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Trade agreements and subnational income of border regions

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Abstract

This paper analyses the differential effect of trade agreements on income per capita of subnational regions with international borders. We construct an extensive panel dataset covering 1350 regions in 86 countries worldwide between 1950 and 2017. Our results show that trade agreements are positively associated with income per capita of regions sharing contiguous borders with trading partners, relative to regions sharing borders with countries with whom no trade agreements exist. For border regions, the positive relationship of trade agreements and regional income roughly compensates potential income disadvantages of having international borders. These insights help in explaining and mitigating regional inequalities.

KEYWORDS
GDP per capita, regions with international borders, subnational analysis, trade agreements

JEL CLASSIFICATION
F15, F43, O18, R12

1 | INTRODUCTION

Trade is an essential part of the economy with potential to increase welfare. Individuals trade both across subnational regions within countries and across countries. In *intra*national trade, the goods and services cross regional borders, while in *inter*national trade, they cross national borders. National borders are politically devised constraints, affecting the trade of goods and services. Specifically, they make trade between regions of different countries more costly than trade between regions within a country. Hence, regions might avoid trade with their international neighbors and instead focus on trade with neighboring regions in the same country.

Abbreviations: ARDECO, Annual Regional Database of the European Commission's Directorate General for Regional and Urban Policy; EEC, European Economic Community; EU, European Union; GADM, Database of Global Administrative Areas; GDP, gross domestic product; GIS, Geo-Information System; GISCO, Geographic Information System of the Commission; NAFTA, North American Free Trade Agreement; NUTS, Nomenclature des unités territoriales statistiques; PBL, Planbureau voor de Leefomgeving (Netherlands Environmental Assessment Agency); RTAs, Regional Trade Agreements; UK, United Kingdom; USD, United States dollar; USMCA, United States-Mexico-Canada Agreement; WTO, World Trade Organization.

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Aiming at reducing international trade barriers and facilitating trade, countries conclude trade agreements, such as the European Union or the North American Free Trade Agreement and its successor, the United States-Mexico-Canada Agreement (USMCA). While the predominantly positive effects of trade agreements on trade between countries are heavily studied in the literature, the effects of trade agreements on income per capita in subnational regions worldwide has, to the best of our knowledge, not been investigated. Subnational regions, which share a border with a country with whom a trade agreement has been concluded, may see their international trade increase. As a consequence, they may benefit more from the trade agreement in terms of economic growth than regions not neighboring this trading partner, since the latter do not encounter changes at their borders that could positively affect trade. This gives rise to the question whether international borders and trade agreements help explain regional income inequalities.

We empirically analyze the relevance of trade agreements for income per capita of subnational regions sharing international borders with trade agreement partners.[1] To estimate the differential effect of trade agreements for these regions, we use the shift-share method and construct variables measuring regions' degree of exposure to trade agreements due to sharing a contiguous border with the respective countries. We expect a positive differential effect of trade agreements between border regions' home countries and the regions' contiguous neighboring countries on income per capita. Our expectations are informed by three empirical regularities. First, trade agreements lower international trade costs and increase trade, as shown by Baier and Bergstrand (2007) and a large literature. Second, inspired by Frankel and Romer (1999), many studies show that trade raises income. Despite ongoing discussions regarding drivers of income growth (e.g., institutions, culture, geography, or trade, among others), there is a broad consensus that trade can serve as a channel to increase income per capita. Hence, provided that trade agreements increase trade and that trade raises income, trade agreements can be expected to have a positive effect on regional income. Third, focusing on regions with international borders, which we call *border regions*, we acknowledge the fact that their international borders may bring along negative *border effects*. McCallum (1995) as well as subsequent literature have highlighted the relevance of border effects, reducing international trade compared to trade among regions within a country. The potential positive effect of trade agreements may mitigate such a potential negative border effect on trade. Whether and to which extent trade agreements affect income per capita of border regions neighboring trade agreement partners is essentially an empirical question.

Our empirical results suggest a positive differential impact of trade agreements on income per capita for border regions, which mitigates a potential income disadvantage of border regions. Thus, despite cultural and linguistic barriers, which may remain when trade agreements have been formed, especially border regions seem to benefit from trade agreements with their neighboring countries. We establish these findings with a newly constructed dataset on 1350 regions from 86 countries worldwide over the years 1950–2017. Our dataset combines two data sources on regional income per capita with corresponding geographic information files. The following section provides a literature overview. Section 3 presents the data and the empirical method. In Section 4, we present and interpret our empirical results. Section 5 tests heterogeneity and robustness. Finally, Section 6 offers concluding remarks.

2 | LITERATURE

Our study is related to three strands of literature: (i) the literature on trade and growth, (ii) the international trade literature studying the effects of trade agreements and borders on trade, and (iii) the economic geography literature.

There is considerable research on the question whether international trade is beneficial for economic growth, as stressed for instance by Rodríguez and Rodrik (2001). So far, the literature has mainly focused on the cross-country effect of trade on growth. In their seminal cross-country study Frankel and Romer (1999) find a robust positive effect of international trade on income per capita. The overall positive effect of trade on economic growth has become an established fact in the literature (see Lewer & Van den Berg, 2003 for a survey and Feyrer, 2019 for a more recent study).

An extensive literature studies the effects of trade agreements and borders on international trade. In a survey, Maggi (2014) offers support to the expectation that trade agreements reduce trade costs, leading to more trade. Baier and Bergstrand (2007) and Romalis (2007), among others, show evidence for a strongly positive effect of trade agreements on trade flows among their member countries. In the international trade literature, the so-called "border effect" refers to the negative impact of international borders on trade volume, decreasing trade across countries relative to trade within countries (see Evans, 2003). Starting with McCallum (1995), empirical studies have found substantial border effects, suggesting that international borders impose high trade costs. Trade costs can result from differences in language, culture, customs, and regulations (see Anderson and van Wincoop, 2001, 2004).

We contribute to the literature on trade and growth as well as the literature on trade agreements and border effects, while differing in two main aspects. First, instead of providing country-level insights, we consider more disaggregated

subnational regions. While there are numerous recent efforts studying regional inequalities and regional growth (e.g., Crespo-Cuaresma et al., 2014; Greßer & Stadelmann, 2019; Proost & Thisse, 2019), existing regional studies lack a perspective on trade, mostly for reasons of data availability.[2] Detailed regional and standardized bilateral trade data, up to now, only exist for a handful of countries with a comparatively short time frame.[3] Therefore, we study the direct impact of trade agreements on border regions' income per capita, for which data with a worldwide coverage and a long time scope exist. This establishes our second difference, in that we focus on regional income per capita and do not explain trade flows as such. While the above-mentioned literature on trade and growth, trade agreements, and border effects suggests that changes in trade affect income, we do not offer evidence for the exact mechanism lying behind our findings. Hence, the evidence in our study, that border regions tend to be poorer than regions without an international border, differs from the classical *border effect*, which focuses on trade flows.

Theoretically, the link between trade and growth at the regional level and its relation to regional inequality has been pointed out by the economic geography literature, see Baldwin and Venables (1995, Section 4) as well as Baldwin and Martin (2004) and Ottaviano and Thisse (2004). Head and Mayer (2004) offer a survey on empirical strategies analyzing the regional distribution of economic activity and trade. An aspect that is often highlighted is the importance of market access for economic development. Redding and Sturm (2008) use the German division after the Second World War to show that cities close to the new border experienced lower economic development than cities with a greater distance to the border. Our analysis of border regions builds on the idea of lower economic development for border regions. We take international borders as constant over time[4] and explore changes in trade agreements formed across international borders. Focusing on Austrian regions, Brülhart et al. (2012) find positive effects of trade liberalization following the fall of the Iron Curtain on border regions' wages and employment. Our study extends and enriches such analyses by focusing on income per capita of subnational regions worldwide and trade agreements formed from 1950 onwards. Further recent attempts to link trade patterns to subnational economic activity use geo-referenced data and nightlights as proxy for development (e.g., Brülhart et al., 2019; Eberhard-Ruiz & Moradi, 2019).[5] To the best of our knowledge, our analysis is the first with a worldwide scope to consider the effects of trade agreements on income of regions sharing borders with countries with whom trade agreements exists.

