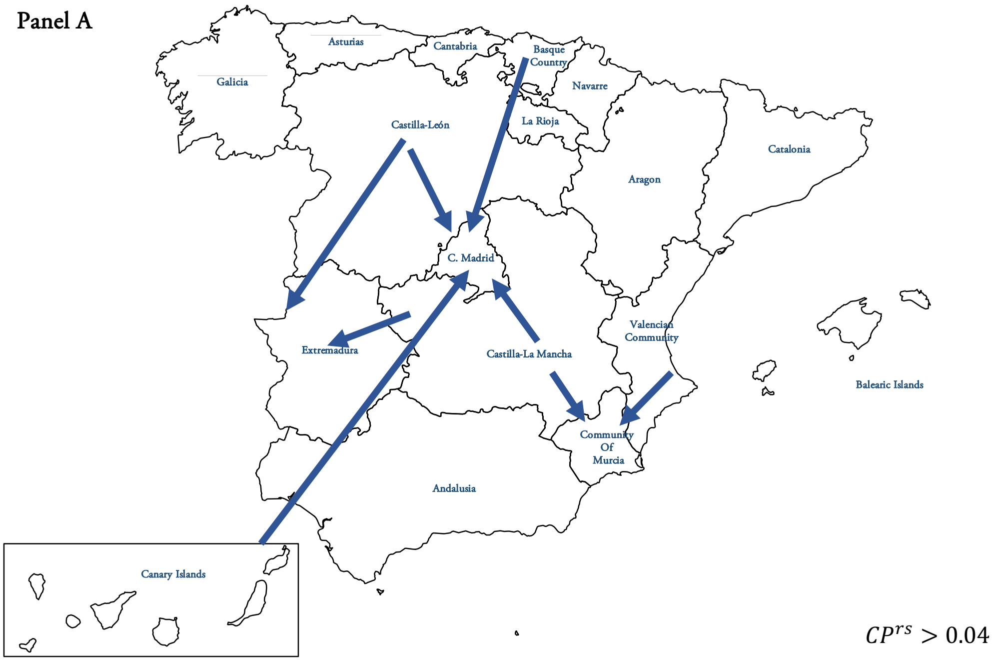
	GAL	AST	CNT	P.V.	NAV	L.R.	ARA	MAD	C.L.	C.M.	EXT	CAT	C.V.	BAL	AND	MUR	CEU	MEL	CAN
GAL	0.820	0.001	-0.005	0.014	0.000	-0.009	0.007	0.036	0.002	-0.002	0.032	0.020	0.009	0.002	0.012	0.027	-0.004	-0.001	0.018
AST	0.007	0.769	0.001	0.009	0.003	-0.008	0.010	0.028	0.004	0.002	0.025	0.019	0.009	0.000	0.017	-0.001	-0.001	0.031	0.008
CNT	0.009	0.005	0.694	0.010	0.003	-0.005	0.007	0.012	0.008	0.004	0.001	0.023	0.011	0.005	0.019	-0.005	-0.001	0.013	0.014
P.V.	-0.002	0.001	0.000	0.799	-0.001	0.011	-0.001	0.047	-0.008	-0.006	-0.006	0.019	0.009	-0.001	0.007	0.005	-0.008	-0.008	0.011
NAV	0.008	0.003	0.000	0.018	0.688	0.005	0.012	0.017	0.004	0.003	-0.001	0.025	0.012	0.003	0.017	0.000	-0.002	-0.002	0.013
L.R.	0.013	0.010	0.007	0.008	0.014	0.653	0.016	-0.001	0.010	0.007	0.006	0.020	0.012	0.006	0.013	-0.008	0.007	0.005	0.009
ARA	0.005	0.000	-0.003	0.012	0.000	-0.001	0.720	0.013	0.001	-0.001	0.015	0.029	0.012	0.010	0.013	0.017	-0.004	0.001	0.011
MAD	-0.013	-0.002	0.023	-0.024	0.016	0.033	0.014	0.812	-0.027	-0.012	0.014	0.020	0.000	-0.004	0.007	0.010	-0.011	0.016	-0.015
C.L.	0.011	0.009	0.006	0.025	0.008	0.002	0.015	0.047	0.820	0.007	0.043	0.020	0.018	0.000	0.015	0.035	-0.004	-0.005	0.004
C.M.	0.012	0.009	0.005	0.020	0.009	0.001	0.019	0.045	0.009	0.738	0.050	0.029	0.021	0.010	0.017	0.043	-0.006	0.006	0.012
EXT	-0.004	0.004	0.026	0.017	0.024	0.025	0.015	0.023	-0.005	0.002	0.464	0.037	0.007	0.022	0.021	0.008	0.039	0.048	0.016
CAT	0.000	0.002	0.003	0.001	0.001	0.006	-0.003	-0.001	-0.003	-0.003	-0.005	0.817	0.002	-0.009	0.012	0.011	-0.005	0.027	0.000
C.V.	0.009	0.011	0.014	0.012	0.016	0.015	0.019	0.032	0.000	0.006	0.030	0.021	0.782	0.014	0.014	0.064	-0.004	-0.005	0.021
BAL	0.012	0.008	0.000	0.013	0.007	-0.001	0.012	0.034	0.012	0.007	0.006	0.036	0.016	0.707	0.022	0.024	0.004	0.005	0.015
AND	0.003	0.002	0.001	0.018	0.006	0.005	0.010	0.023	0.001	0.002	0.016	0.011	0.009	0.024	0.796	0.018	0.105	-0.008	0.003
MUR	-0.003	0.020	0.034	0.009	0.027	0.037	0.014	0.022	-0.011	0.003	0.036	0.032	-0.007	0.017	0.019	0.515	0.043	0.002	0.012
CEU	0.006	0.003	0.004	0.009	0.005	-0.002	0.006	0.029	0.005	0.008	0.004	0.023	0.012	0.006	0.003	0.004	0.549	0.002	0.003
MEL	0.006	0.001	0.004	0.010	0.006	0.001	0.007	0.017	0.008	0.008	0.002	0.021	0.011	0.009	0.013	0.003	0.006	0.578	0.006
CAN	0.007	0.008	-0.003	0.009	0.000	-0.005	0.007	0.042	0.016	0.008	0.007	0.023	0.013	0.004	0.021	0.027	0.001	0.001	0.731

