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Europe, We Have a Problem! Local Economic Winners and Losers of Border Closures

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Europe, We Have a Problem!
Local Economic Winners and Losers of Border Closures*

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Abstract

In response to COVID-19, Schengen countries temporarily reintroduced internal border controls, disrupting cross-border integration. Using this policy change as a natural experiment and monthly nighttime lights data, we estimate the short-run effects on European municipalities. Municipalities along internal Schengen borders experienced a 3–4% decline in economic activity relative to interior municipalities, with larger estimated effects when external-border municipalities form the comparison group. Losses were greater in smaller and less densely populated municipalities and along economically asymmetric East–West borders, whereas municipalities along more economically similar borders generally experienced smaller declines. The effects also depended on the pre-pandemic purpose of cross-border mobility: higher shares of work- and business-related travel, services, and shopping were associated with larger losses, while the results for leisure and social mobility are consistent with greater scope for domestic reallocation of activity. Overall, the findings show that the local consequences of internal border closures depend on municipality characteristics, cross-border economic asymmetries, and the purpose of mobility.

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1 Introduction

The Schengen Agreement, by removing systematic internal border controls on people within participating European countries, has substantially reduced mobility frictions across national borders. While the free movement of workers and trade liberalization are rooted in the EU Single Market (Kahanec et al., 2016), Schengen has made these freedoms effective in practice by facilitating cross-border commuting, worker mobility, access to services, shopping, and business travel. Over time, this allowed many border regions to develop into highly integrated local economies in which labor markets, consumption patterns, and everyday economic interactions extended across national boundaries. Since internal border controls were first abolished in 1995, the absence of routine border checks has therefore become an important condition for the functioning of European border regions.

This long-standing arrangement was unexpectedly disrupted during the COVID-19 pandemic, when European governments reintroduced internal border controls as part of emergency public health measures. The resulting restrictions affected not only everyday mobility, but also the practical exercise of free movement by cross-border workers. Unlike nationwide lockdowns, internal Schengen border closures created a highly localized shock by sharply increasing mobility and transaction costs in municipalities situated along internal national borders. These municipalities were particularly exposed because their economies were closely linked through cross-border labor markets, service provision, shopping, and other consumption flows.

The sudden reintroduction of internal border controls during the first wave of the COVID-19 pandemic therefore created a natural experiment that allows us to identify the causal impact of border closures on local economic activity. While existing research has largely focused on the aggregate macroeconomic effects of lockdowns and travel restrictions at the national level, much less is known about how the restoration of internal borders affected municipalities directly dependent on cross-border mobility, or why some border regions experienced economic losses while others proved comparatively resilient. Using monthly nighttime lights data at the local administrative unit (LAU-2) level for 17 European countries, combined with information on pre-pandemic cross-border mobility purposes, we address two central questions: *(1) What were the short-run local economic effects of internal Schengen border closures during the COVID-19 pandemic?* and *(2) how did these effects vary across border regions, and to what extent was this heterogeneity related to the pre-existing function of cross-border mobility?*

Comparing municipalities located along internal Schengen borders with municipalities further inland, we find that border closures reduced nighttime luminosity by approximately

3–4%. The estimated decline is larger when external-border municipalities are used as the comparison group, but the conclusion is consistent across specifications: municipalities directly exposed to the reintroduction of internal Schengen border controls experienced a disproportionate contraction in local economic activity.

The average effect masks considerable spatial heterogeneity. Declines were greatest in geographically smaller and less densely populated municipalities, which may have had fewer domestic alternatives and a more limited capacity for adaptation. The distribution of losses also depended on the orientation of the border. For Eastern municipalities, the adverse effect of border closures was larger when the neighboring country was Western rather than Eastern. Conversely, for Western municipalities, losses were greater when the neighboring country was Eastern rather than Western. This pattern is visible across all three comparison groups, although the magnitude of the estimates varies. Municipalities located along borders connecting countries within the same broad European region generally experienced smaller declines than those situated along borders connecting Eastern and Western countries.

This geographic heterogeneity is consistent with differences in both the economic relationship between neighboring regions and the function of cross-border mobility. Borders connecting Eastern and Western countries often link labor markets and local economies characterized by larger differences in wages, employment opportunities, and service provision. Cross-border commuting, labor supply, shopping, access to services, and business activity may therefore be especially important in these areas and difficult to replace when mobility is restricted. The survey-based results complement this interpretation: municipalities where cross-border mobility was more strongly associated with work and business, services, and shopping experienced larger declines, whereas the results for leisure and social mobility are consistent with greater scope for domestic reallocation of spending and activity. The relatively smaller declines observed in some border regions should be interpreted cautiously. Nighttime luminosity captures changes in the location and intensity of local economic activity, but not the broader consequences of border restrictions, including reduced individual choice, disrupted family and social ties, and greater uncertainty.