3 | DATA AND EMPIRICAL METHOD

3.1 | Data

We establish a new dataset combining data on regional GDP per capita from Gennaioli et al. (2014) with data from the Annual Regional Database of the European Commission's Directorate General for Regional and Urban Policy (ARDECO). Our dataset includes a total of 17,233 observations of GDP per capita over the time period 1950–2017 from 1350 regions in 86 countries worldwide.

A region within a country is understood as a subnational administrative unit or disaggregated statistical division, such as the Eurostat NUTS2 in Europe. Combining the data from Gennaioli et al. (2014) on GDP per capita for regions worldwide with at most 5-year frequency (1950–2010), with yearly data on European regions from ARDECO (1980–2017) results in an extensive unbalanced panel dataset for our empirical analysis. About 60% of all observations in our sample originate from the ARDECO database, while 40% originate from Gennaioli et al. (2014). Our sample includes a large set of regions from Asia, Europe, North America, South America, and Oceania; African regions are, however, under-represented. Details on the countries in our sample, administrative regions per country, as well as years of observation are given in Table C1 in Supporting Information S2. In 2000, the year with the highest number of observations, the sum of all total regional GDP values in our sample amounts to 86% of global GDP.

The long time period covered in our dataset as well as its wide geographic scope provide us with abundant variation in trade agreements over time, which allows us to study the differential effect of trade agreements for border regions. Our independent variables measure regions' exposure to trade agreements due to contiguous international borders with the respective trading partner countries. More precisely, the variables indicate whether a region within a country shares a contiguous international border with a neighboring country with whom a trade agreement exists in a given year. We construct these as shift-share variables, where the "shifters" are trade agreements and the "shares" are international borders. In our initial specification, we construct the dummy variable $BORDERTA_{it}$, which takes the value 1 if region i has an international border and a trade agreement is in place with a neighboring country of region i in year t. We assemble further more precise measures of international borders by counting the number of regions' neighboring

countries and calculating the lengths of regions' international borders. In the same manner as for $BORDERTA_{it}$ we construct shift-share variables measuring regions' exposure to trade agreements using our different border measures.

When calculating our border measures, we understand an international border as a land border between two regions from different countries. The border characteristics are extracted from geospatial datasets (GIS files) originating from the GISCO dataset of the European Commission, Gennaioli et al. (2014), and the Database of Global Administrative Areas. Data on trade agreements are taken from Mario Larch's Regional Trade Agreements Database from Egger and Larch (2008), which provides annual information on trade agreements between countries worldwide from 1950 onwards and is constantly updated. The definition of a trade agreement is in line with the definition of the World Trade Organization, according to which it consists of (a combination of) a Free Trade Agreement, a Customs Union, an Economic Integration Agreement, or a Partial Scope Agreement.

Control variables come from diverse sources. Depending on the use of fixed effects, we account for regional coastal access, the absolute value of the region's geographical latitude, land area of the region, regions hosting the country's capital city, regional population density, and national trade openness, as well as national political institutions. Access to the coast may facilitate trade, distance to the equator correlates with economic development (see Andersen et al., 2016), land area may influence regional economic activity and trade, capital cities often represent trade centers and agglomerate national economic activity, and densely populated areas are economically more active. More details on data sources and descriptive statistics are provided in Table A1.

Our data show substantial income inequalities between regions, both across and within countries, as depicted in Figure 1. We aim at investigating to which degree the observed interregional income differences are related to international borders and trade agreements. Among the respective richest regions of each country, 33% have an international border, whereas among the respective poorest regions of each country, 65% have an international border. This suggests a negative association between international borders and regional income.

Figure 2 provides a motivation for our analysis. It shows that, on average, regions sharing a border with a country with whom no trade agreement exists are substantially poorer than regions without a border. However, if a trade agreement exists, regions with an international border have about the same average income levels as regions that do not have an international border. If anything, border regions neighboring a country with whom a trade agreement exists have on average slightly higher incomes than regions without a border and substantially higher incomes than border regions without a trade agreement. This suggests that trade agreements may lead to higher income for regions with international borders. We analyze empirically whether and to which extent trade agreements are directly associated with higher incomes for border regions. While our data does not allow us to identify a reduction in trade costs due to trade agreements and a subsequent rise in trade as the only mechanism to explain the pattern observed in Figure 2, the literature and theoretical reasoning are consistent with such a mechanism.

3.2 | Empirical method

To investigate the relevance of trade agreements for regions which share a border with the respective trading partner country, we capitalize on the literature on shift-share analysis, which was developed to study regional growth and the regional effects of tax and regulation policies, see Creamer (1943). Shift-share analyses model the impact of some intervention, called "shifter", on regions that have differential exposure to the intervention, called "shares". Recently, the shift-share analysis was used to investigate the effects of trade policy on regional outcomes (see e.g., Topalova, 2010; Kovak, 2013; and Caliendo & Parro, 2022 for a survey). Shift-share variables typically capture differential effects.

In our context, the "shifters" are the trade agreements between countries and the "shares" are regions' international borders, that is, we are interested in the differential effects of trade agreements for regions that are especially exposed by sharing a contiguous border with the respective country. Our baseline estimating equation to explain regional income per capita is

$$\ln(GDPpc)_{it} = \alpha_1^d BORDER_i + \alpha_2^d BORDERTA_{it} + \boldsymbol{\beta}\mathbf{x}_{it} + FE + \varepsilon_{it}, \quad (1)$$

where $\ln(GDPpc)_{it}$ is the logarithm of GDP per capita in region i in year t and $BORDER_i$ is a dummy variable taking the value 1 if region i has an international border.

