

COVID EFFECT ON SALES, SIZE, AND INDUSTRY IN THE MINHO BORDER AREA

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ABSTRACT

This paper analyses the effect that the COVID pandemic had on border areas due to international border closures, specifically on the ‘Galician wet border’ of the international Spanish-Portuguese border. This research focuses on how the pandemic affects sales, and the factors that condition sales in border areas. The results show that, although COVID had a significant impact on sales in all the municipalities analysed, there are no significant differences between border and non-border municipalities. They also suggest that in the case of pandemics, the industrial organisation theory offers a better paradigm for action than the resource-based view theory.

Key words: COVID-19; cross-border region; Industry Effect; Resource-Based View; regional economy; Spain/Portugal

INTRODUCTION

The pandemic associated with COVID-19 has affected the lives of millions of people around the world, especially in the most vulnerable areas (Bhattacharjee & Sattar 2022). The pandemic led to the closure of borders due to the fear of contagion, while looking for an urgent solution centred around the nation-states (Nossem 2020) and particularly affected the borders of the European Union (EU) (European Commission 2021). The Schengen Agreement allows for the temporary introduction of border controls in the event of serious security threats, and only because of the migration crisis in 2015 had some borders been restricted (European Commission 2016). However, the complete closure of borders in the EU was an unusual and hard-to-comprehend experience. In border areas, residents were cut off from their

acquaintances and even from their relatives, and of course from their jobs and daily routines on both sides of the border: mobility was directly affected (Wallin Aagesen *et al.* 2022). Almost without warning, border residents experienced something that seemed unbelievable to the younger generation— the appearance of border barriers and the use of security forces to control the movement of people (Opilowska 2021; Böhm *et al.* 2023; Łażniewska *et al.* 2023). All of this had economic repercussions in border areas (Capello *et al.* 2022; European Commission 2021). This paper will specifically address four issues connected to the economic effects of the pandemic in a specific border area: the Galician side of the so-called ‘wet border’ between Galicia (Spain) and Portugal, that is, the area where the Minho river is used to demarcate the international boundary. Previous works have analysed the effect of COVID-19



in the area from a macroeconomic point of view (Paül *et al.* 2022). However, in this study, we aim to focus on specific aspects more precisely and posed four research questions, as follows:

1. In border areas, the effect of COVID-19 had special characteristics, since in the early stages of the pandemic the reintroduction of border controls and subsequently the closure of borders without any warning meant a radical change in the daily lives of countless cross-border travelers and other border dwellers (Novotný 2022). Although different studies have been developed, there is a lack of analysis on how the pandemic has directly affected businesses. Consequently, the first research question that arises is: does COVID condition the sales of businesses in border areas differently from other areas?
2. Szczygielski *et al.* (2022) note that the uncertainty created by COVID-19 negatively impacted all sectors of global industry, albeit differently across industries. Those factors that make border areas attractive as a competitive advantage, such as trade or tourism, were more affected than those not directly associated with such areas, such as manufacturing. Consequently, a second question arises in the relationship between COVID-19 and industry: is the effect on sales in border areas conditioned by type of industry?
3. Regional planning policies point to the importance of knowing the behaviour of firms to foster territorial cohesion in cross-border areas (Knippschild 2011; Makkonen & Rohde 2016). Different works analyse the behaviour of firms in cross-border contexts—for example, Rodríguez-García *et al.* (2024) and Zhao *et al.* (2024) studied technology transfer and innovation; Neuberger *et al.* (2023) and North and Smallbone (2006) studied agri-food enterprises; and Makkonen and Leick (2020) show that small- and medium-sized enterprises (SMEs) benefit from being in border regions in terms of opportunities for cooperation but suffer from negative cross-border externalities. The production function models include invested capital as a key factor and are collected from the assets (Sickles & Zelenyuk 2019) since the assets encompass a series of very important factors for the increase of sales in companies, such as technology, equipment, and intangible assets, that is, the company's knowledge. The relationship between COVID and the industry is also likely to affect the performance of its production functions. Therefore, a third research

question arises: does COVID-19 condition the effect of assets on sales in border areas?