Our analysis builds on a well-established literature that uses remotely sensed nighttime lights as a proxy for economic activity satellite data to study regional development and spatial inequality (Henderson et al., 2012; Hodler and Raschky, 2014; Alesina et al., 2016; Lessmann and Seidel, 2017). We use NASA's Black Marble nighttime lights product, a processed VIIRS-based dataset that improves spatial and temporal comparability by correcting several sources of measurement error.[1] Its monthly frequency and near-real-time coverage allow us to

[1]DMSP–OLS and raw VIIRS data are affected by limitations including coarse spatial resolution, saturation, blooming, moonlight, stray light, atmospheric conditions, and snow cover. These issues are particularly

measure localized economic responses that are not observable in conventional administrative data.

This study contributes to the growing literature on the economic effects of the COVID-19 pandemic. Early evidence primarily focuses on aggregate outcomes at the country level, including national economic activity and financial vulnerability (Demirgüç-Kunt et al., 2021). More recent work adopts finer spatial resolution, often using nighttime lights to study subnational economic effects, including evidence from Indian districts (Beyer et al., 2023), global megacities (Xu et al., 2021), and cities worldwide(Khan et al., 2023). While this literature documents declines in economic activity during the pandemic, it primarily examines lockdowns and broad public health measures affecting urban and metropolitan economies. It therefore does not isolate the consequences of border closures, even though such policies directly increased cross-border mobility costs and disrupted economic interactions in highly integrated border regions.

For Europe, fine-grained evidence remains particularly scarce. Existing subnational studies mainly focus on health outcomes at the NUTS-3 level (Eckardt et al., 2020; Rodríguez-Pose and Burlina, 2021; Coulson et al., 2021). The closest contribution is (Capello et al., 2023), who study the economic implications of COVID-19 border closures across European regions using simulated data at the NUTS-3 level, reflecting the lack of timely regional economic statistics during the pandemic. To our knowledge, there is no municipality-level evidence based on observed economic outcomes showing how abrupt changes in internal border openness affected local economic activity in European border regions.

The paper makes four main contributions. First, it identifies the local economic effects of internal Schengen border closures by exploiting their unexpected and largely synchronized reintroduction during the first wave of the pandemic. Second, it uses monthly NASA Black Marble nighttime lights data for 75,128 municipalities across 17 countries, allowing us to study short-run local responses at an unusually fine spatial scale. Third, it documents systematic heterogeneity related to municipality size, population density, East–West border orientation, and economic asymmetries across neighboring regions. In particular, the largest losses were concentrated in smaller and less densely populated municipalities and along economically asymmetric East–West borders, while same-region border pairs generally experienced smaller declines. Finally, by distinguishing empirically between economically functional and discretionary forms of cross-border mobility, the paper sheds light on the mechanisms through which border closures affect local economic activity.

The remainder of the paper is organized as follows. Section 2 describes the institutional background of internal Schengen border closures and introduces the theoretical framework.

important when studying low-light locations and short-run changes in economic activity(Gibson et al., 2021).

Section 3 presents the data. Section 4 outlines the empirical strategy and baseline results. Section 5 examines heterogeneity and mechanisms. Section 6 concludes.

2 Institutional Setting of Border Closures

For nearly two decades, the Schengen Agreement made internal borders largely invisible in everyday life. People crossed national boundaries freely for work, shopping, and social activities, and border regions gradually became tightly integrated spaces rather than divided territories.

The COVID-19 pandemic disrupted this arrangement. During the first wave in early 2020, European governments reintroduced internal border controls in response to urgent public health concerns. As Figure 1 shows, most internal borders closed within a few days in mid-March. Although the exact timing varied across border pairs, the overall response was rapid and broadly synchronized across Europe. Internal border controls were reintroduced with little warning, differed in their strictness and duration, and were explicitly framed as temporary emergency measures rather than permanent policy changes. By the end of June 2020, most countries had reopened their internal borders. While subsequent waves of the pandemic led to renewed restrictions later in the year, these developments were largely anticipated. As a result, the first wave of border closures constitutes an unexpected shock.