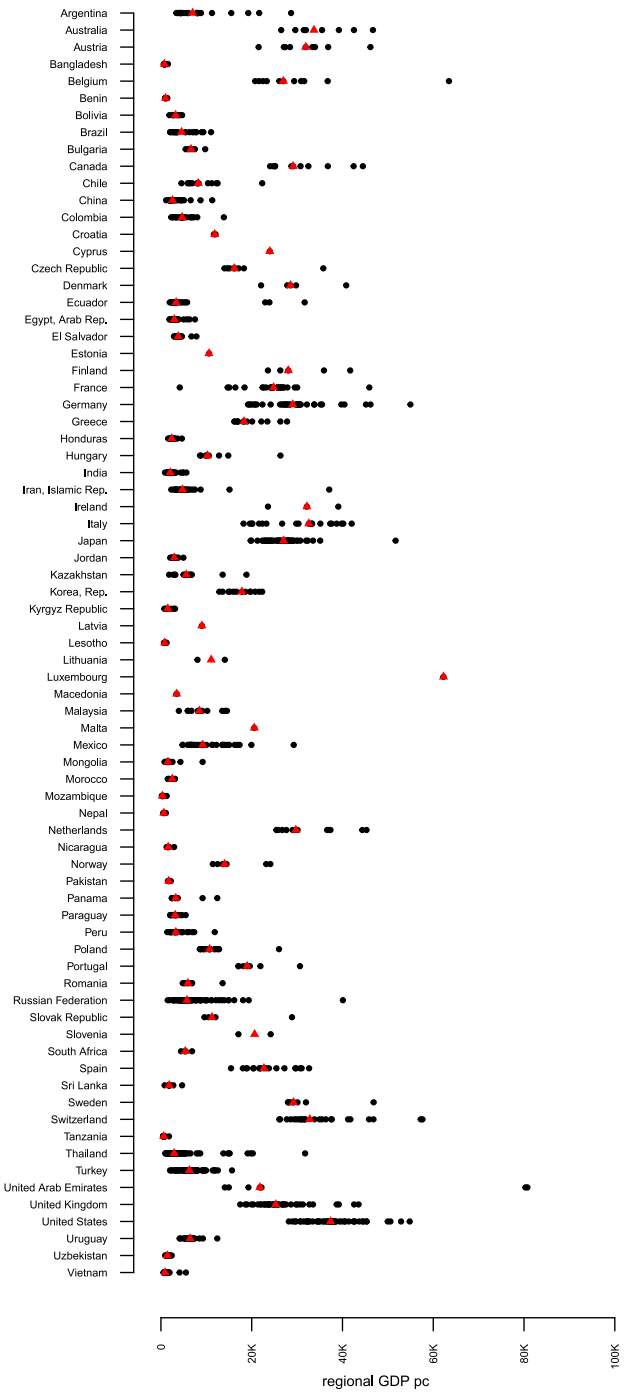

FIGURE 1 Regional GDP per capita in 2000 within Countries. The black dots represent GDP per capita (in USD) in individual regions in the respective country. Red triangles represent the median regional GDP per capita in the country. For 11 countries without observations from 2000, observations from 1998, 1999, 2001, or 2002 are depicted. The UK region Inner London West is excluded as an outlier, with a regional GDP per capita of 139,346 USD. [Colour figure can be viewed at wileyonlinelibrary.com]

$BORDERTA_{it}$ is a dummy variable capturing the exposure of border regions to trade agreements, taking the following shift-share form

$$BORDERTA_{it} = \mathbb{I}\left(\sum_{c\in\mathcal{C}}\sum_{n\in\mathcal{N}} CONTIG_{icn} TA_{cnt}\right),$$

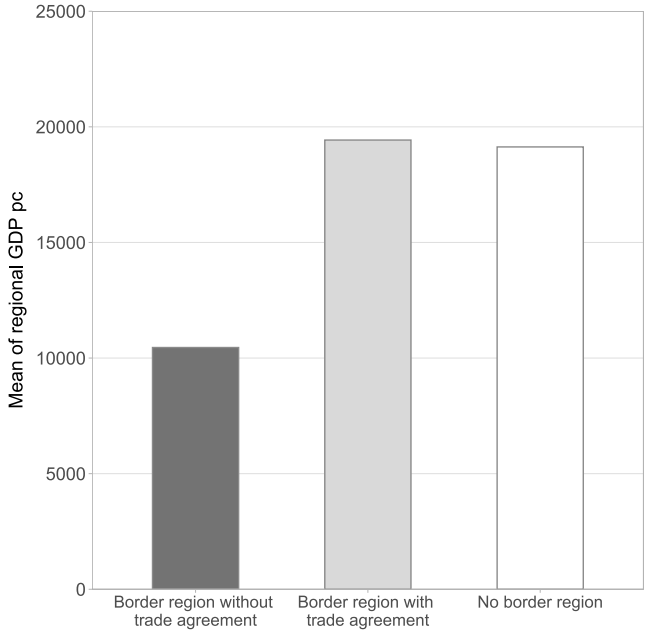

FIGURE 2 Average regional GDP per capita, conditional on trade agreements and borders. The bars show the average GDP per capita (in USD) for regions with an international border without a trade agreement (left), regions with an international border with a trade agreement (middle), and regions without an international border (right).

where $\mathcal{C}$ is the set of all countries for which we have regional data, $\mathcal{N}$ is the set of all their neighboring countries, $CONTIG_{icn}$ is an indicator variable taking the value 1 if region i is in country c and shares an international border (i.e., is contiguous) with country n, TA_{cnt} is an indicator variable taking the value 1 if country c has a trade agreement with country n in year t, and $\mathbb{I}$ is an indicator function giving the value 1 if $\left(\sum_{c\in\mathcal{C}}\sum_{n\in\mathcal{N}} CONTIG_{icn}TA_{cnt}\right) > 0$, and 0 else. Hence, $BORDERTA_{it}$ takes the value 1 if region i shares a border with at least one country with whom a trade agreement exists in year t and 0 else. $\mathbf{x}_{it}$ is a vector of control variables and $\boldsymbol{\beta}$ is a corresponding vector of coefficients. FE are different kinds of fixed effects (region fixed effects or country-year fixed effects). ε_{it} is an idiosyncratic error term. α_1^d gives the association between having an international border and regional income per capita. The differential effect of sharing a border with a country with whom a trade agreement exists on regional income per capita, relative to sharing a border with a country with whom no trade agreement exists, is $\left[\exp\left(\alpha_2^d\right) - 1\right] \times 100$ percent.

The inclusion of fixed effects, which control for unobserved heterogeneity, naturally reduces variation in the regressors. Since $BORDER_i$ and $BORDERTA_{it}$ are dummy variables, our specification improves by using variables with more variation. Thus, we refine and extend estimating Equation (1) by introducing different measures of international borders. A first refinement are count variables, $\#BORDER_i$ and $\#BORDERTA_{it}$, counting the number of a region's international borders with different countries and the number of international borders shared with countries with whom trade agreements exist, respectively. $\#BORDERTA_{it}$ directly captures the sums,

$$\#BORDERTA_{it} = \sum_{c\in\mathcal{C}}\sum_{n\in\mathcal{N}} CONTIG_{icn}TA_{cnt}.$$

Using count variables rather than dummy variables is preferable, as it accounts for the fact that regions may share a border with several countries, some with and others without trade agreements. Our second estimating equation is thus

$$\ln(GDPpc)_{it} = \alpha_1^n \#BORDER_i + \alpha_2^n \#BORDERTA_{it} + \boldsymbol{\beta}\mathbf{x}_{it} + FE + \varepsilon_{it}. \quad (2)$$

The differential effect of sharing an additional border with a country with whom a trade agreement exists, relative to an additional border with a country with whom no trade agreement exists, on regional income per capita is $\alpha_2^n \times 100$ percent.

A further refinement as well as a robustness check of our border variables is measuring the length of regions' international borders. The length of international borders may serve as a more precise measurement than dummy or

count variables and longer borders may give more opportunity to trade across the border. Our third estimating equation is thus

$$\ln\left(GDPpc\right)_{it} = \alpha_1^l BORDERkm_i + \alpha_2^l BORDERkmTA_{it} + \boldsymbol{\beta}\mathbf{x}_{it} + FE + \varepsilon_{it}, \tag{3}$$

where $BORDERkm_i$ is the length of region i's international border in 100 km. The shift-share form using the length of borders becomes

$$BORDERkmTA_{it} = \sum_{c\in\mathcal{C}}\sum_{n\in\mathcal{N}} CONTIGkm_{icn}TA_{cnt},$$

where $CONTIGkm_{icn}$ gives the length of the contiguously shared international border in 100 km between region i in country c and country n. $BORDERkmTA_{it}$ thus measures the length of international borders shared with countries with whom trade agreements exist. The differential effect of sharing an additional 100 km of international border with a country with whom a trade agreement exists, relative to an additional 100 km of international border with a country with whom no trade agreement exists, on regional income per capita is $\alpha_2^l \times 100$ percent.