4. An industry has assets associated with certain technologies, equipment, and intangibles. At the same time, each company has specific assets that differentiate it from other companies within the same industry. Therefore, when considering the effect of the assets, it is essential to check whether the differences are due to the industry to which the firms belong or are specific to the firm. Previous work analyses the effect of different assets considering the industry effect—for example, Andonova and Ruíz-Pava (2016) study the effect of intangible assets on the performance of Colombian companies. However, those papers do not divide the asset effect according to whether it refers to the industry level or the firm level. Does COVID condition the effect of the industry's assets on sales in border areas? This research fills this gap.

Overall, this work contributes to previous research in two main aspects. Firstly, the paper combines a microeconomic approach with a geographical approach, presenting a scheme of analysis based on the importance of specific areas—that is, border areas—as regards doing business. Since many of the sales of small firms in cross-border areas are not included in exports, the approach used complements previous studies on the border effect (McCallum 1995). In addition, the study is conducted at the municipal level, which allows the effects to be disaggregated. Analysing the COVID effect at an understudied geographical level enables a deeper understanding of the connection between the geographical approach and the economic approach. Secondly, it delves into the effect of border areas on firms, introducing the effect of investments and possible crises such as COVID, in line with suggestions from Makkonen and Leick (2020).

This study also contributes to the key EU pillars according to its treaties: economic, social, and territorial cohesion, an aim which is permanently monitored (European Commission 2024). The paper presents an analysis of the COVID effect in borderlands, suggesting actions to limit the effect in European cross-border areas following the Territorial Agenda 2030 (Informal Meeting of Ministers... 2020).

The paper is structured as follows: first, it presents a theoretical reflection on the challenges and opportunities for firms located near borders. Considering these reflections and the four research questions already explained, the hypothesis is set forth. Then, the case study area is introduced, followed by the material and methods used in this research. After that, the results of the empirical analysis are presented, using a sample of firms in municipalities in the border area. Finally, the discussion and conclusions of the results are expanded on considering previous work.

THEORETICAL FOUNDATION

Border areas are usually understood as the peripheral limits of nation-state territories, far away from state capitals and reinforcing the idea of bounded spaces (Paasi 2022). Historically conceived as the remote areas to be the front line in the continuous conflicts between national armies, in times of globalisation they have become spaces of encounter (Widdis 2010). If we look at the interplay between economy and borders, a combination of positive and negative effects is identified by literature (Koschatzky 2000; Bressan 2017; Shahriar 2020; Novotný 2022).

On the one hand, borders are seen as impediments to the market, as different political and legal systems and different jurisdictions collide (Knippschild 2011). Consequently, there are differences in taxation, labour, legislation, etc., which have a direct impact on the economic life of border regions (Bressan 2017). In addition, specific factors may condition trade relations—for example, cultural barriers, different consumer tastes and behaviours, the organisation of traditional companies, social security and welfare systems, or the organisation and strength of trade unions, all of which have a direct impact on the economic life of border regions (Koschatzky 2000). On the other hand, some authors consider borders as a resource for economic activities; they enable certain economic activities that are only possible because of the existence of the border itself—for example, trade, tourism, etc. (Shahriar 2020).

In this line of thought, Makkonen and Leick (2020) point to several cross-border externalities, as regards opportunities

and threats for SMEs. Negative factors include competitive pressure from foreign firms, a functional specialisation of space that relies on social and economic inequalities (Obermeit & Schulze 2011; Durand *et al.* 2020), cross-border crime and violence, spillover effects of economic shocks (Nelles 2011; Libman & Vinokurov 2012), different regulations and anti-competitive practices (Martyniszyn 2021), environmental issues (Chen *et al.* 2022a) and possible changes in foreign trade (Tykkyläinen & Lehtonen 2008). Positive externalities include access to a wider pool of labour, knowledge, technology, know-how, and cooperation (ESPON EGTC 2019; Borbon-Galvez *et al.* 2021), transnational cluster cooperation (Pauna *et al.* 2014; Fernández-Jardón & Martínez-Cobas 2021), sources of supply, new markets and capital or credit, and the attraction of foreign investment (Blonigen 2005; Fidrmuc & Hainz 2013). However, some of these factors have been criticised—for example, foreign investment is often directed at the establishment of large production plants, discouraging local business activity and replacing local firms (Brown 2002). In the case of cross-border labour, price–cost differentials are often exploited, leading to a situation where the weaker side of the region is dependent on the more advanced side. In the case of markets, it is often difficult to design products and services to suit both domestic and cross-border customers (Weidenfeld *et al.* 2016).