2.1 Theoretical Framework

We follow a multi-region, market-access-based model from New Economic Geography (NEG) to establish the empirical analysis. The framework builds on Krugman (1991), Fujita et al. (1999), Redding and Sturm (2008), and Brakman et al. (2012), but departs from the standard focus on gradual and persistent improvements in market access associated with economic integration. Instead, we study the opposite type of shock: a sudden and temporary increase in trade and mobility costs triggered by the reintroduction of internal border controls during the COVID-19 pandemic.

While the NEG literature largely emphasizes long-run adjustments to persistent changes in trade costs, including firm relocation and population sorting, the COVID-19 border closures offer a unique setting to study the short-run consequences of a sudden and unexpected increase in border frictions. Firms and households had limited scope to reoptimize location decisions. We therefore interpret the model in a *short-run equilibrium*, in which locations, population stocks, and infrastructure are fixed, while market access, prices, and the utilization of local services adjust immediately.

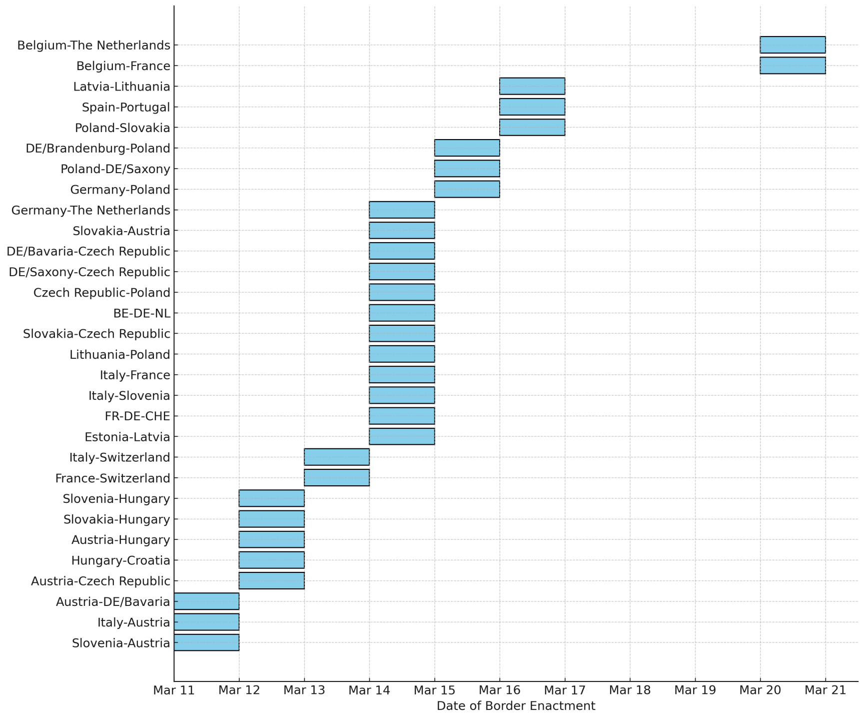

Figure 1: Timing of Internal Border Closures during the First Wave

The economy consists of a set of locations indexed by $a \in \{1, \ldots, A\}$, corresponding to municipalities. Each municipality is endowed with a fixed stock of nontradable services and amenities, denoted by $\bar{H}_a$. In much of the existing literature, this component is treated as fixed and fully utilized. However, in the context of short-run border closures, what matters is not only the availability of local amenities but also how intensively they are used.

We therefore distinguish between the fixed stock of nontradable infrastructure, $\bar{H}_a$, and its effective utilization, $u_a(T_a)$, which depends on mobility costs. Changes in cross-border mobility affect where consumption takes place and how intensively local services are used, even though the underlying infrastructure stock remains unchanged. Accordingly, we write effective nontradable activity as

$$H_a(T_a) \equiv \bar{H}_a \cdot u_a(T_a),$$

where $u_a(T_a)$ captures short-run demand and utilization responses to changes in border openness.

Consumers allocate a fraction $\mu \in (0, 1)$ of income to tradable goods, while the remaining share $1 - \mu$ is spent on nontradable services. Firms operate under monopolistic competition with increasing returns to scale and a constant elasticity of substitution $\epsilon > 1$. Trade between municipalities is subject to iceberg trade costs $T_{ai} > 1$. Internal border closures raise T_{ai} for cross-border links. Because border municipalities rely more heavily on cross-border commuting, services, and consumption, they are exposed to this shock.