Note: GAL= Galicia, AST= Asturias; CNT= Cantabria: P.V.= Basque Country; NAV= Navarre; L.R.= La Rioja; ARA = Aragon; MAD = Community of Madrid; C.L.= Castilla-León; C.M. = Castilla-La Mancha; EXT= Extremadura; CAT= Catalonia; C.V.= Valencian Community; BAL= Balearic Islands; AND= Andalusia; MUR= Region of Murcia; CEU= Autonomous City of Ceuta; MEL= Auton. City of Melilla; CAN= Canary Islands.
Source: compiled by the authors based on the EUREGIO database.

* It should be noted that the CP^{rs} coefficients presented are derived from Pavía-Miralles and Cabrer-Borrás (2004). Specifically, they represent the average of the coefficients from the GVA flow matrix and its transposed matrix, thereby capturing the intensity of flows both in terms of GVA acquisition and transfer.

FIGURE 2.
GVA flows between regions using the coefficient CP^{rs}

Panel A



Panel B

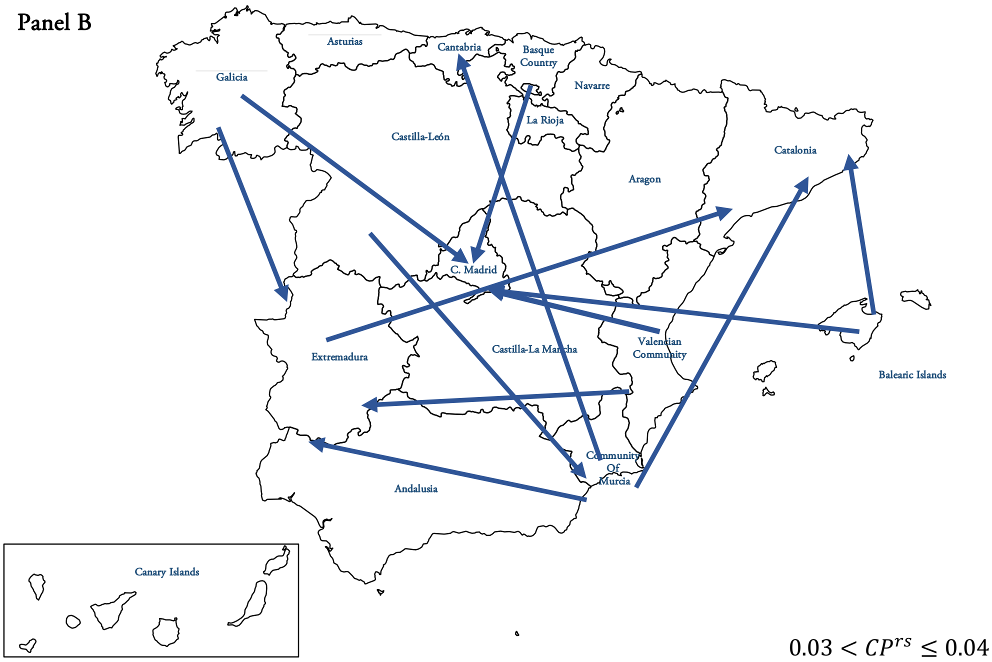
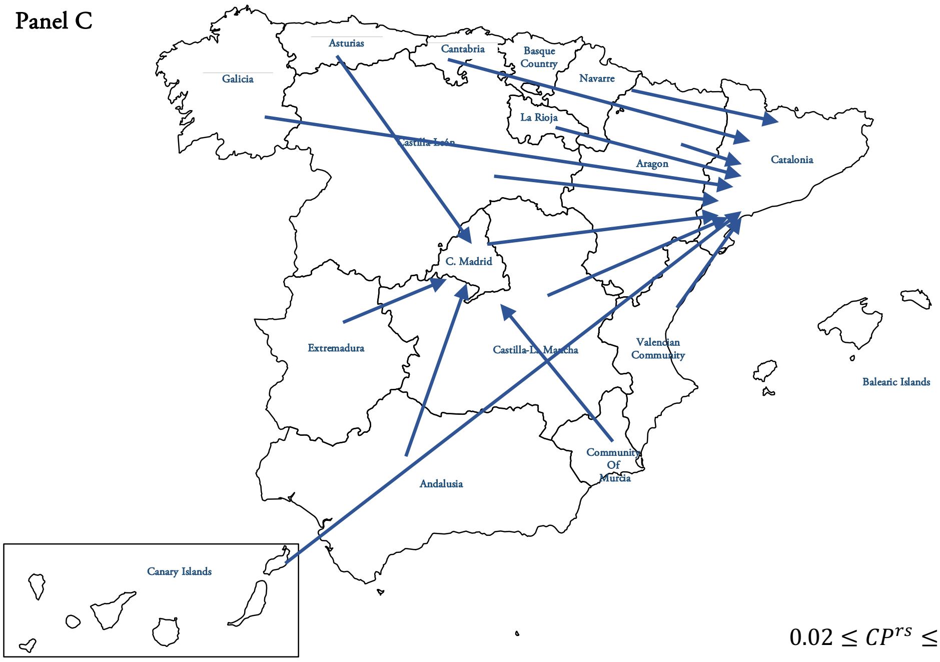