Moreover, sharing institutional information is a key factor for all the actors involved in cross-border initiatives and projects. In this regard, institutions ‘comprise both ‘hard’ forms (e.g., juridical regulations) and rather ‘soft’ forms (e.g., informal networks) with a certain *de facto* role’ (Chilla & Lambracht 2023). Hence, developing mutual trust as regards not only institutions but also enterprises, is vital to build effective cross-border cooperation (Chen *et al.* 2022b; Medeiros *et al.* 2024). The COVID-19 pandemic has shown that the idea of a borderless Europe does not withstand certain crises (Wille and Kanesu 2020; Lara-Valencia and Laine 2022). Nation-states still perceive territorial borders as limits of the state and, in a situation of risk, use

them as a control mechanism to protect national interests, from a centralist perspective (Klatt 2020). However, it has also been shown that the collective self-perception of the inhabitants of border regions did not match the decisions taken by national governments (Novotný 2022), since the inhabitants of cross-border areas see people on the other side as close neighbours rather than foreigners. The constraints imposed because of the pandemic have shown the degree of interconnectedness that already exists in European border regions, and how many of them have already become transnational cross-border spaces (Opilowska 2021; Sohn 2023).

The COVID-19 pandemic generated a significant economic recession in all countries (McKibbin & Fernando 2020). Consequently, there was a decline in business sales, and the number of people unemployed increased (Zhang & Zheng 2022). The pandemic led to a major economic downturn in all countries, resulting in lower business sales, increased unemployment, and governments were forced to direct much of their public spending to deal with the effects of the pandemic. However, it is not clear what this effect has been on the performance of firms in border and cross-border areas since, depending on sectors and size, there have been different effects (Shin *et al.* 2021; Das *et al.* 2022).

Border areas witnessed quite different situations, with different economic consequences. We must differentiate the borders that have been completely closed to the passage of people and goods from the borders in which the closure has been partial, allowing certain mobility. In the EU, in general, both situations have occurred, because a full closure of state borders would collapse the European economy in a few days, including food production and distribution. On the one hand, secondary border crossings have been completely closed, and on the other hand, the main crossings have been kept open, to facilitate the transport of goods and not collapse production in business value chains, which generally have suppliers and clients across Member States and that import and export through different countries (Paül *et al.* 2022). Cross-border worker mobility has also been allowed, with many limitations (Martínez-Cobas & Fernandez-Callis 2021). Novotný (2022) points out that, on

the border of the Czech Republic and Germany, commuters argue that they simply use the open borders and the opportunity to work within the EU, but that the government and the regions have prevented them from doing so.

The consequences of the above, depending on the proximity to totally or partially closed border posts, would lead to a drop in sales and economic activity greater than in other territories, and a greater increase in unemployment; however, those differences are likely to depend on each industry. The activities most conditioned by the mobility of people could have had a sharp drop, while other activities, by allowing the passage of goods, would not have been affected. This is where the objective of this study is focused: to analyse and quantitatively measure the differences in a border area compared to an area not directly affected by the border and to determine if there has been a greater drop in sales and activity. In this study, due to the availability of sources, only the Galician side is taken into consideration.

Considering the elements revised in the previous sections, and considering the specific case study of the Galician side of the Minho river border region, we propose four hypotheses, as follows:

H1 Sales of firms in border areas declined more than in the rest of the areas because of COVID-19.

The pandemic, with the subsequent associated closure to avoid possible contagion, caused a large drop in economic activity. However, this drop could have been vastly different depending on the industries—for example, the food sector would have continued to maintain its normal activity and, in some cases, would have increased, while sectors such as construction, industry, and, above all, hotel and restaurant services, closely associated with border areas, would have been severely affected by the pandemic. Consequently,

H2 The industry conditions the effect of COVID in border areas.