Let w_a denote nominal wages, L_a employment, P_a^M the Dixit–Stiglitz price index, n_a the number of firms, and p_a the free-on-board price of a variety produced in municipality a. In the short run, equilibrium real economic activity can be written as

$$EA_a = \Omega \underbrace{\left(\sum_i \frac{w_i L_i P_i^M}{T_{ai}^{\epsilon-1}} \right)^{\theta_1}}_{\text{FMA}} \underbrace{\left(\sum_j \frac{n_j p_j P_j^M}{T_{ja}^{\epsilon}} \right)^{\theta_2}}_{\text{CMA}} \underbrace{\frac{1}{\bar{H}_a \, u_a(T_a)}}_{\text{NTA}}. \tag{1}$$

where θ_1, θ_2, and Ω are functions of structural parameters and the common real wage.

This expression highlights three channels through which border closures affect local economic activity. The first is firm market access (FMA), which captures how easily firms can reach consumers and markets elsewhere. The second is consumer market access (CMA), reflecting how easily consumers can access varieties produced in other locations. The third is local nontradable activity (NTA), which reflects short-run changes in the utilization and demand for locally provided services and amenities, rather than changes in the underlying infrastructure stock. Although infrastructure itself does not adjust in the short run, changes in mobility costs alter where consumption takes place. Higher cross-border mobility costs can redirect spending toward locally provided services, increasing their utilization, or reduce overall demand when cross-border mobility supplies productive interactions. As a result, local nontradable activity responds endogenously to border closures through demand reallocation, rather than through changes in population, firms, or infrastructure.

Taking logs and differentiating with respect to trade costs yields the short-run decomposition:

$$d \ln EA_a = \theta_1 \frac{dFMA_a}{FMA_a} + \theta_2 \frac{dCMA_a}{CMA_a} - \frac{du_a(T_a)}{u_a(T_a)}. \tag{2}$$

This decomposition shows that border closures affect local economic activity through firm market access, consumer market access, and the endogenous utilization of local nontradable services. The short-run implications of these channels should depend on the purpose of cross-border mobility prior to the pandemic. When mobility primarily supports *productive* interactions, such as commuting, business travel, or access to customers, higher trade and mobility costs reduce market access, leading to a contraction in local economic activity. However, when cross-border mobility is primarily *discretionary*, such as for social visits or leisure, border closures can redirect consumption toward locally provided non-tradable services, partially offsetting the loss in market access and resulting in smaller declines or even short-run gains. Appendix A provides the analytical derivations and shows the conditions under which each effect arises.

3 Data

3.1 NASA's Black Marble Nighttime Lights

Remotely sensed nighttime lights are increasingly used in economics as a proxy for human and economic activity (Gibson et al., 2021). To overcome satellite-related limitations[2], we use NASA's Black Marble nighttime lights data from the Visible Infrared Imaging Radiometer Suite (VIIRS). The VIIRS day–night band provides improvements over DMSP-OLS, including higher spatial resolution (approximately 750 meters), greater radiometric sensitivity, minimal saturation, and onboard calibration. These features make VIIRS particularly well suited for capturing short-run economic dynamics, such as those induced by sudden internal border closures during the COVID-19 pandemic.

Our main outcome variable is nighttime light intensity derived from NASA's Black Marble product. We utilize the VNP46A3 Lunar BRDF-adjusted monthly nighttime lights dataset, which corrects for the effects of moonlight, atmospheric conditions, and sensor viewing angle. We collected data for 2018, 2019, and 2020 at a 500 $\times$ 500 meter resolution. We aggregate pixel-level radiance to the municipality (LAU-2) level using zonal statistics in QGIS. Black Marble data are distributed in Hierarchical Data Format (HDF5) and were converted to GeoTIFF format to enable spatial processing in GIS software. We use the snow-free, all-angle radiance composite and corresponding quality flags. Pixels affected by cloud contamination, sensor issues, or missing data are excluded.

Several features make nighttime lights particularly appropriate for our research design. First, the monthly frequency allows us to capture short-run economic responses to border closures. Second, because the VIIRS satellite takes pictures of earth at approximately 1:30 a.m. local time, the recorded luminosity primarily captures persistent economic activity rather than transient population movements.

3.2 Interreg-A Cross-border Cooperation Survey

To explore the mechanisms behind the effects of border closures and their heterogeneous impacts, we merge nighttime lights data with administrative data from the European Com-

[2]Most existing studies rely on data from the Defense Meteorological Satellite Program (DMSP-OLS), which has been extensively used to study long-run relationships between luminosity and socioeconomic outcomes since the early 1990s. Despite its usefulness for long-run analysis, DMSP-OLS suffers from coarse spatial resolution, saturation, blooming, and the absence of onboard radiometric calibration, limiting its suitability for studying short-run and localized economic shocks.