FIGURE 2. CONT.
GVA flows between regions using the coefficient CP^{rs}

Panel C



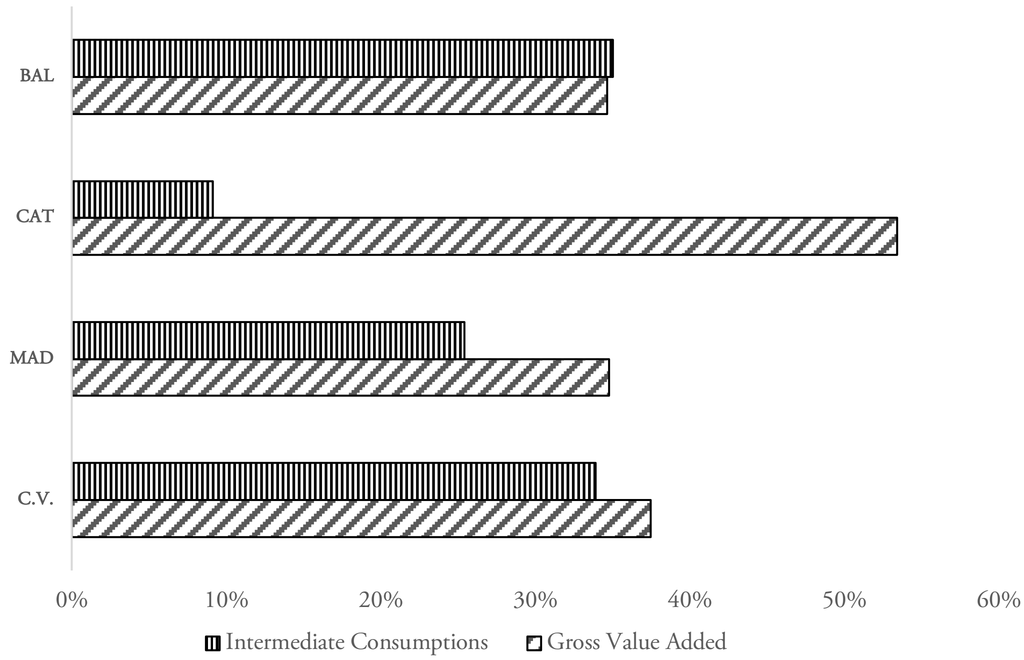
$0.02 \leq CP^{rs} \leq 0.03$

Note: The values of intraregional trade flows (the elements of the main diagonal of matrix V) have not been considered in the analysis. The arrows represent the flow of GVA between regions using the coefficients, in **CP** matrix, that exceeds the specified thresholds. Their direction indicates the origin region and the receiving region. Additionally, the thickness of the arrows represents the intensity of the flows. Panel C shows the information only for Madrid and Catalonian regions.
Source: compiled by the authors based on Table 2.

Figure 3 shows the production structure of the regions of the Balearic Islands, Catalonia, Community of Madrid and the Valencian Community, which are analysed through the intraregional flows of intermediate consumption, matrix **Z**, and GVA, matrix **V**. The results show that the production structures, from a supply perspective, are similar for the Community of Madrid, the Valencian Community and the Balearic Islands, while the Catalonia production system is characterised by presenting very high values in GVA flows to the detriment of intermediate consumption flows.

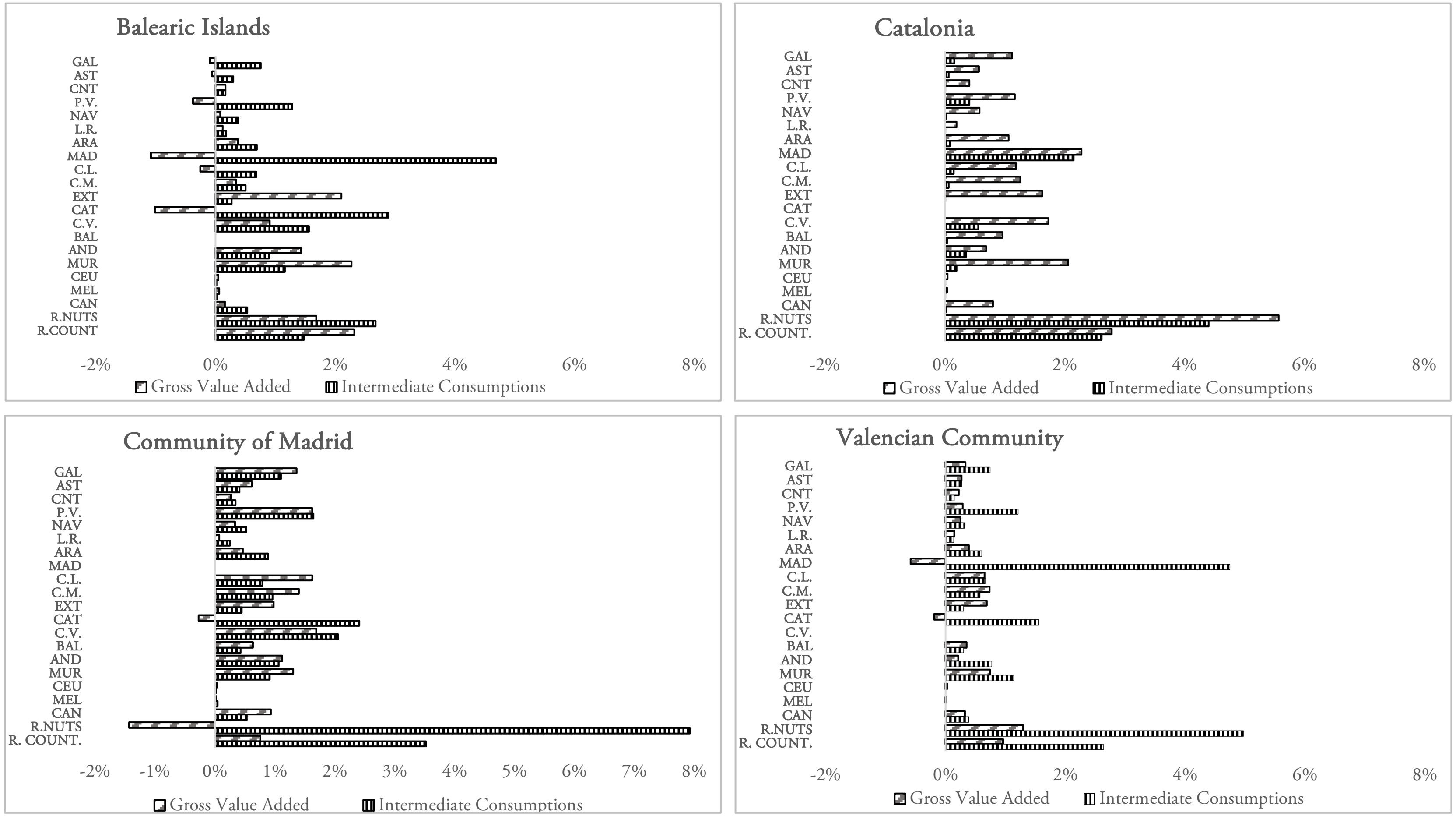
Finally, the interregional production structure of the four regions considered, see Figure 4, shows that the Balearic Islands present a negative GVA flow with the communities of Madrid, Catalonia, and the Basque Country. However, it should be noted that most of the company headquarters are in the Community of Madrid, Catalonia and the Basque Country. The Community of Madrid presents a considerably negative GVA flow with the rest of EU NUTS II, and a more moderate negative flow with Catalonia. In contrast, all Catalonia GVA flows are positive. Finally, in the Valencian Community, this region presents a negative flow with Catalonia and a much more intense negative flow with the Community of Madrid.