The capital invested in the firm, collected from assets, is a source of value generation included in almost all production function

models (Sickles & Zelenyuk 2019). Assets include several important productive factors for increasing sales in firms. Firstly, they include the equipment and infrastructures on which the company relies. Secondly, they include intangible assets such as patent protection, etc., which are part of the company's intellectual capital. They also include the technology that the company uses to generate value. Assets are associated with firm size and have generally been included as measures of that effect. Asset turnover is used to evaluate the efficiency of investments (Baker & Powell 2009), suggesting the importance of this factor in the company's sales. Based on these two assumptions, COVID is expected to impact the effect of assets on sales in some way. When a recession occurs, it seems logical to think that the larger the company, the greater the effect of that recession. However, larger firms are more resilient to downturns as they have more resources. The effect of size decreases because of COVID, therefore, it is proposed that:

H3 COVID conditions the effect of company assets on sales in border areas.

COVID presents an interaction with the industry, and the effect of assets may be different when analysed at the firm level or when analysed at the industry level since each of them has its own particularities. Large companies may be more diversified in several sectors so that the effect of the recession will be less noticeable. The specific characteristics of each industry sector may change the effect of the assets, that is, the different effects of COVID on industries (Szczygielski *et al.* 2022), thus,

H4 COVID conditions the effect of the industry's assets on sales in border areas.

The case study area is the province of Pontevedra (NUTS III), a border area in Galicia (Spain), facing the district of Alto Minho (NUTS III) in Portugal, on the other side of the Minho river. The Minho river cross-border region covers both banks of this river in its lower course, an area located in the core of the north-western Iberian urban

corridor linking Greater Porto, in Portugal, with the main Galician cities (Vigo, Santiago de Compostela and A Coruña). This area is very relevant to study the decrease or increase of the border effect for three reasons: the unification of the EU's border, the similarity of cultural behaviours between the municipalities of the province of Pontevedra (Galicia) and the Northern Region of Portugal, and the relevant trade between those territories. The Minho border area corresponds to 5% of the total border between Spain and Portugal. However, the number of vehicles on the five international bridges over the Minho river represents 48% of the total mobility of vehicles between Spain and Portugal (OTEP 2019).

This paper considers the border effect as the change in the sales in border areas. Therefore, to measure the border effect, the 63 municipalities of Pontevedra are divided analytically into two groups: (a) border municipalities (9), that is, those physically adjacent to the Minho river; (b) non-border municipalities (54), those not directly reaching the shore of the river. The nine municipalities included in the first group are Arbo, Crecente, A Guarda, As Neves, O Rosal, Salceda de Caselas, Salvaterra de Miño, Tomiño, and Tui, accounting for 75,381 inhabitants in 2022. The total population of the province is 943,015 (2022).

There are several reasons for using a dummy variable that indicates a border municipality versus a non-border municipality as a way of measuring the border effect.

First, the municipalities in Pontevedra near the border are usually municipalities where small businesses abound. Small businesses usually move to a local market that covers the municipality and some nearby. Businesses that are next to the river encompass nearby municipalities in another country. Consequently, the regular sales of a large part of them take place in Portugal. Therefore, the border effect is particularly noticeable in the sales of companies based in these municipalities (Fernández-Jardón & Martínez-Cobas 2021). Second, on the border of the Minho river, there is a long tradition of economic exchange in the riverside municipalities of Spain and Portugal. Initially, exchanges were carried out across the river, some because of smuggling and

others through trade and legal manufacturing. When the EU's borders were liberalised, bridges were built in some of these municipalities that connected a town in Spain with another in Portugal. This meant that the exchanges that were formerly made by boats were now made through those bridges, both in the town where the bridge had been built and those near it. Therefore, the border effect is particularly noticeable in the economic exchanges in these bi-national towns, many of them so-called 'eurocities' (Trillo-Santamaría & Paül 2014).

Finally, the province of Pontevedra has 61 municipalities and 4495 km². Consequently, the municipalities are not very extensive and therefore are a better reflection of the essence of the diversity of border behaviours compared to other municipalities.