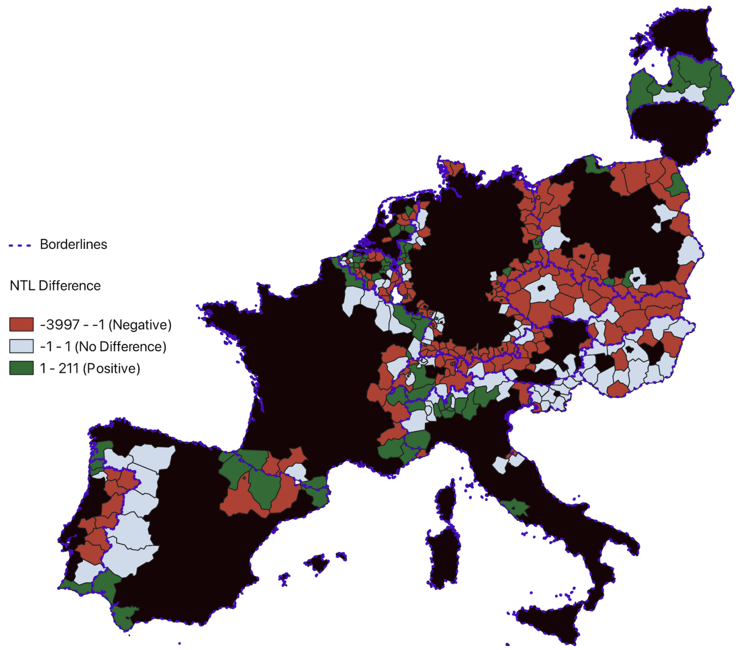

Figure 2: Difference in Nighttime Lights (Post vs. Pre)

Notes: The figure shows the difference in average nighttime light intensity between the post- and pre-periods based on VIIRS NTL data. Values are aggregated at the regional level. Red indicates increases in luminosity, while green indicates declines. Dashed lines denote international borders.

mission's ARDECO database. These data provide information on population size, population density, and size of the geographic area at the municipality level.

Additionally, we utilize data from the Interreg A Cross-Border Cooperation (CBC) surveys from 2020.[3] These surveys cover roughly 40,000 respondents living in European border regions.

We use the reported purposes of cross-border trips to characterize the mobility profile of each cross-border cooperation area. We distinguish mobility connected to work and market transactions, including business travel, use of services, and shopping, and mobility connected primarily to leisure and social visits. In the theoretical framework, the former corresponds to *productive mobility* or economically functional mobility (work, shopping, and services), whereas the latter corresponds to *discretionary mobility* (leisure and social visits). This classification describes the expected short-run economic function of a trip; it does not rank the personal or social importance of different forms of mobility. In particular, social and family visits may be highly important to the individuals concerned even though they are less

[3] Although the surveys were conducted in 2020 during the pandemics, the relevant questions refer to cross-border mobility during the preceding year, 2019, when conditions were still normal. The resulting measures, therefore, capture pre-pandemic mobility patterns and are not affected by behavioral responses to the border closures.

directly connected to contemporaneous production and market access. The survey therefore complements the nighttime-lights outcome by providing information on why people crossed borders before the pandemic.

For preliminary analysis and descriptive purposes, we merge CBC data with nighttime lights and show changes in monthly luminosity before and after the enactment of border controls across cross-border cooperation areas in Figure 2. There is a sharp decline in nighttime lights following border closures highlighted in red.

4 Empirical Strategy

We exploit the unexpected and temporary reintroduction of internal Schengen border controls during the first wave of the COVID-19 pandemic as a localized mobility shock. The treatment group consists of municipalities located along internal Schengen land borders, which experienced a sudden transition from largely unrestricted cross-border movement to temporarily reintroduced border controls. We compare changes in their economic activity before and during the closure period with changes in municipalities that were not exposed to the same discrete policy shift. Our preferred control group consists of interior municipalities, while alternative specifications use external-border municipalities—including coastal municipalities and municipalities along non-Schengen external land borders—or combine the two groups. This difference-in-differences design allows us to identify the short-run local effects of the reintroduction of internal border controls .[4]

Our analysis focuses on municipalities in 17 Schengen countries. We distinguish between the Old EU Member States in Western Europe, which joined the Schengen Area in 1995 (Austria, Belgium, France, Germany, Italy, the Netherlands, Portugal, and Spain), and the New Member States in Central and Eastern Europe, which joined in 2008 (Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia), as well as Switzerland. We exclude European microstates, island countries, and Scandinavian countries because of their distinct geographic characteristics and COVID-19 policy regimes.