Especially regions whose borders consist to a large extent of international borders may face higher trade barriers than regions whose borders consist to a larger part of within-country borders. Hence, we introduce a further variable, giving the percentage share of international border in the total perimeter of a region, $\%BORDER_i$, yielding our fourth estimating equation

$$\ln(GDPpc)_{it} = \alpha_1^p \%BORDER_i + \alpha_2^p \%BORDERTA_{it} + \boldsymbol{\beta}\mathbf{x}_{it} + FE + \varepsilon_{it}. \tag{4}$$

Here, the shift-share form is given by

$$\%BORDERTA_{it} = \sum_{c\in\mathcal{C}}\sum_{n\in\mathcal{N}} \%CONTIG_{icn}TA_{cnt},$$

where $\%CONTIG_{icn}$ gives the percentage share of the contiguously shared international border between region i in country c and country n in the total perimeter of region i. $\%BORDERTA_{it}$ accordingly measures the percentage share of international borders shared with countries with whom trade agreements exist in the region's total perimeter. The differential effect of a one percentage point increase in international border shared with a country with whom a trade agreement exists, relative to a one percentage point increase in international border shared with a country with whom no trade agreement exists, on regional income per capita is $\alpha_2^p \times 100$ percent.

Figure 3 illustrates our different variables, taking the French region Alsace as an example. Alsace has two international borders, with Germany and Switzerland, implying $BORDER_{Alsace} = 1$ and $\#BORDER_{Alsace} = 2$. The total length of Alsace's international border is 280 km, implying $BORDERkm_{Alsace} = 280$ km, where the shared border with Germany is 219 km long and the shared border with Switzerland is 61 km long. With a perimeter of 630 km, the international border makes up about 44% of Alsace's total perimeter, $\%BORDER_{Alsace} = 44\%$, where the shared border with Germany amounts to roughly 34% and the shared border with Switzerland amounts to roughly 10%. In 1950, France had not yet formed any trade agreement with Germany or Switzerland, such that the variables take the values as specified in Figure 3. By 1958, France and Germany had both joined the European Economic Community, implying that a trade agreement existed between France and Germany, while there was still no trade agreement between France and Switzerland. Hence, *BORDERTA* takes the value one, *#BORDERTA* counts one trade agreement, *BORDERkmTA* gives the border length between Alsace and Germany, and *%BORDERTA* gives the percentage of Alsace's perimeter shared with Germany. In 1973, a trade agreement with Switzerland entered into force, such that from this year onwards also a trade agreement existed between France and Switzerland, implying the values given in the figure.

3.3 | Potential endogeneity concerns

A causal interpretation of the estimated coefficients for our border measures and our shift-share variables capturing border regions' exposure to trade agreements is only possible if these regressors are exogenous.

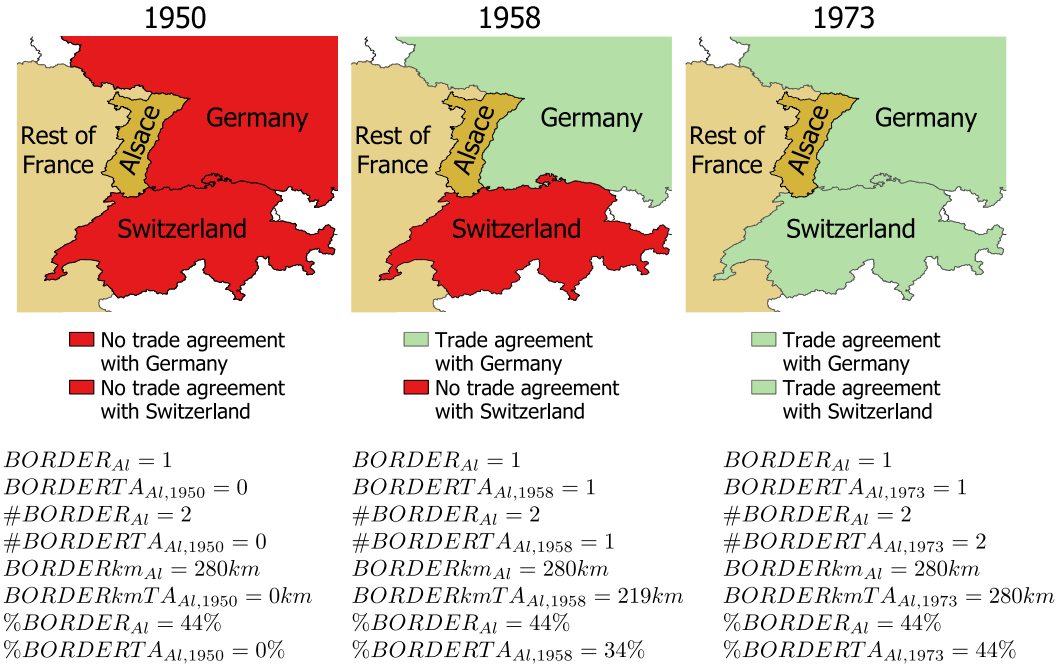

FIGURE 3 Trade agreements and the international borders of Alsace. Map of the French region Alsace for the years 1950 (no trade agreement), 1958 (trade agreement with Germany), and 1973 (trade agreement with Germany and Switzerland). Details on calculations are provided in Supporting Information S2. *Source*: Own illustration, based on Geo-Information System file from Eurostat GISCO. [Colour figure can be viewed at wileyonlinelibrary.com]

First, consider potential endogeneity of our different border measures. International borders have to be as good as randomly assigned in order to be exogenous for quantifying the effects on regional income. As argued by Santamaria et al. (2021), this could be violated when border demarcation is affected by geography, such as coasts, ruggedness, or rivers. Geography precedes borders and affects trade, which, in turn, affects regional income, according to our above discussion. In our sample, international borders do not vary over time, similarly as geography does not vary over time.[6] Hence, the remaining variation in borders is across regions. On the one hand, this precludes the possibility of geography causing a change in borders in our sample. On the other hand, this allows us to perfectly control for geography and borders with region fixed effects. When estimating the effects of border regions' exposure to trade agreements, we also use specifications with region fixed effects that perfectly control for regional geography and international borders and hereby control for potential endogeneity of international borders.

Second, consider potential endogeneity of trade agreements. The effects of trade agreements on trade and related potential endogeneity concerns are discussed at length in the literature (Baier & Bergstrand, 2007; Egger et al., 2011; Head & Mayer, 2014). Countries may not select their trade agreement partners randomly, but select them well. In our estimations, we are not interested in the overall effect of trade agreements, but in the differential effect of trade agreements on regional income per capita for border regions. Hence, the information on trade agreements serves for the construction of our shift-share variables, but is not used as variable itself. Nevertheless, given that they are a component of our variables, we want to discuss the potential endogeneity of trade agreements with respect to regional income per capita. One may argue that for a region the conclusion of a trade agreement is credibly exogenous, considering that trade agreements are a national policy choice. However, regions may exert influence on national decisions, with richer regions potentially having larger influence. If this was the case, the conclusion of trade agreements might be influenced by regional income. To control for national policy decisions in our estimations, we use some specifications with country-year fixed effects. In these specifications, we perfectly control for potential endogeneity of trade agreements.

Third, consider potential endogeneity of our shift-share variables, quantifying the differential effect of trade agreements for border regions due to their differential exposure. Endogeneity concerns may arise if the discussed potential endogeneity of trade agreements is systematically related with the fact of being a border region. Although we estimate specifications with different fixed effects, we cannot fully exclude this possibility and are cautious not to make strong causal claims. Our various specifications and robustness checks, however, control for many concerns and we therefore believe that we offer relevant and new empirical insights into the relevance of trade agreements for border regions.

4 | RESULTS

4.1 | Borders, trade agreements, and regional income

We start by estimating our easily interpretable dummy variable specification in Equation (1) with *BORDER* and *BORDERTA*. We cluster our standard errors at the country-year level to allow errors of regions to be correlated within countries for each year. In our setting, with regional income being observed at the region-year level while trade agreements are observed at the country-year level, different clustering methods are possible (see also Abadie et al., 2023) and yield robust results.[7]

Overall, the results in Table 1 show that international borders are negatively associated with regional income, while trade agreements are positively associated with income of regions sharing a contiguous border with the respective trading partner country. The negative and positive coefficients in each respective specification are of similar magnitude, such that the tendencies tend to effectively cancel each other out.