This cross-border area, despite belonging to different countries, shares common characteristics, which have been forged because of a common cultural base and the economic and political transactions within the formal and informal economies, which have always existed (Bassols *et al.* 2017). It is an area characterised by high environmental diversity, the result of a combination of coast, mountains, and rivers. The municipalities on the banks of the Minho river present a productive diversity according to their natural conditions. Productive diversity is manifested in crops, industrial diversification, and tourism because of the landscape value and the rich archaeological heritage.

In addition to the important presence of the primary sector and commercial activity (a typical feature of border economies), in the last two decades, a process of industrialisation has been linked to the metropolitan expansion of Vigo, the need for business parks, and some other competitive advantages, particularly in the Portuguese area (Fernández-Jardón & Martínez-Cobas 2021). This leads to a series of particularities in the business activity of the cross-border area.

The geographical, cultural, historical, or linguistic conditioning factors show that the whole area in Spain and Portugal shares more shared factors when compared to other territories of both countries (Trillo-Santamaría & Paül 2014; Paül *et al.* 2022). This common

substrate has been supported by the disappearance of the border and the integration of economies because of EU policies, which have led to a huge transfer of citizens from both sides of the border affecting almost all activities. This common background has also forged strong cross-border cooperation projects and structures in the area, supported by EU policies and funds, such as the Minho River EGTC (European Grouping of Territorial Cooperation), a leading stakeholder that has promoted a common strategic plan for the cross-border region (AECT Rio Minho 2019). Being a European border, some of the previous externalities do not occur in this area, such as foreign trade regulations or cross-border violence.

METHODOLOGY

Data – The sample was obtained from the SABI (System for the Analysis of Iberian Balance Sheets) database of the Bureau van Dijk. The original sample was composed of 19,260 companies in the province of Pontevedra with accounting data for the entire period 2016–2020, classified by sector with a disaggregation level of four digits CNAE (Spanish acronym for 'National Classification of Economic Activities'). The strangest companies were discarded, that is with very little or a lot of turnover, together with the companies with missing data in some variable, which led to a variation in the number of companies in each year, leaving 17,294 available in 2016, 16,982 in 2017, 16,204 in 2018, 15,419 in 2019, and 14,633 in 2020.

Table 1 shows the sample's descriptive statistics, classified by large sectors of the economy. Although the number of companies is not uniform, given that some companies do not present data on income or assets, the mean and standard deviation are shown for each of the two variables. In total, 69,046 observations were selected. A Kruskal-Wallis test showed that in both cases the differences between sectors were significant, justifying the introduction of the industry effect, both when analysing sales and when introducing size through assets.

The correlations between the variables show a high relationship between sales and

Table 1. Descriptive statistics of data sample (2016–2020) in miles of euros.

	Total assets		Sales	
	Mean	Std. dev.	Mean	Std. dev.
Farming	2126.50	6541.29	1566.16	4880.42
Extractive	2532.44	5184.49	1416.02	2756.64
Manufacture	4400.58	43,918.54	7119.41	132,264.20
Energy	3575.33	7228.18	1346.84	4639.84
Sanitation	2244.06	5289.83	3114.56	11,759.72
Building	1408.75	15,170.18	772.50	12,282.74
Trade	1589.72	13,819.19	2287.05	16,043.77
Transport	1598.24	5989.81	1524.71	4756.58
Hostelry	487.36	1530.46	379.06	873.04
Information	493.07	1508.84	585.66	2413.42
Finance	11,870.63	117,205.00	1150.94	12,480.38
Real estate	1429.63	4595.19	119.36	312.39
Professionals	1495.79	20,136.89	284.67	1044.24
Administrative	1461.29	6445.20	677.49	3304.02
Public administration	3.23	4.59	8.20	7.86
Education	439.01	1468.90	336.16	747.12
Health	955.32	8353.65	984.99	6982.16
Recreational	1036.05	7902.29	698.11	4398.93
Other services	949.03	13,273.39	252.57	1152.77

Source: Own elaboration.

Table 2. Correlations of variable introduced.

	AT	ly	Border	Covid
AT	1			
ly	0.584	1		
Border	-0.0031	0.0149	1	
Covid	0.0331	-0.0046	-0.0009	1

Source: Own elaboration.

assets. The rest hardly present significant relationships (see Table 2).