FIGURE 3.
Structure of intraregional intermediate consumptions and GVA of the Balearic Islands, Catalonia, Community of Madrid, and the Valencian Community



Note: MAD = Community of Madrid; CAT= Catalonia; C.V.= Valencian Community; BAL= Balearic Islands.
Source: compiled by the authors.

Figure 4.
Structure of interregional intermediate consumptions and GVA of the Balearic Islands, Catalonia, Community of Madrid, and the Valencian Community



Note: acronims are as in Figure 1.
Source: compiled by the authors.

4. Econometric gravity model

In order to justify and quantify the possible causes of interregional flows, an econometric gravity model is specified. Imbalances between actual flows (data) and potential flows under the hypothesis of independence (predicted or estimated flows) are linked causally through this gravity model. The proposed gravity model is inspired by the model put forward by Santamaría et al. (2023).

As discussed in Section 2, the gravity model is an adaptation of Newton's model. In this context, applying the gravity model yields a mathematical equation that relates interregional flows to the factors characterising the origin and destination regions of the flows.

In the case under study, the endogenous variable captures flow imbalances as represented by the elements of matrix **Y**. Each element y^{rs} of the square flow matrix **Y** is obtained from the following equation:

$$y^{rs} = \frac{x^{rs}}{x^{*rs}} \tag{3}$$

where y^{rs} is a generic element of matrix **Y**; x^{rs} is a generic element of the matrix of real interregional flows[7]; and x^{*rs} is a generic element of the matrix of interregional flows estimated under the independence hypothesis:

$$x^{*rs} = \sum_{r} x^{rs} \cdot \sum_{s} x^{rs} \tag{3.a}$$

The original data matrices are normalised, that is, they are weighted so that the sum of the elements of the row-transformed matrix is equal to one. Furthermore, in the event that any element of the flow matrix has a negative value, a rescaling of the elements of the original matrix is carried out so that, in the transformed matrix, all the elements of the interregional flow matrix are positive. From the rescaled matrix, the flow matrix estimated under the independence hypothesis is calculated.

Each of the elements of the matrix **Y**, that is, y_t^{rs}, measures, for year *t*, the deviation between the real flow from region *r* to region *s* and the estimated or predicted flow under the hypothesis of independence. A high value of the y_t^{rs} ratio would point to a greater imbalance in the flow between both regions.

In short, the gravity model considered is specified from the following function:

$$y_t^{rs} = \exp\left\{\sum_{m} \beta_m \, z_{mt}^{rs}\right\} \tag{4}$$

where z_{mt}^{rs} is a set of variables that determine the interregional flows between regions *r* and *s*, for year *t*, and β_m are the parameters that affect these *m* variables. z_{mt}^{rs} includes regressors representing the attraction between the origin and destination regions. Specifically, three variables capturing the intensity of interaction between regions have been used in this study: the geographical distance between regions, territorial contiguity (i.e., whether two regions share a common border) and an economic attraction variable. We define the economic attraction variable between regions *r* and *s* for year *t* as:

[7] For each year in the sample period (2000–2010), there are four matrices available: the matrix of intermediate consumption flows (Z), the matrix of final demand flows (F), the matrix of production flows (X), and the matrix of GVA flows (V). However, our analysis focuses on the GVA matrix, as it provides a more direct measure of the economic value generated in each region. Unlike intermediate or final demand flows, which may reflect reallocation or redistribution of value, GVA flows are better suited to capturing the net contribution of regional productive activities to the overall economy.

$$wg_t^{rs} = \frac{gdp_t^{\alpha r\cdot}\ gdp_t^{\beta . s}}{dist^{\gamma rs}\ \left(1 - \varphi\ contiguity^{rs}\right)} \tag{5}$$

where $\alpha = 1$, $\beta = 1$ and $\gamma = 1$. $gdp_t^{r\cdot}$ represents the GDP per capita of region *r*, the origin of the flow, for year *t*, while gdp_t^{s} represents the GDP per capita of region *s*, the destination of the flow, for the same year. $dist^{rs}$ measures the kilometer distance between regions *r* and *s*. When regions *r* and *s* share a border, $contiguity^{rs} = 1$. In this case, the distance between two contiguous regions is reduced by 10%, $\varphi = 0.1$ In short, the numerator of equation **(5)** captures the economic mass or attractiveness of the origin and destination regions, while the denominator quantifies the friction or barriers to interaction them.

According to Feenstra (2015) and Peeters & Chasco (2013), gravity model estimators can suffer from bias problems. To address such problems, it is recommended to include variables that capture factors affecting trade flows from both source and destination regions. Consequently, the proposed model incorporates dummy variables that capture the fixed effects of interregional flows.