Column (1) shows a negative and significant association between *BORDER* and regional income per capita, while *BORDERTA* is significant and positively associated with regional income per capita. All control variables are positively related to regional income and mostly significant.[8] Given the structure of our panel data, we can apply different types of fixed effects to control for unobserved heterogeneity. As noted, fixed effects naturally reduce the variation of our regressors of interest, which is already limited for binary dummy variables. Nonetheless, before moving on to our alternative border measures, we include region fixed effects in Column (2), which allow to control for any factor affecting regional income per capita for each individual region that is constant over time. Especially, geography and international borders are controlled for, such that the remaining identified variables are the shift-share term *BORDERTA* aside time-varying regional population density and the national controls of trade openness and institutions.[9] When region fixed effects are included, border regions with whose neighbors no trade agreements exist in the entire sample's time period are not used to identify *BORDERTA*. In this setting, the coefficient of *BORDERTA* is identified from regions which share a border with a country with whom a trade agreement exists and border regions neighboring countries with whom a trade agreement does not yet exist. As shown in Column (2), the differential effect amounts to a highly significant increase in regional income of about 7.9%.

The following columns of Table 1 show the results of estimating Equation (2) using our border count variables *#BORDER* and *#BORDERTA*. Column (3) shows that the findings are qualitatively and quantitatively similar, where an additional international border is negatively associated with regional income, while an additional border shared with a country with whom a trade agreement exists is positively associated with regional income. With count variables having more variation than our dummy variables, we apply two different kinds of fixed effects. In Column (4), we include country-year fixed effects which control, for instance, for national GDP in a given year, changes in national institutions, or in national trade openness. Especially, country-year fixed effects control for an average effect of trade agreements for all regions in the same country. In this setting, the coefficient of *#BORDERTA* is identified from regions sharing borders with countries with whom trade agreements exist and regions in the same country which share borders with countries with whom trade agreements do not (yet) exist. The difference between border and non-border regions is captured by the border measure (here *#BORDER*). The coefficient for *#BORDERTA* is highly significant and amounts to an increase in regional income of about 4.1%.

Note that country-year fixed effects only account for a general country-time specific effect. Hence, *#BORDERTA* picks up part of a differential country-specific globalization trend between border regions and non-border regions. This trend is not necessarily related to trade agreements and not captured by the border measure, which captures overall (non-country-specific, non-time-varying) differences between border regions and non-border regions. In Column (5), we therefore show results when restricting the sample to only the border regions. Restricting the sample to the border regions also prevents potentially overestimating the differential effect of trade agreements for border regions due to spillovers, considering that after trade agreements have entered into force, economic activity may be relocated from countries' interior to border regions. These interior regions are excluded from this sample. The differential effect of trade agreements is highly significant and amounts to an increase in regional income of about 7.6%. We also run all regression specifications from Table 1 for the restricted sample including only border regions (Table C4 in Supporting Information S2). Results are robust. In Column (6), including region fixed effects, an additional border with a country with whom a trade agreement exists increases regional income by an additional 5.8%.[10]

Next, we investigate pre-trend effects of trade agreements for regions sharing a border with the trading partner, which could potentially bias our estimates. To do so, we follow Baier and Bergstrand (2007) and add a lead, that is, the

TABLE 1 Borders, trade agreements, and regional income: regression results.

	Dependent variable: ln(GDPpc)					
	(1)	(2)	(3)	(4)	(5)	(6)
BORDER	−0.297***					
	(0.051)					
BORDERTA	0.243***	0.076***				
	(0.060)	(0.022)				
#BORDER			−0.191***	−0.032***	−0.030***	
			(0.022)	(0.007)	(0.006)	
#BORDERTA			0.205***	0.041***	0.076***	0.058***
			(0.029)	(0.008)	(0.009)	(0.012)
Coast	0.188***		0.191***	0.090***	0.115***	
	(0.027)		(0.028)	(0.015)	(0.015)	
Latitude	0.033***		0.033***	0.019***	0.013***	
	(0.002)		(0.002)	(0.001)	(0.002)	
Area	0.0004***		0.0004***	0.0002***	0.0001***	
	(0.0001)		(0.0001)	(0.00003)	(0.00003)	
Capital	0.218***		0.242***	0.466***	0.392***	
	(0.029)		(0.030)	(0.016)	(0.024)	
ln(PopDensity)	0.099***	0.286***	0.099***	0.041***	−0.002	0.285***
	(0.016)	(0.041)	(0.016)	(0.005)	(0.006)	(0.041)
Openness	0.0004	0.008***	0.0002			0.008***
	(0.001)	(0.0005)	(0.001)			(0.0005)
Polity2	0.088***	0.007*	0.087***			0.007*
	(0.007)	(0.004)	(0.007)			(0.004)
Constant	6.887***		6.879***			
	(0.104)		(0.107)			
Region FE		Yes				Yes
Country-year FE				Yes	Yes	
Only border regions					Yes	
Observations	16,266	16,266	16,266	17,183	7884	16,266
Adjusted R^2	.641	.957	.644	.913	.933	.957

Note: Standard errors clustered at the country-year level are reported in parentheses.
p-values of the two-sided *t* test are reported with asterisks, with *$p < .1$, **$p < .05$, and ***$p < .01$.

future level of the shift-share variables, as well as four lags to our regressions with region fixed effects. The plots in Figure D1 in Supporting Information S2 show the effects of the lead and the lags, where the lead is insignificant, while the positive effects of our shift-share variables become significant from the second period onwards after a trade agreement was concluded. Hence, we find no evidence for significant pre-trends.

4.2 | Length of borders, trade agreements, and regional income

In the following, we estimate Equations (3) and (4), using our refined border measures *BORDERkm* and *%BORDER*. Columns (1)–(3) of Table 2 show significant results for the border length, where an increase in the border length is

TABLE 2 Length of borders, trade agreements, and regional income: regression results.

	Dependent variable: ln(GDPpc)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
BORDERkm	−0.029***	−0.005***	−0.005***					
	(0.004)	(0.002)	(0.002)					
BORDERkmTA	0.019***	0.007***	0.009***	0.011***				
	(0.006)	(0.002)	(0.002)	(0.002)				
%BORDER					−0.010***	−0.002***	−0.003***	
					(0.001)	(0.0004)	(0.0004)	
%BORDERTA					0.010***	0.002***	0.003***	0.002***
					(0.002)	(0.0004)	(0.0005)	(0.001)
Coast	0.186***	0.088***	0.100***		0.176***	0.083***	0.096***	
	(0.026)	(0.015)	(0.015)		(0.028)	(0.015)	(0.016)	
Latitude	0.033***	0.019***	0.014***		0.033***	0.018***	0.012***	
	(0.002)	(0.001)	(0.002)		(0.002)	(0.001)	(0.002)	
Area	0.001***	0.0002***	0.0001***		0.0003***	0.0002***	0.0001***	
	(0.0001)	(0.00003)	(0.00003)		(0.0001)	(0.00003)	(0.00002)	
Capital	0.226***	0.464***	0.387***		0.239***	0.463***	0.391***	
	(0.031)	(0.016)	(0.024)		(0.029)	(0.016)	(0.024)	
ln(PopDensity)	0.102***	0.041***	−0.0002	0.282***	0.096***	0.038***	−0.006	0.289***
	(0.016)	(0.005)	(0.006)	(0.040)	(0.016)	(0.005)	(0.006)	(0.041)
Openness	0.0004			0.008***	0.0004			0.008***
	(0.001)			(0.0005)	(0.001)			(0.0005)
Polity2	0.087***			0.007*	0.088***			0.007*
	(0.007)			(0.004)	(0.007)			(0.004)
Constant	6.841***				6.905***			
	(0.108)				(0.105)			
Country-year FE		Yes	Yes			Yes	Yes	
Region FE				Yes				Yes
Only border regions			Yes				Yes	
Observations	16,266	17,183	7884	16,266	16,266	17,183	7884	16,266
Adjusted R^2	.640	.913	.932	.957	.644	.913	.933	.957