Variables – Dependent variable:

- The dependent variable used was company income. To facilitate the homogenisation of the data, logarithms have been used.

Independent variables:

- To assess the size and the set of factors associated with invested capital, total assets have been considered in logarithms. Size is considered at two levels:
 - At the industry level, it is measured by the average of the logarithm of the total

assets among all companies in each industry.

- At the company level, it is defined by the difference between the logarithm of total assets and its average at the industry level.
- These definitions ensure that there is no collinearity between the variables (Bell & Jones 2015).
- To measure the effect of COVID, a dummy variable has been defined that takes the value of 1 in 2020 and 0 in the rest of the years.
- To measure the border effect, a dummy variable has been defined that takes the value of 1 when the municipality is on the border of the Minho river with Portugal and zero otherwise.
- The interaction between the COVID effect and the border effect has been used to assess whether COVID affected the border area in any way.
- To evaluate the effect of industry, the study considers the level of the industry as a random variable that directly or indirectly

conditions the values of the coefficients. This effect is measured in two coefficients:

- The constant indicates whether the industry affects average sales.
- The coefficient of the COVID effect indicates whether the industry changes the COVID effect.
- The interaction between size and COVID was used to see whether COVID moderated the importance of size in sales at the two levels previously considered.

Model – In measuring the relative importance of the various effects, we applied a hierarchical linear model (HLM) or random-effects model. This model provides estimators of the coefficients and variability of each of the components of the equation and, therefore, provides exploratory information on the importance of each element. HLM makes it possible to test whether this prior information can be considered significant or not. Some examples of the application of HLM in the debate on the firm-industry effect can be found, among others, in the works of Andonova and Ruíz-Pava (2016) and Fernández *et al.* (2019).

HLM allows random effects to be studied at various levels of analysis. The method generates a 95% confidence interval for each standard deviation. This interval enables the comparison of the different variances.

The model follows this specification.

$$ly_{it} = \beta_0 + \beta_1 ATC_{it} + \beta_2 ATM_{it} + \beta_3 Covid_{it} + \beta_4 B_{it} + \beta_5 CB_{it} + \beta_6 CAT_{it} + \beta_7 CAM_{it} + \varepsilon_{it}$$

where the subscripts i refer to the company and t refer to time.

- ly points out the logarithm of sales
- ATC indicates the effect of size on the firm as measured by the logarithm of total assets minus its industry average.
- ATM indicates the effect of size in the industry as measured by the logarithm of the average total assets in the industry.
- $Covid$ measures the effect of COVID, separating 2020 sales from the rest.
- B is a dummy variable that indicates whether the company belongs to a border municipality or not.

- CB is an interaction variable between the COVID effect and border effect.
- CAT is a variable interaction between ATC and COVID.
- CAM is a variable interaction between ATM and COVID.

The coefficients β_0 and β_3 are assumed to be random to include the effect of industry, so their general form will be:

$$\beta_j = \gamma_j + u_{jit} \text{ con } j = 0, 3$$

Coefficient β_5 measures hypothesis H1, that is, whether the COVID effect was more important in border areas. The coefficients β_6 and β_7 indicate whether there is an interaction between COVID and industry, allowing us to test hypothesis H3. The variance of the u_{3it} coefficient β_3 indicates whether the industry somehow conditions the COVID effect, testing hypothesis H2. The introduction of this variance in the model is tested using a likelihood ratio test which, although conservative, enables us to detect whether this effect exists. STATA 14.0 is used to perform the calculations.

EMPIRICAL ANALYSIS

Table 3 shows the results of the HLM estimation. The first part of the table shows the estimation of non-random coefficients, their standard error, and the statistic that shows if it is different from zero. The second part measures the estimation of the standard deviations associated with the perturbations of random coefficients, indicating the corresponding 95% confidence interval for each standard deviation. It is observed that the effect of assets is significant on sales both at the company level and at the industry level, as expected. The elasticity corresponding to the industry is 0.80, indicating that a large part of the investments is transferred to turnover regardless of the industry analysed. The elasticity in the companies is 0.13, completing an important part of these investments. Considering the two levels, investments are almost totally transferred to turnover.