We implement a difference-in-differences framework comparing changes in nighttime light intensity in internal Schengen border municipalities (the treatment group) with changes in

[4]Comparing border areas with interior locations is standard in the literature examining the spatial effects of country-level integration policies, particularly in city- and region-level analyses (Brakman et al., 2012). Our setting differs because the treatment is a localized increase in border frictions rather than a country-wide policy change. In addition to interior municipalities, we therefore use external-border municipalities as an alternative comparison group. Coastal municipalities have no adjacent international land crossing, while municipalities along non-Schengen external land borders were already subject to systematic border controls before the pandemic. Neither group experienced the same unexpected transition from an open internal Schengen border to temporarily reintroduced controls.

the relevant control group before and during the closure period. The definition of the treated group remains fixed across specifications, while the control group varies.

Let NTL_{it} denote the log-transformed nighttime light intensity observed in municipality i at time t. Our baseline empirical specification is:

$$NTL_{it} = \beta + \gamma(\text{Border}_i \times \text{Closure}_t) + \delta_t + \alpha_i + \varepsilon_{it}, \tag{3}$$

where Border_i is an indicator equal to one if municipality i is located within 25km along an internal Schengen land border. The indicator Closure_t equals one during March, April, May, and June 2020, when internal border controls were in place, after which Schengen countries gradually began to reopen their internal borders. The pre-treatment period consists of the corresponding calendar months in year 2018 or, in the extended specification, in both 2018 and 2019. Comparing the same months across years controls for seasonal variation.

The interaction term $(\text{Border}_i \times \text{Closure}_t)$ captures the differential change in nighttime lights in municipalities located along internal Schengen borders during the closure period relative to the relevant control group. A negative and statistically significant estimate of γ indicates that municipalities exposed to the reintroduction of internal border controls experienced a larger decline in economic activity than municipalities not exposed to the same policy change.

We consider three comparison groups. First, our preferred specification uses interior municipalities located away from international borders. These locations serve as a within-country counterfactual for municipalities exposed to the common pandemic shock but not directly dependent on an international border. Second, we use external-border municipalities, including coastal municipalities and municipalities located along non-Schengen external land borders. Coastal municipalities were not exposed to a land-border closure, while external land-border municipalities already operated under systematic border controls before the pandemic and therefore did not experience the same sudden change in border openness. Third, we combine interior and external-border municipalities into a broader comparison group. These alternative counterfactuals allow us to assess the robustness of the estimated treatment effects.

The empirical specification includes time fixed effects δ_t, which absorb common shocks affecting all municipalities, and municipality fixed effects α_i, which account for time-invariant local characteristics, including institutional and geographic characteristics. The error term ε_{it} captures idiosyncratic shocks and standard errors are robust to heteroskedasticity.

4.1 Baseline Results

Table 1 reports the baseline estimates from Equation (3), which quantify the effect of internal Schengen border closures on nighttime light intensity. In all specifications, the treated group consists exclusively of municipalities located along internal Schengen borders. The treatment period corresponds to March, April, May and June 2020, when internal border closures were in place. The counterfactual periods are defined as the same calendar months in 2018 (Columns(1)–(3)), or in 2018–2019 (Columns(4)–(6)), when borders were fully open.

Columns (1) and (4) compare internal Schengen border municipalities with interior municipalities. The estimated effects are negative and statistically significant in both specifications, corresponding to relative declines in nighttime light intensity of approximately 4.5% when 2018 is used as the reference period, and 3.1% when both 2018 and 2019 are included. Thus, during the closure period, municipalities located along internal Schengen borders experienced a 3–4% reduction in nighttime luminosity relative to municipalities further inland. Since interior municipalities were exposed to the common pandemic shock but not directly to the reintroduction of internal border controls, these estimates provide our preferred measure of the local economic effect of the policy.

Columns (2) and (5) use external-border municipalities as the comparison group. This group comprises coastal municipalities and municipalities located along non-Schengen external land borders. Internal Schengen border municipalities experienced relative declines in nighttime light intensity of approximately 15% using 2018 as the reference period, and 12% using both 2018 and 2019. These effects are substantially larger than those estimated using interior municipalities as the comparison group, suggesting that municipalities along internal Schengen borders experienced a considerably less favorable trajectory during the period of border closures than those along external borders. A likely explanation is that the restrictions represented a much larger change for internal-border municipalities, where cross-border movement had previously been largely unrestricted. The change was much smaller elsewhere: coastal municipalities had no neighbouring international land border, and external borders were already subject to regular controls before the pandemic.