Note: Standard errors clustered at the country-year level are reported in parentheses.
p-values of the two-sided *t* test are reported with asterisks, with *$p < .1$, **$p < .05$, and ***$p < .01$.

negatively associated with regional income, while in Columns (1)–(4) an increase in the border length shared with a country with whom a trade agreement exists is significant and positively associated with regional income. Columns (5)–(7) show significant results for the border percentages, where an increase in the share of international border is negatively associated with regional income, while an increase in the share of international border with a country with whom a trade agreement exists is significant and positively associated with regional income in Columns (5)–(8). For both border measures, the countervailing tendencies are of similar magnitude. Thus again, the disadvantage of being a border region may be compensated by a trade agreement with a neighboring country.

In Columns (2) and (6) country-year fixed effects control for a general effect of trade agreements for regions in the same country. Results for the same specifications, while considering only border regions in our sample, are shown in

Columns (3) and (7). The results in Column (3) suggest that an additional 100 km of border length shared with a country with whom a trade agreement exists is associated with an additional increase in regional income of 0.9%. The results in Column (7) suggest that a 10 percentage point increase in international border shared with a country with whom a trade agreement exists is associated with an additional increase in regional income of 3%.

In a setting with region fixed effects (Columns 4 and 8), when comparing border regions, with whose neighbors trade agreements exist, to other border regions, with whose neighbors trade agreements do not yet exist, an additional 100 km of border length is associated with an additional increase in regional income of 1.1%. A 10 percentage point increase in international border shared with a country with whom a trade agreement exists is associated with an additional increase in regional income of 2%. All these results suggest a positive differential effect of trade agreements for border regions, no matter which border measure is used.[11]

To illustrate the quantitative implications of our estimated coefficients, we focus on some exemplary regions and specifications with only border regions and country-year fixed effects. Consider our example from Figure 3. Alsace is especially exposed to trade agreements concluded with Germany and Switzerland due to being a direct neighbor, compared with French border regions that are not direct neighbors of these countries. Hence, for Alsace, the results in Column (3) imply that the trade agreement with Germany would be expected to increase income by an additional 2%, while the trade agreement with Switzerland would be expected to increase income by an additional 0.5%.[12] More generally, for a region with the mean border length of 358 km among the border regions in the sample, the conclusion of a trade agreement with its neighboring country implies an additional increase in income of about 3.2%, compared with border regions that do not share a border with this country.

Turning to the percentage shares in Column (7), for Alsace, the trade agreement with Germany would be expected to increase income by an additional 10.2%, while the trade agreement with Switzerland would be expected to increase income by an additional 3%. For a region with the mean percentage share of international border in its total perimeter, among the border regions in the sample, of 29.3%, the conclusion of a trade agreement with its neighboring country implies an additional increase in income of about 8.8%. Thus, border regions seem to particularly profit from trade agreements with neighboring countries.

5 | HETEROGENEITY AND ROBUSTNESS

To shed light on the mechanisms lying behind our findings, we investigate potential heterogeneity of the differential effect of trade agreements for border regions. We use our refined border measures *#BORDER*, *BORDERkm*, and *%BORDER* for better precision and more variation when employing fixed effects.

Trade agreements may be of different importance for border regions in countries with a smaller and a larger home market. Hence, we split our sample into high-income and non-high-income countries, based on the World Bank's country classification. Table C6 in Supporting Information S2 shows results for both country groups separately. Especially specifications using the subsample of border regions and country-year fixed effects suggest that the significant and positive effect of trade agreements for border regions holds for regions in high-income as well as for regions in non-high-income countries. If anything, the results with region fixed effects appear more robust for high-income countries, that is, for regions in countries with a larger home market.

Next, we investigate the home market in terms of land area. Table C7 in Supporting Information S2 shows that the results are qualitatively the same for regions in countries with a large land area and those with a small land area, that is, the border measures are negatively associated with regional income, while the shift-share variables on trade agreements for border regions are positively associated with regional income.

According to the empirical trade literature, the income levels of trading partners increase trade flows, such that we may expect the relative economic importance of neighbors to influence the differential effect of trade agreements for border regions. Similarly, relative population densities across neighbors may matter, see Li (2021). Thus, we split the subsample of border regions into a sample of regions with an economically important neighbor and a sample of regions with an economically less important neighbor. Table C8 in Supporting Information S2 shows that, by and large, the positive differential effect of trade agreements for border regions holds, both for regions with and without economically important neighbors. Regarding magnitude, the coefficients of the shift-share variables tend to be larger for regions with economically important neighbors, in line with the empirical trade literature and Li (2021).

Next, we explore potentially different effects for different types of trade agreements, which have varying levels of integration. To test for such heterogeneity, we differentiate between four groups of trade agreements: (i) Free Trade Agreements,[13] which cover goods trade amongst member countries, (ii) Customs Unions,[14] which also cover goods

trade, while members also commit to a common external policy regarding non-members, (iii) Economic Integration Agreements (EIA), which cover services trade amongst member countries, and (iv) Partial Scope Agreements, which cover only certain products. Results for our border measures and shift-share variables using the different types of trade agreements are shown in Table 3. We obtain similar point estimates for Free Trade Agreements and Customs Unions, while EIA appear to be especially beneficial for border regions, notably in specifications with region fixed effects. This suggests that the differential effect of services trade agreements plays a major role for border regions, which could be due to the fact that many services are still hard to trade and more localized. More recently, services trade has become increasingly important and the fall of multilateral tariffs for goods over time may also mitigate the differential effect of goods trade agreements. Partial Scope Agreements tend to be less significant, as could be expected.

We provide further robustness checks, using different subsamples of our data. First, given that our panel dataset is unbalanced, which comes with the advantage of a wide coverage of regions worldwide over a long time period, we address the concern of sample composition effects by testing whether our results hold in balanced subsamples. On the one hand, we can turn our worldwide dataset into a fully balanced panel, also in terms of availability of all control variables. For this, we use the five most frequently observed years (1990, 1995, 2000, 2005, 2010), yielding 2530 observations on 506 regions. Results for this balanced subsample are shown in Panel A of Table C10 in Supporting Information S2. In some specifications, we see a loss in significance, especially in specifications with region fixed effects. This is perhaps not surprising, given that we only use variation of 5 years and thus have a low number of observations (2530 compared with 16,266 observations in our unbalanced dataset, when considering availability of all control variables).

Note that the ARDECO dataset, which contributes to about 60% of our combined dataset, provides yearly data and is nearly balanced. We thus turn the ARDECO subsample of European regions into a fully balanced sample, also in terms of availability of all control variables, by which we obtain 7790 observations on 205 regions observed in 38 years. The results for regressions using this balanced subsample, shown in Panel B of Table C10 in Supporting Information S2, are by and large robust, especially when using region fixed effects. However, as in the above case, the results appear not as robust as for the entire unbalanced dataset. This highlights the advantage of our effort to combine the worldwide but less frequent data from Gennaioli et al. (2014) with the more frequent yearly European data from ARDECO.