From equation **(4)** the behavioural equation or econometric model **(6)** is specified. To do this, logarithms are taken in equation **(4)**, including the characteristics of the origin and destination regions of the interregional flows, and a random error term is added. Moreover, in order to analyse the effect of headquarters location on the intensity of flows, we incorporate a proxy variable H^r . The gravity model is specified through the following behavioural equation:

$$\log(y_t^{rs}) = \sum_r^R \gamma^{Or}\ DS^{r} + \sum_s^S \gamma^{Ds}\ DD^{s} + \delta\ T_t + \sum_m \beta_m\ z_{mt}^{rs} + \theta H^r + u_t^{rs} \tag{6}$$

where:

y_t^{rs} are the imbalance flows between region *r* and *s* at time *t*.

DS^r are dummy variables that represent the fixed effects of the region of origin of the flows.

DD^s are dummy variables that represent the fixed effects of the destination region of the flows.

T_t is a variable that includes possible temporal changes throughout the sample period.

z_{mt}^{rs} are variables that represent characteristics of the regions of origin of the flows, those of destination or simultaneously of both regions at time *t*.

H^r is a proxy variable the location.

u_t^{rs} is a random variable.

As control variables, a temporal variable and dummy variables representing the fixed effects of the origin and destination regions of interregional flows are included. As explanatory factors, the distance in kilometres between the origin and the destination regions[8], a dummy variable for the regional contiguity, and the economic attraction variable, see equation **(5),** are considered. The parameter θ captures the effect of the location of company headquarters on the intensity of interregional flows.

The variable amount of VAT is used as a proxy variable to represent the location effect of the company headquarters, see Appendix B. VAT is a consumption tax collected by the selling company at the point of sale. Although the tax is collected where the transaction with the final customer takes place, it is reported and paid to the tax authorities by the company's headquarters. As a result, from an administrative and statistical perspective, VAT revenues are typically recorded in the region where the company is fiscally registered, which usually corresponds to the location of its headquarters. Therefore, VAT records serve as a reasonable proxy for the geographical location of company headquarters.

To account for the dynamic nature of flows between regions, the gravity model specified in equation **(6)** is extended by including the lagged dependent variable, $\log(y_{t-1}^{rs})$. This inclusion captures potential persistence in interregional flows over time. The resulting behavioural equation is given by:

[8] The distance between the Spanish regions is obtained from the website distance.to.

$$\log(y_t^{rs}) = \sum_r^R \gamma^{Or}\, DS^r + \sum_s^S \gamma^{Ds}\, DD^s + \delta\ T_t + \sum_m \beta_m\ z_{mt}^{rs} + \theta H^r + \rho_1\ \log(y_{t-1}^{rs}) + u_t^{rs} \qquad (7)$$

where the parameter ρ_1 quantifies the *temporal inertia* of imbalances between actual and predicted trade flows under the independence hypothesis.

Finally, following the approach of Anselin (1988, 2003), the possible *spatial inertia* (i.e., substantive spatial autocorrelation) is introduced into the gravity model through the lagged endogenous variable, weighted by the economic attraction variable, $wg_{t-1}^{rs}.\log(y_t^{rs})$. In this way the following behaviour equation is obtained:

$$\log(y_t^{rs}) = \sum_r^R \gamma^{Or}\, DS^r + \sum_s^S \gamma^{Ds}\, DD^s + \delta\ T_t + \sum_m \beta_m\ z_{mt}^{rs} + \theta H^r + \rho_2\ wg_{t-1}^{rs}.\log(y_{t-1}^{rs}) + u_t^{rs} \qquad (8)$$

The parameter ρ_2 quantifies the *spatial inertia* of imbalances between actual and predicted trade flows under the independence hypothesis.

5. Application of the model to the Spanish regions

Based on the full gravity model specified in equation (6), we analyse a set of alternative model specifications, presented in Table 3 and referred to as Model 1 to through 4.

We must note that the term $\log(y_t^{rs})$ into the gravity model proposed in equation (6), is an endogenous variable and it is the logarithm of the imbalance of interregional flows between region *r* and region *s* over the sample period *t* and is denoted by. This variable was derived from the interregional GVA flows.

Analysing the results in Table 3, Models 1 to 4 show that the coefficient associated with the contiguity variable in the gravity model is statistically significant. Furthermore, the expected sign of this coefficient is negative, indicating that regions sharing a border tend to experience lower imbalances in interregional flows.

These models also show that the coefficient associated with the economic attraction variable[9] is statistically significant. The coefficient is also negative, suggesting that greater attraction between regions is associated with reduced interregional imbalance. Overall, it can be concluded that the economic attraction variable captures commercial flows between regions better than the contiguity variable, as the models including economic attraction exhibit greater accuracy.

Finally, when comparing the elasticities of these variables, the results are similar regardless of whether the contiguity or attraction variable is used. In fact, the elasticity in the first case (contiguity in Model 1) is *exp(-0.599)=0.549,* while in the second case (attraction in Model 2) it is *exp(-0.658)=0.518*. This suggests that the findings are robust.

When both contiguity and attraction are included as explanatory variables, the results confirm that the corresponding coefficients are statistically significant and have the expected sign, see Model 3 in Table 3. The combined elasticity is estimated at 31.6% (calculated as *exp(-0.634)·exp(-0.520)=0.316*).

[9] Given the high correlation among the distance between regions and the attraction variable, the latter variable has been used in this study.