Columns (3) and (6) combine interior and external-border municipalities into a broader comparison group. The coefficients remain negative and statistically significant, corresponding to relative declines of approximately 5.4% and 3.9%. These estimates are considerably closer to those obtained using interior municipalities alone and confirm that the main finding is robust to broadening the comparison group.

Overall, all six specifications show a statistically significant decline in nighttime luminosity in municipalities exposed to the reintroduction of internal Schengen border controls. The estimated magnitude varies with the counterfactual, but the sign and qualitative conclusion

Table 1: Border Closure Effects on Nighttime Lights

	Reference Period: 2018			Reference Period: 2018–2019		
	(1)	(2)	(3)	(4)	(5)	(6)
Border × Closure	-0.045^{***}	-0.152^{***}	-0.056^{***}	-0.031^{***}	-0.122^{***}	-0.040^{***}
	(0.005)	(0.010)	(0.005)	(0.004)	(0.008)	(0.004)
Observations	488,428	231,780	518,309	736,505	348,687	781,544
Within R^2	0.3203	0.3298	0.3175	0.3216	0.3217	0.3189
Treated	Internal Borders	Internal Borders	Internal Borders	Internal Borders	Internal Borders	Internal Borders
Control	Interior	External Borders	External Borders & Interior	Interior	External Borders	External Borders & Interior
FE: LAU	✓	✓	✓	✓	✓	✓
FE: Year–Month	✓	✓	✓	✓	✓	✓

Notes: The dependent variable is the natural logarithm of monthly nighttime light. The reported coefficient measures the average effect of internal Schengen border closures on treated municipalities relative to the indicated comparison group. Columns (1)–(3) use 2018 as the pre-treatment reference period, while Columns (4)–(6) use both 2018 and 2019 as the pre-treatment reference period. In all specifications, the treated group consists of municipalities located along internal Schengen borders. The control groups are interior municipalities (Columns (1) and (4)), external-border municipalities, comprising coastal municipalities and municipalities located along non-Schengen external land borders (Columns (2) and (5)), and external-border municipalities together with interior municipalities (Columns (3) and (6)). All specifications include municipality (LAU) and year–month fixed effects. Robust standard errors are reported in parentheses. Statistical significance is denoted by $^{*}p < 0.10$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

are consistent throughout. We therefore take the 3–4% decline relative to interior municipalities as our principal baseline result. The larger effects obtained relative to external-border municipalities further indicate that the sudden loss of internal-border permeability represented a particularly disruptive shock for affected local economies.

5 Heterogeneity and Mechanisms

The baseline results show that municipalities located along internal Schengen borders experienced a decline in nighttime light intensity during the closure period under each of the three control-group definitions. However, the local effects of border closures may differ depending on municipalities' economic structure, adjustment capacity, and reliance on cross-border interactions. We therefore examine heterogeneity along three dimensions. We first consider municipality size and population density, then study the orientation and economic relationship of the regions on the both sides of the border, and finally investigate the role of pre-pandemic cross-border mobility purposes.

5.1 Municipality Size and Local Adjustment Capacity

Table 2 examines whether the effect of internal Schengen border closures varies with municipality size. In all columns, the treated group consists of municipalities located along internal Schengen borders. Columns (1) and (2) use interior municipalities as the comparison group; Columns (3) and (4) use external-border municipalities; and Columns (5) and (6) combine the two groups of municipalities. Municipality size is measured using inverse geographic area in the odd-numbered columns and inverse population density in the even-numbered columns. Higher values of these variables therefore characterize municipalities with smaller geographic area or lower population density.

The triple-interaction coefficients are negative and statistically significant in all six specifications. This result indicates that the adverse effect of internal border closures became stronger as municipalities became geographically smaller or less densely populated. The pattern is stable across the three alternative comparison groups. For inverse area, the negative interaction coefficients range from -0.240 to -0.319, and for inverse population density, they range from -0.568 to -0.664. Thus, across all specifications, the negative interaction terms show that smaller and lower-density internal-border municipalities experienced larger relative declines than larger and more densely populated border municipalities.

These results are in line with differences in local adjustment capacity. Smaller and less densely populated municipalities may have thinner local markets, fewer domestic employment and consumption alternatives, and greater dependence on cross-border workers, customers, shopping opportunities, and services. Larger and denser municipalities, however, typically have more diversified local economies and a wider range of domestic substitutes, allowing activity to adjust more easily when cross-border mobility becomes difficult. The results therefore suggest that the local costs of border closures were amplified where domestic substitution possibilities were limited.