Having noted the importance of combining the data from our two sources, we split our joint sample by data source and individually run our regressions with the data originating from ARDECO and from Gennaioli et al. (2014). Results of these separate regressions are given in Table C11 in Supporting Information S2. They show that it is crucial to extend the dataset, that is, to combine the long time coverage and wide geographic coverage of the dataset of Gennaioli et al. (2014), allowing for lots of variation in trade agreements, with more recent yearly data on European regions of the ARDECO dataset.

Recapturing our discussion of endogeneity in Section 3.3, one may argue that regions in more decentralized countries exert more influence on national decisions and thus the conclusion of trade agreements is more likely endogenous for these regions. We exclude regions in decentralized countries (based on Fisman & Gatti, 2002) from our sample and run our regressions for the obtained subsample separately, shown in Table C12 in Supporting Information S2. The border measures are significant and negatively associated with regional income, while the shift-share variables on trade agreements for border regions are positively associated with regional income. Thus, the same picture emerges also for regions which have less influence on national decisions.

Overall, our additional checks confirm the results of a positive differential effect of trade agreements for border regions neighboring trade agreement partners, which are largely robust even for much smaller subsamples from our original dataset. The positive differential effect of trade agreements for border regions holds regardless of home market size. The underlying mechanism inducing a positive estimate for the differential effect of trade agreements for border regions may indeed be international trade, where trade agreements play a larger role if the neighboring market is economically important and if trade barriers are reduced by deep rather than shallow trade agreements. All this is also in line with predictions from the new trade theory and empirical results from the international trade literature. In these studies, trade agreements are associated with a decrease in trade costs and, ceteris paribus, lead to larger gains in terms of income for larger foreign markets (see e.g., Baier & Bergstrand, 2004) and for stronger trade cost reductions through deeper trade agreements (see e.g., Dür et al., 2014).

6 | CONCLUSION

We explore the relevance of trade agreements for income per capita of subnational regions which share a contiguous border with a trade agreement partner country. Regressions using an extensive panel dataset covering 1350 regions in 86 countries worldwide between 1950 and 2017 find a positive differential effect of trade agreements on regional income

TABLE 3 Regression results for different types of trade agreements.

	Dependent variable: ln(GDPpc)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
#BORDER	−0.029***	−0.026***							
	(0.007)	(0.007)							
#BORDERFTA	0.032***	0.073***	0.045***						
	(0.011)	(0.010)	(0.012)						
#BORDERCU	0.033***	0.036**	0.030**						
	(0.012)	(0.014)	(0.014)						
#BORDEREIA	0.012	0.038***	0.072***						
	(0.009)	(0.013)	(0.012)						
#BORDERPSA	0.005	0.041	0.031						
	(0.023)	(0.028)	(0.026)						
BORDERkm				−0.006***	−0.006***				
				(0.002)	(0.002)				
BORDERkmFTA				0.003	0.008***	0.013***			
				(0.003)	(0.003)	(0.003)			
BORDERkmCU				−0.001	−0.002	0.005			
				(0.004)	(0.005)	(0.005)			
BORDERkmEIA				0.010***	0.010***	0.035***			
				(0.003)	(0.003)	(0.004)			
BORDERkmPSA				0.007***	0.008***	0.009***			
				(0.003)	(0.003)	(0.002)			
%BORDER							−0.001***	−0.002***	
							(0.0004)	(0.0004)	
%BORDERFTA							0.001	0.002***	0.001**
							(0.001)	(0.0005)	(0.001)
%BORDERCU							0.0004	0.0003	0.001*
							(0.001)	(0.001)	(0.001)
%BORDEREIA							0.001***	0.002***	0.002***
							(0.0005)	(0.001)	(0.001)
%BORDERPSA							−0.0004	−0.0003	−0.0004
							(0.001)	(0.001)	(0.001)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-year FE	Yes	Yes		Yes	Yes		Yes	Yes	
Region FE			Yes			Yes			Yes
Only border regions		Yes			Yes			Yes	
Observations	17,183	7884	16,266	17,183	7884	16,266	17,183	7884	16,266
Adjusted R^2	.913	.933	.957	.913	.932	.958	.913	.932	.957

Note: Four different types of trade agreements are used for construction of the shift-share variables: FTA (summarizing Free Trade Agreements and Free Trade Agreements & Economic Integration Agreements), CU (summarizing Customs Unions and Customs Unions & Economic Integration Agreements), EIA (Economic Integration Agreements), and PSA (Partial Scope Agreements). Standard errors clustered at the country-year level are reported in parentheses. *p*-values of the two-sided *t* test are reported with asterisks, with $*p < .1$, $**p < .05$, and $***p < .01$.

for border regions neighboring the trading partner. The relevance of trade agreements for border regions is independent of home market size and tends to be stronger for border regions with an economically important neighboring country or with a neighboring country with whom a deep integration agreement exists.

Our analysis extends and complements existing literature by taking a subnational perspective and shows the importance of considering regional heterogeneity when quantifying the effects of trade agreements. Applying the shift-share method to our new and extensive dataset allows us to offer novel insights into the ambitious study of the effects of trade agreements at the subnational level. Especially our broad coverage of regions worldwide over a long time period allows us to use abundant variation in trade agreements and the shift-share method makes it possible to quantify border regions' differential exposure to these trade agreements due to their international borders.

Our results imply that trade agreements may affect inequalities across regions by reducing potential income disadvantages which we empirically observe for border regions. Thereby, our findings can help explaining and mitigating regional inequalities within countries. Having an international border is associated with a lower income per capita than having no international border, other things being equal. According to our results, a possible mitigation of the observed disadvantage of having an international border is the conclusion of a trade agreement, since a region with an international border is likely to benefit relatively more from a trade agreement with its neighboring country than a region without an international border. Thus, trade agreements may help border regions to catch up with non-border regions in terms of income per capita. Viewed from that standpoint, policy aiming to reduce interregional inequalities may want to consider the relevance of trade agreements.

Overall, our results and interpretations are consistent with the view of the literature that (i) trade increases income, (ii) international borders decrease trade, and (iii) trade agreements increase trade. Nonetheless, we acknowledge that our setting does not deliver direct evidence on the mechanism through which borders and trade agreements affect regional income. More precisely, we do not analyze specifically whether it is via their effect on trade that trade agreements influence regional income of border regions. We see further fruitful research avenues on the underlying mechanisms as well as alternative specifications and identification strategies. A promising avenue for exploring the precise mechanisms by which borders and trade agreements affect regional income may be to investigate regional specialization after trade agreements, both across international borders and when comparing border and non-border regions within countries. Another avenue is to establish a theoretical model on the channel from international borders and trade agreements to interregional trade and from interregional trade to regional income. Given the restricted data availability of bilateral regional trade flows, our empirical approach may serve as a starting point for such models.

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DATA AVAILABILITY STATEMENT

The data and replication files that support the findings of this study are openly available in openicpsr at https://doi.org/10.3886/E191609V3.

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ENDNOTES

[1] In the World Trade Organization's (WTO) terminology, Regional Trade Agreements (RTAs) refer to trade agreements among countries. To avoid misunderstandings, we use the term *trade agreements*. When referring to *regional* income, we mean income per capita of *subnational* regions within countries.

[2] Nonetheless, macroeconomic shocks and trade have been shown to induce different effects across regions within a country (see Krebs, 2020, for a study of Germany). Additionally, note that substantial growth inequalities among regions within countries exist, see Puga (2002) for regions in the EU, Acemoglu and Dell (2010) for regions in the Americas, or Mitton (2016) and Gennaioli et al. (2014) for regions worldwide.