Table 3.
The Gravity Model

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Coefficient	t statistic	Coefficient	t statistic	Coefficient	t statistic	Coefficient	t statistic	Coefficient	t statistic	Coefficient	t statistic
Constant	-0.514***	-16.729	-0.512***	-16,922	-0.512***	-16.866	-0.208**	-1.991	-0.005	-0.095	-0.208*	-1.840
Contiguity	-0.599***	-5.877			-0.634***	-8.867	-0.622***	-8.307	-0.058	-1.551	-0.539***	-4.408
Economic attraction			-0.658***	-8,772	-0.520***	-4.761	-0.522***	-4.791	-0.065	-0.635		
Log (VAT)							-0.085***	-3.000	-0.009	-0.724	-0.075***	-2.509
Temporal inertia									0.897***	20.497		
Spatial inertia											0.185***	5.959
R squared	0.374		0.393		0.399		0.400		0.876		0.400	
F statistic	52.105		56.476		56.362		55.166		410.082		44.300	
Log. Likelihood	-3,219.688		-3,170.603		-3,154.435		-3,150.914					
J statistic									0.000		0.000	
Number of observations	3,179		3,179		3,179		3,179		2,601		2,601	

Note: The dependent variable is $\log(y_t^{rs})$. Temporal inertia=$\log(y_{t-1}^{rs})$; Spatial inertia=$wg_{t-1}^{rs}\,.\log(y_{t-1}^{rs})$All models include a time dummy variable and fixed effects of origin and destination regions. Models wihout *inertia* have been estimated by OLS and models with *inertia* have been estimated by Arellano and Bond (1991) method. The variance and covariance of the coefficients are adjusted for heteroscedasticity and autocorrelation. The estimations have been made using Eview Version 8.1 Software. The symbols *, ** and *** indicate the probabilistic significance levels of 10%, 5% and 1%, respectively.
Source: compiled by the authors.

Model 4 in Table 3 incorporates a variable representing the effect of company headquarters location. For this purpose, a proxy variable is included in the model, defined as the logarithm of the VAT collected in each region. The negative sign of the coefficient indicates that the *headquarters effect* reduces interregional imbalances between the regions involved. Thus, in regions where company headquarters are concentrated, the imbalances between the real and the estimated flow are smaller. Therefore, the presence of *headquarters effect* contributes to the overvaluation of regional GVA accounting, and consequently, of regional GDP.

Model 5 in Table 3 includes *temporal inertia* using equation **(7)**, and the goodness of fit improves substantially. However, the coefficient associated with the inertia term is close to one and highly significant, which may indicate a potential misspecification of the model. While the *temporal inertia* factor helps to explain the persistence of trade imbalances in GVA flows, its magnitude also suggests that some relevant variables might be omitted from the model.

To address potential endogeneity issues arising from the inclusion of the lagged dependent variable, the model has been estimated using the Arellano and Bond (1991) method. This approach applies the generalized method of moments (GMM)**,** using lagged values of the endogenous variable as instruments. This estimation technique controls for the endogeneity of the lagged dependent variable and eliminates unobserved individual effects, improving the reliability of the estimates.

Lastly, Model 6 in Table 3 presents the results of the estimations of equation **(8),** which consider possible *spatial autocorrelation or spatial inertia*. To address potential endogeneity problems, the proposed gravity models are again estimated using the method proposed by Arellano and Bond (1991). The results indicate that that the explanatory variables related to *contiguity*, *spatial inertia* and the *headquarters effect* are all statistically significant, and their signs are consistent with expectations. Both the *contiguity* and the *headquarters effect* present negative values, while the coefficient for *spatial inertia* (spatial autocorrelation) is positive. However, it is worth noting that the inclusion of *spatial inertia* does not lead to an improvement in the model's goodness of fit compared to Model 4 in Table 3.

The results show that the *contiguity effect,* the *attraction effect,* and the *company headquarters effect* are all significant determinants of interregional imbalances in GVA flows. The positive *spatial inertia* coefficient supports the hypothesis that trade imbalances tend to persist across neighbouring regions, potentially due to structural or institutional interdependencies. Nonetheless, spatial autocorrelation may also reflect omitted spatially correlated factors, introducing a potential source of bias. In conclusion, the gravity model confirms the relevance of company headquarters location and spatial proximity —through contiguity and attraction— in explaining the GVA distribution across regions, and consequently, their GDP.

6. Conclusions

The analysis of interregional flows provided by the origin-destination matrices of the Input-Output Table is an appropriate tool for studying trade imbalances between regions, which ultimately determine economic inequalities.

One of the contributions of this study is the use of the accounting method to obtain the GVA flow matrix. This method provides a more accurate view of interregional flows because it allows for the correct allocation of GVA in cases where company headquarters and production centres are located in different regions. In such situations, the accounting method assigns the value added generated to the region where the economic activity actually takes place, rather than to the location of the administrative headquarters, thus avoiding distortions in the regional distribution of GVA.

A simple visualisation of the GVA flow matrix, which presents positive and negative values, provides an idea of the possible imbalances in trade flows between the different regions that make up the Spanish economy. It should be noted that the traditional techniques used in the analysis of interregional flows are insufficient to fully explain their behaviour, as they fail to account for imbalances that occur from flows being generated in one region but computed in another.

The fact that some of the interregional GVA flows are positive and others negative implies that some regions benefit from trade flows while others lose out. From an accounting point of view, this leads to an underestimation (or overvaluation) of the regional GVA and, consequently, of the regional GDP.

The estimated gravity model corroborates the hypothesis that the *contiguity effect* and *attraction effect* play a significant role in explaining the intensity of interregional trade flows. Specifically, better results are obtained when analysing the intensity of interregional GVA flows, leading to the conclusion that contiguity and stronger attraction between regions reduce trade imbalances between them.

The existence of a company headquarters effect is also confirmed. The results show that regions with a concentration of company headquarters experience smaller commercial imbalances. However, this effect also contributes to an overestimation of the regional GVA and, consequently, of the regional GDP, as value added generated in other regions may be statistically attributed to the region where the headquarters of the companies are located. While this may reflect the administrative structure of companies, from a territorial perspective, it can lead to distortions in regional economic indicators and reinforce existing disparities between regions.

To the extent that these distortions reinforce the position of already more developed regions and weaken the position of more peripheral or productive regions without a company headquarters, they may exacerbate economic imbalances between regions, thus hindering territorial convergence.