The COVID effect is significant, causing sales to decrease significantly by 17% compared to their average value in other years,

Table 3. Results of the model estimation by HLM.

ly	Coef.	Std. err.	z	$p > z $
ATC	0.13	0.00	26.12	0.00
ATM	0.80	0.03	25.45	0.00
Covid	-0.18	0.05	-3.49	0.00
B	-0.07	0.05	-1.61	0.11
CB	0.02	0.02	0.97	0.33
CAT	-0.02	0.00	-6.90	0.00
CAM	0.01	0.01	1.31	0.19
_cons	0.90	0.18	4.94	0.00

Random-effects parameters	Estimate	Std. err.	95% Conf Interval	
Industry effect				
sd(Covid)	0.09	0.01	0.08	0.12
sd(_cons)	0.58	0.03	0.53	0.64
Company_effect				
sd(_cons)	1.43	0.01	1.41	1.45
sd (Residual)	0.58	0.00	0.58	0.58

LR test versus linear model: $\chi^2(3) = 88958.66$, Prob > $\chi^2 = 0.0000$.

Source: Own elaboration.

which points to the important effect it had on all the companies in the province. A significant border effect has not been observed, that is, the sales of the companies located in the border municipalities do not decrease significantly in relation to the other companies in the area studied. Nor is it observed that the COVID effect was more significant in the border area than in the rest of the province, which indicates that hypothesis H1 is not verified.

A significant effect is detected in the interaction between COVID and firm size, causing this effect to decrease significantly from an elasticity of 0.12 to 0.10. This confirms hypothesis H3. The interaction with the industry size of the COVID effect does not appear to be significant, possibly because much of this effect is already captured when considering the random coefficient of the COVID effect. Consequently, hypothesis H4 is not accepted.

The company effect explains 74% of the variation in sales and is the most important, like other previous studies. It is observed that the industry effect is 12%, which is also important. The variation explained by the industry in the COVID effect is 0.32%, but it is

also significant. This suggests that the effect of COVID is different depending on the industry in which the company is located. Thus, hypothesis H2 is accepted.

DISCUSSION AND CONCLUSIONS

This paper analyses the effect that the COVID pandemic had on border areas because of international border closures (Opitowska 2021) on the Galician (Spanish) side of the ‘wet border’, that is, the westernmost section of the international Spanish-Portuguese border. Hence, it is a very particular case of changes in the condition of the (semi)permeability of the border (Kortelainen & Rannikko 2015). This research studies how the pandemic affected sales and the factors that condition sales in border areas. The results show that although there is a significant effect of COVID on sales in all the municipalities analysed, there are no significant differences between border and non-border municipalities. Thus, it seems that there is a combination of positive and negative effects on the border, as pointed out by the literature (Koschatzky 2000; Bressan 2017; Shahriar 2020; Novotný 2022).

The results show that, in the case study area, the capital invested in the firm measured by the assets is a source of value generation according to Sickles and Zelenyuk (2019), both at the firm level and the industry level. The research confirms the results of Trippel (2010) and Zhao *et al.* (2024) on the importance of technology transfer in the sales of firms in (cross)border areas. The case study shows that COVID had an effect at the firm level but no significant effect at the industry level. Possibly this is due to the configuration of firms and industries and institutional issues (Chilla & Lambracht 2023; Medeiros *et al.* 2024), such as closing the border to people, which affects consumption, but allowing goods and services to pass through, which protected production and cross-border value chains (Paül *et al.* 2022). The specific strategies of each firm led to a different use of their assets, supported by the resource-based theory (Barney *et al.* 2011), so their effect on sales is significant. COVID affected the business strategies, limiting the resources and capabilities and affecting the markets in the lower

Minho river region. However, at the industry level, the actions of the companies are possibly compensating, so the assets of the industry tend to have a similar effect in all industries in the case study.

The sales do not show a border effect in the study case, because the Minho river corresponds to a border in which the closure was partial, allowing mobility of goods and services and some mobility of people (cross-border employment). The main cross-border value chains between Galicia (Spain) and Portugal (automotive, textile, wood, and food) continued to produce and overcome border controls and delays. This is a successful case of European integrated production during the pandemic. The fact that there is no difference in the cross-border areas of the Minho river supports the possibility of establishing cross-border innovation systems as suggested by Makkonen and Rohde (2016) and Rodríguez-García *et al.* (2024), connected to regional innovation systems. Nevertheless, our analysis is only one case, on one side of the cross-border area (Chilla & Lambracht 2023). Policy actions strengthening these systems support cross-border cooperation and are a source of territorial cohesion as suggested by Knippschild (2011) and Makkonen and Rohde (2016).