[3] Krebs (2020) provides data for German regions, allowing quantification of regional economic effects of trade in Germany. Llano-Verduras et al. (2021) use trade data on Spanish Autonomous Communities. The PBL Netherlands Environmental Agency and the European Commission have developed interregional trade data for European NUTS2 regions for the period 2000–2010, see Thissen et al. (2019). While their data is useful for regional input-output analyses within Europe, they do not suit our worldwide long-run evaluation of the effects of trade agreements for border regions. To capture these effects of trade agreements we need a wide coverage of countries and time.

[4] Observations on regions with changes in their international borders, for example, due to the dissolution of the Soviet Union, are not included in our dataset. Thus, international borders in our sample are constant over time. Details can be found in Supporting Information S2.

[5] While Brülhart et al. (2019) include international trade as an explanatory variable in their subnational analysis of light intensity, the trade information used is at the national level.

[6] In the longer historical term, changes in international borders occur. However, observations on affected regions are not included in our dataset (for details, see Supporting Information S2).

[7] We show an extensive set of possible clustered standard errors for our specification with region fixed effects, while controlling for regional population density, national trade openness, and institutions, in Table C2 in Supporting Information S2. The choice of the level at which standard errors are clustered largely does not affect the significance of our estimates.

[8] Note that the inclusion of controls reduces the number of observations relative to the 17,233 observations we have on regional GDP per capita. This is due to data missing on certain control variables. We have a full set of variables for 16,266 observations. However, we do not want to drop about 1000 observations, such that we let the number of observations vary from specification to specification, where the fixed effects capture different control variables. We run our regressions with all our different border measures for the full sample of 17,233 observations with fixed effects and without controls, shown in Table C3 in Supporting Information S2. Overall, the results are robust.

[9] Three countries in our sample (Germany, Kazakhstan, and Tanzania) experienced changes in their capital cities. Thus, for six regions in our dataset the variable capital is not constant over time. We nonetheless omit this variable from regressions with region fixed effects.

[10] In principle, alongside region fixed effects, we could include year fixed effects or country-year fixed effects. However, they nearly pick up the entire variation in our dependent variable. In this case, the only variation left is region-year variation besides a general or country-specific time trend, leaving only very little variation to be explained by further regressors.

[11] Results for all specifications shown in Table 2 for the sample restricted to only border regions are given in Table C5 in Supporting Information S2.

[12] Details on the calculations are given in Supporting Information S2.

[13] Also including Free Trade Agreements & Economic Integration Agreements.

[14] Also including Customs Unions & Economic Integration Agreements.

[15] https://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/administrative-units-statistical-units/nuts, scale 1:1 m.

[16] https://gadm.org/data.html.

[17] https://ec.europa.eu/knowledge4policy/territorial/ardeco-online_en.

[18] https://ec.europa.eu/eurostat/web/products-datasets/-/tgs00002.

[19] World Bank national accounts data and OECD National Accounts data files, https://data.worldbank.org/indicator/NE.TRD.GNFS.ZS.

[20] http://www.systemicpeace.org/inscrdata.html.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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APPENDIX A

TABLE A1 Descriptive statistics, data sources, and variable description.

Variable	*N*	Mean	St dev	Min	Max	Source	Description
BORDER	17,233	0.460	0.498	0	1	Own computation, for EU regions: Shapefile from Eurostat,[15] for non-EU regions: Shapefiles from the Database of Global Administrative Areas,[16] manually adjusted to fit the regions from Gennaioli et al. (2014)	Dummy variable: Value of 1 if a region has an international land border, 0 else
BORDERTA *(border regions)*	17,233 (7929)	0.364 (0.790)	0.481 (0.407)	0 (0)	1 (1)	Own computation, data on trade agreements from Mario Larch's Regional Trade Agreements Database from Egger and Larch (2008)	Shift-share variable: Value of 1 if a region shares a border with a country with whom a trade agreement exists, 0 else
#BORDER *(border regions)*	17,233 (7929)	0.720 (1.565)	0.964 (0.834)	0 (1)	8 (8)	Own	Count variable: A region's number of international borders
#BORDERTA *(border regions)*	17,233 (7929)	0.524 (1.138)	0.803 (0.839)	0 (0)	6 (6)	Own	Shift-share variable: A region's number of international borders shared with countries with whom trade agreements exist
BORDER*km* *(border regions)*	17,233 (7929)	1.646 (3.577)	4.104 (5.450)	0 (0.0003)	71.069 (71.069)	Own	Length of a region's international border in 100 *km*
BORDER*km*TA *(border regions)*	17,233 (7929)	1.057 (2.297)	2.744 (3.677)	0 (0)	71.069 (71.069)	Own	Shift-share variable: A region's border length (in 100 *km*) shared with countries with whom trade agreements exist
%BORDER *(border regions)*	17,233 (7929)	13.485 (29.309)	19.927 (19.981)	0 (0.000)	100 (100)	Own	Percentage share of international borders in the total perimeter of a region

(Continues)

TABLE A1 (Continued)

Variable	N	Mean	St dev	Min	Max	Source	Description
%BORDERTA *(border regions)*	17,233 (7929)	10.257 (22.293)	17.798 (20.498)	0 (0)	100 (100)	Own	Shift-share variable: A region's percentage share of international borders shared with countries with whom trade agreements exist in its total perimeter
GDPpc *(border regions)*	17,233 (7929)	18,378 (17,560)	13,742 (12,423)	189 (189)	195,334 (166,007)	For EU regions after 1980: ARDECO,[17] for non-EU regions and EU regions before 1980: Gennaioli et al. (2014)	Regional GDP per capita in 2005 constant US dollars
Coast *(border regions)*	17,233 (7929)	0.495 (0.399)	0.500 (0.490)	0 (0)	1 (1)	Own	Dummy variable: Value of 1 if region has access to coast, 0 else
Latitude *(border regions)*	17,233 (7929)	40.112 (41.724)	15.247 (14.287)	0.022 (0.022)	69.720 (69.720)	Own calculation	Absolute value of the geographical latitude of a region's center
Area *(border regions)*	17,233 (7929)	54.796 (74.580)	206.335 (266.655)	0.013 (0.013)	3920 (3920)	For EU regions: Eurostat,[18] complemented where missing by own computation using geo- spatial datasets, for non-EU regions: Own computation using geospatial datasets	Land area of a region in 1000 km^2
Capital *(border regions)*	17,233 (7929)	0.085 (0.060)	0.279 (0.237)	0 (0)	1 (1)	For EU regions after 1980: Own research, for non-EU regions and EU regions before 1980: Gennaioli et al. (2014), adjusted for changes by own research	Dummy variable: Value of 1 if national capital is located in region, 0 else
PopDensity *(border regions)*	17,183 (7884)	379.944 (182.135)	1176 (493.397)	0.010 (0.010)	23,282 (6328)	Own calculation based on population data (for EU regions after 1980: ARDECO, for non-EU regions and EU regions before 1980: Gennaioli et al., 2014) and land area	Regional population density in persons per km^2
Openness *(border regions)*	16,360 (7557)	64.044 (72.577)	36.266 (39.265)	4.952 (4.952)	408.362 (408.362)	World Bank[19]	Country's trade (sum of ex- ports and imports) as share of country's GDP, in percent
Polity2 *(border regions)*	17,189 (7919)	7.552 (7.515)	4.915 (4.914)	−10 (−10)	10 (10)	Polity5: Regime authority characteristics and transitions datasets, Integrated Network for Societal Conflict Research (INSCR) of the Center for Systemic Peace[20]	Country's Revised combined Polity Score: Regime authority, taking values from −10 (hereditary monarchy) to +10 (consolidated democracy)

Note: *N* gives the number of observations available for the respective variable, *Mean* gives the average of the observations for the variable, *St dev* reports the standard deviation, *Min* reports the minimum among the observations, *Max* reports the maximum among the observations, *Source* reports the data source, and *Description* describes the variable. Values reported in parentheses are statistics for the subsample of regions with an international border.