Finally, the results confirm the relevance of the location of company headquarters, as well as territorial *contiguity,* and economic attraction in determining the GVA flows for each region and, consequently, their GDP.

The analysis has been based on aggregate data, and the use of disaggregated sectoral data would allow for examining whether the effect of *company headquarters* differs depending on the type of economic activity. This could be an interesting direction for future research.

References

Anderson, J.E. (2010). *The gravity model*. NBER Working Paper No. 16576

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

Anselin, L. (2003). Spatial Econometrics. In Badi H. Baltagi (Ed.), *A Companion to Theoretical Econometrics* (pp. 310-330). Blackwell Publishing Ltd.

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and application to employment equations, *Review of Economic Studies*, *58*(2), 277-297.

Baldwin, R., & Taglioni, D. (2006). *Gravity for dummies and dummies for gravity equations*. NBER Working Paper Series, Working paper 12516.

Distance.to. https://es.distance.to. Retrieved September 12, 2023.

EUROSTAT (1995). *Métodos de Contabilidad Regional. Valor Añadido Bruto y Formación de Capital Fijo por Rama de Actividad*. Brussels.

Evenett, S., & Keller, W. (2002). On Theories Explaining the Success of the Gravity Equation, *Journal of Political Economy, 110*(2), 281-316.

Feenstra, R.C. (2015). *Advanced international trade: theory and evidence*. Priceton University Press.

Frankel, J., & Romer, D. (1999). Does Trade Cause Growth? *American Economic Review*, *89*(3), 379-399.

Ghosh, A. (1958). Input–output approach in an allocation system, *Economica*, *25*(97), 58-64. https://doi.org/10.2307/2550694

He, L., & Duchin, F. (2009). Regional Development in China: Interregional Transportation Infrastructure and Regional Comparative Advantage, *Economic Systems Research*, *21*(1), 3-22.

Head, K., & Mayer, T. (2014). Gravity Equations: Workhorse, Toolkit, and Cookbook. In *Handbook of International Economics*, *4*, 131-195. Elservier.

Head, K., & Mayer, T. (2019). Brands in Motion: How Frictions Shape Multinational Production, *American Economic Review, 109*(9), 3073-3124.

Head, K., & Mayer, T. (2021). The United States of Europe: A Gravity Model Evaluation of the Four Freedoms, *Journal of Economic Perspective, 35*(2), 23-48.

Hernández García, M.C. (1997). *El valor añadido como indicador económico de la responsabilidad social de la empresa: una aplicación empírica*. Universidad de la Laguna.

Kabir, M., Salim, R., & Al-Mawali, N. (2017). The gravity model and trade flows: Recent developments in econometric modelling and empirical evidence, *Economic Analysis and Policy*, *56*, 60-71.

Leontief, W. (1953). *The structure of American economy 1919-1929: An empirical application of equilibrium analysis*. Harvard University Press.

Mayer, T., Vicard, V., & Zignago, S. (2019). The cost of non-Europe, revisited. *Economic Policy*, *34*(98), 145-199.

Nitsch, V., & Wolf, N. (2013). Tear down this wall: on the persistence of borders in trade, *Canadian Journal of Economics*, *46*(1), 154-179.

Official Journal of The European Union (2013). *Regulation (EU) No 549/2013 of the European Parliament and of the Council of 21 May 2013 on the European system of national and regional accounts in the European Union Text with EEA relevance*. Brussels.

Pavía Miralles, J.M., & Cabrer-Borrás, B. (2004). Espacio y comercio interregional en España. *Estudios de Economía Aplicada*. *22*(3), 517-538.

Peeters, L., & Chasco, C. (2016). Identifying local determinants of destination choices of international immigrants to the Madrid metropolitan area. *Papers in Regional Science*, *95*(2), 281-307. https://doi.org/10.1111/pirs.12130

Reuveny, R., & Li, Q. (2003). Economic openness, democracy, and income inequality. An Empirical Analysis, *Comparative Political Studies*, *36*(5), 575-601.

Santamaría, M., Ventura, J., & Yeşilbayraktar, U. (2023). Exploring European regional trade, *Journal of International Economics*, *146*. https://doi.org/10.1016/j.jinteco.2023.103747

Serrano-Domingo, G., Cabrer-Borrás, B., & Requena-Silvente, F. (2020). Networks and location of foreign migrants: evidence for Southern Europe. *Journal of Regional Research, 47*(2), 97-112. https://doi.org/10.38191/iirr-jorr.20.012

Shahriar, S., Qian, L., Kea, S., & Abdullahi, Z.M. (2019). The Gravity Model of Trade: A Theoretical Perspective, *Review of Innovation and Competitiveness, A Journal of Economic and Social Research*, *5*(1), 21-42.

Tinbergen, J. (1962). *Shaping the World Economy*. The Twentieth Century Fund.

Thissen, M., Lankhuizen, M., Van Oort, F., Los, B., & Diodato, D. (2018). EUREGIO: The construction of a regional IO DTABASE with regional detail for Europe for 2000-2010. Tinbergen Institute Discussion Paper, TI 2018-084/VI.

Thissen, M., Ivanova, O., Mandras, G., & Husby, T. (2019). *European NUTS 2 regions: construction of interregional trade-linked Supply and Use tables with consistent transport flows*. European Commission, JRC Technical Report.

Tormo, L., Rico, P., Morillas-Jurado, F., & Cabrer-Borrás, B. (2023). A new approach to the hypothetical extraction method: regional full extraction. *Economic Systems Research*. https://doi.org/10.1080/09535314.2022.2157249

Winters, A., McCulloch, N., & McKay, A. (2004). Trade Liberation and Poverty: The Evidence so Far, *Journal of Economic Literature*, *42*(1), 72-115.

Wang, Z. (2021). Headquarters gravity: How multinationals shape international trade. *Journal of International Economics*, *131*. https://doi.org/10.1016/j.jinteco.2021.103477

Wrona, J. (2018). Border effects without borders: What divides Japan's internal trade? *International Economic Review*, *59*(3), 1209-1262.