The results indicate that there is an important industry effect on sales in the municipalities studied. Furthermore, it is shown that industry is an important factor in the COVID study, as stated by Paül *et al.* (2022) and Szczygielski *et al.* (2022). The results show that the COVID effect is different in each industry, generating significant uncertainty in the decrease in sales. The activities affected by the restrictions on the movement of people (trade, hotels, restaurants) felt a greater impact than the others in the border areas.

The results also suggest a series of specific actions for companies in border areas of the Minho river and territorial cohesion policies. While industry strategies have not been affected by COVID, those of individual firms have been affected, pointing to a negative effect. Consequently, the results indicate that, in the event of a crisis due to pandemics such as COVID, the more in line with the industry the company's actions are, the less negative effect they will have. This suggests that in the case of pandemics, the industrial organisation theory

(Mason 1939; Bain 1951) offers a better paradigm for action than the resource-based view theory (Barney *et al.* 2011) when it comes to guiding the company's strategies.

The fact that elasticity is 0.8 at the industry level and 0.13 at the firm level indicates that not all capital invested is passed on to sales, although large firms have more sales than small firms. Consequently, policy actions in (cross) border areas should aim at enhancing cooperation and increasing the scale advantages of small- and medium-sized firms, which tend to be more common in such areas. This result is supported by Makkonen and Leick (2020), suggesting that SMEs are more likely to cooperate across borders. These actions to promote cross-border cooperation reduce the disparities between border and non-border firms, facilitating territorial cohesion in line with the Territorial Agenda 2030 (Informal Meeting of Ministers... 2020). These results are consistent with studies that point out convergence in gross interior product and employment in border areas between Spain and Portugal (Chamusca 2024; Viegas *et al.* 2024).

The paper shows that there is no differential effect of COVID on the sales between the border and non-border areas. However, introducing industry as an important conditioning factor suggests that studies should be done to prove that the effects are not significant in each of the differentiated industries. Opiłowska (2021) points out that the COVID crisis shows that borders are not resilient to crisis shocks. However, the fact that it did not have a significant effect on firms' sales shows that firms in (cross)border areas could be resilient to shocks, assuming the effect is like in other territories.

The results show that the industry effect behaves differently in border areas. These differences point to the effect of some barriers that possibly remain at the borders according to previous literature, such as cultural constraints (Koschatzky 2000), difficulties in cooperation (Knippschild 2011), and territorial organisation (Fricke 2015). However, the results are not conclusive enough to be able to attribute the explanation to any of these three causes. Lastly, the results show that there are no territorial type differences in terms of firms' sales, nor differences in terms of the effect of COVID as opposed to McCallum (1995). But as firms

in border areas tend to be smaller, it is possible that at the aggregate level such an effect may be found. The institutions of border areas should consider the spatial characteristics of the territories when establishing policies for joint action that promote territorial cohesion, as per Fricke (2015).

To conclude, it should be noted that the work developed in this study has some limitations that call for caution when generalising the results. Firstly, as already mentioned, the data comes from companies on the Galician side of the border area, which, although it is like other border contexts in Europe, has its own specific characteristics. Secondly, the selected companies are those that present accounts in the official register; therefore, some small companies are left out of the study. Thirdly, assets have been used as a summary of the firm and industry characteristics. Future studies should separate these into several components to analyse the specific effect of each type of asset. Furthermore, for a broader approach to border obstacles in the Minho area, it would be useful to fully implement the method proposed by Capello *et al.* (2018), breaking down the border effect into three large groups of obstacles: physical, institutional, and socio-cultural. This may expand the focus to the broader cross-border region, leading to possible comparative studies with other European areas.

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CONFLICT OF INTEREST

The authors have no relevant financial or non-financial interests to disclose.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available upon reasonable request. Please contact the author to access the data.

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