Yotov, Y.V. (2021). On the role of domestic trade flows for estimating the gravity model of trade. *Contemporary Economic Policy*, *40*, 526-540.

ORCID

Francisco Morillas-Jurado https://orcid.org/0000-0002-4204-906X

Paz Rico-Belda https://orcid.org/ 0000-0002-5634-6022

Appendix A

GVA can be defined in the following two ways:

1. Remuneration of production factors; employee remuneration, consumption of fixed capital, interest, and business profits. Thus, the GVA, in a simplified way, is obtained as the sum of the wage bill plus the gross operating surplus.

In the case of a regional input-output matrix, there may be an accounting problem when the headquarters of company A is in region *r*, which does not coincide with region *s* where its production plant is located (see EUROSTAT, 1995).

2. Value of the set of goods and services produced in a region during a period of time, discounting indirect taxes and intermediate consumption.

   From the accounting point of view, the value of GVA can be negative when production is less than its intermediate consumption (IC). In the case of a regional input-output matrix, an accounting problem may exist when region *s* where production is located does not coincide with region *r* from which the IC comes (see Hernández García, 1997).

There are different ways to calculate GVA flows. Below are just some examples:

The **Expenditure Method** consists of measuring the total expenses (total purchases) that are made in a region in consumption and investment by economic agents (families, companies and government). Purchases of intermediate goods and/or services are excluded.

The **Income Method** consists in measuring the remuneration of the factors of production (workers, entrepreneurs, capital, shareholders, etc.).

The **Value Added Method** consists in subtracting intermediate consumption from the total value of a region's production.

GVA = Production – IC

Example of accounting method for Regional GVA

a) **Production approach.** See the Official Journal of the European Union (2013). Regulation No. 549/2013; section 13.35.

Suppose we have a company that has two centres, the headquarters (local EAU), in Region 1 and the production plant (local EAU) in Region 2. This Company A has a production volume of 90 €, which the Central Headquarters (local EAU) manages, located in Region 1. In this case the income is accounted for as:

Production (Sales) of Company A			
	Region 1	**Region 2**	**TOTAL**
Region 1	90 €		90 €
Region 2			
TOTAL	90 €		90 €

The value of the company's intermediate consumption (IC), in total, amounts to 24 €, while in the production plant located in Region 2 this is 20 €, and the IC at the headquarters located in Region 1 amounts to 4 €. The expenses of Company A in IC are accounted for as:

IC of Company A			
	Region 1	**Region 2**	**TOTAL**
Region 1	4 €		4 €
Region 2		20 €	20 €
TOTAL	4 €	20 €	24 €

Furthermore, the amount of personnel costs (PC) at the production plant located in Region 2 amount to 35 €, while the PC costs at the headquarters located in Region 1 amount to 6 €. These expenses in PC are accounted for as:

PC costs of Company A (GVA component)			
	Region 1	Region 2	TOTAL
Region 1	6 €		6 €
Region 2		35 €	35 €
TOTAL	6 €	35 €	41 €

The gross operating surplus (remuneration of capital) at the production plant located in Region 2 amounts to (-55 €), while at the headquarters located in Region 1 this amounts to 80 €. These concepts are accounted for as:

Gross Operating Surplus of Company A (GVA component)			
	Region 1	Region 2	TOTAL
Region 1	80 €		80 €
Region 2		-55 €	-55 €
TOTAL	80 €	-55	25 €

To obtain the GVA of Company A in a consolidated manner, through the difference between its production and its IC, we have:

GVA of Company A			
	Region 1	Region 2	TOTAL
Region 1	86 €	-20 €	66 €
Region 2			
TOTAL	86 €	-20 €	66 €

The previous tables show that the total GVA of Company A is €66 and that of Region 1 is 86 €. However, there is a negative GVA flow, from an accounting point of view, between Region 1 and Region 2 that amounts to (-20 €).

b) **Income approach.** See the Official Journal of the European Union (2013). Regulation No. 549/2013; section 13.36.

An alternative way of calculating the GVA (following the methodological recommendations of regional accounting; see EUROSTAT, 1995) assumes that Company A has a production volume of 90 €, which is managed by the headquarters of Company A in Region 1. The PC of the production plant, located in Region 2 amounts to 35 € while the headquarters, located in Region 1, registers a PC of 6 €. The total costs in PC of Company A amount to 41 €. The PC of the production plant located in Region 2 is paid by the headquarters in the amount of 35 €. The company's total operating surplus (profit) amounts to 25 €. Thus, the company's total GVA amounts to 66 € (41 €+25 €). The total GVA to be accounted for by Company A's headquarters is: 86 € (66 €+20 €), while the GVA flow between Region 1 (headquarters) and Region 2 (production plant) is (-20 €).

GVA of Company A			
	Region 1	Region 2	TOTAL
Region 1	66 €	-20 €	46 €
Region 2	20 €		20 €
TOTAL	86 €	-20 €	66 €

Appendix B: Sources of data on VAT

Several data sources were used to obtain the VAT accounting of the Spanish regions:

- **Community of Navarre, special regime:**
  Gráfico nº 11. Evolución temporal de la recaudación tributaria - memoria 2019 - navarra.es
- **Spain, general regime:**
  https://javiersevillano.es/IVA.htm#Recaudaci%C3%B3n%20Del%Microsoft Word - nota_calculo_indicador.docx (ine.es)
- **Canary Islands, special regime:**
  ISTAC | Recaudación Tributaria del Estado acumulada. Comunidades autónomas y provincias por periodos | Banco de datos (gobiernodecanarias.org)

  https://www3.gobiernodecanarias.org/istac/statistical-visualizer/visualizer/data.html?resourceType=data
- **Basque Country, special regime:**
  Recaudación de las Diputaciones Forales por tributos concertados - Departamento de Hacienda y Economía - Gobierno Vasco - Euskadi.eus