Table 2: Border Closure Effects by Municipality Size

	(1) ln(NTL)	(2) ln(NTL)	(3) ln(NTL)	(4) ln(NTL)	(5) ln(NTL)	(6) ln(NTL)
Border × Closure	-0.009	-0.019*	-0.116***	-0.123***	-0.013*	-0.018*
	(0.009)	(0.011)	(0.012)	(0.014)	(0.007)	(0.009)
Border × Closure × Size	-0.319***	-0.662***	-0.317***	-0.664***	-0.240***	-0.568***
	(0.068)	(0.224)	(0.068)	(0.225)	(0.053)	(0.199)
Observations	488,428	482,970	231,780	229,121	781,544	773,498
Within R^2	0.3208	0.3224	0.3311	0.3359	0.3191	0.3199
Size	Inverse Area	Inverse Density	Inverse Area	Inverse Density	Inverse Area	Inverse Density
Treated	Internal Borders	Internal Borders	Internal Borders	Internal Borders	Internal Borders	Internal Borders
Control	Interior	Interior	External Borders	External Borders	External Borders & Interior	External Borders & Interior
FE: LAU	✓	✓	✓	✓	✓	✓
FE: Year–Month	✓	✓	✓	✓	✓	✓

Notes: The dependent variable is the natural logarithm of monthly nighttime light. The reported coefficient on *Border × Closure* measures the average impact of internal Schengen border closures on treated municipalities relative to the indicated comparison group. The interaction term captures whether the effect varies with municipality size, measured by the inverse of municipality area in Columns (1), (3), and (5), and by the inverse of population density in Columns (2), (4), and (6). All specifications include municipality (LAU) and year–month fixed effects. Robust standard errors are reported in parentheses. Statistical significance is denoted by $^{*}p < 0.10$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

5.2 East-West Border Orientation and Economic Asymmetries

The economic consequences of internal border closures may depend not only on the characteristics of the municipality itself but also on the degree of economic integration across the border. Differences in wages, prices, employment opportunities, and service provision create stronger incentives for cross-border commuting, shopping, and the use of services. Border closures are therefore expected to have larger effects in these areas than along borders separating more similar economies. Table 3 therefore examines whether the effect of border closures varies according to the municipality's location in Eastern or Western Europe and the corresponding orientation of its neighboring country. Although this classification does not directly measure economic asymmetry, it distinguishes borders between countries within the same broad European region from those separating Eastern and Western Europe.

The table contains three panels corresponding to the three alternative control groups used in the baseline analysis. Panel A compares internal Schengen border municipalities with interior municipalities. Panel B uses external-border municipalities as the comparison group. Panel C combines interior and external-border municipalities. Within each panel, Columns (1) and (2) estimate the average closure effect separately from the perspective of Eastern and Western municipalities. Columns (3) and (4) additionally interact the closure effect with an indicator for whether the municipality's cross-border (closest) neighbor is located in Eastern Europe.

Panel A provides our preferred comparison with interior municipalities. Column (1) shows that Eastern Schengen-border municipalities experienced a statistically significant relative decline in nighttime light intensity of approximately 17.5%. On the other hand, the corresponding estimate for Western internal-border municipalities in Column (2) is small and statistically insignificant.

Columns (3) and (4) reveal substantial heterogeneity depending on whether the neighboring country is in Eastern or Western Europe. Among Eastern municipalities, those bordering a Western country experienced a relative decline of approximately 27.1%. The positive interaction with an Eastern neighbor implies a considerably smaller point estimate of approximately 12.5% decline in night lights for Eastern municipalities bordering another Eastern country. This difference is statistically significant, suggesting that the economic effects of border closures were considerably stronger along Eastern–Western borders.

For Western municipalities, the estimated effect is close to zero and statistically insignificant for those bordering another Western country. In contrast, municipalities bordering an Eastern country experienced a relative decline of approximately 12.7%. The difference is statistically significant, indicating that Western municipalities were also more adversely affected when the border separated Western and Eastern Europe rather than two Western countries.

The results in Panel A show that the economic effects of border closures were stronger along East–West borders. Municipalities on both sides of these borders experienced sizable declines, particularly where neighboring countries differed more economically.

Panels B and C demonstrate that the precise magnitude of the coefficients depends on the control group, but the central pattern remains consistent. In Panel B, relative to external-border municipalities, the implied point estimates for Eastern border municipalities are approximately -14% when the neighboring country is Western and 3.4% when it is Eastern. For Western municipalities, the corresponding estimates are approximately -23% along Western borders and -38% along borders with Eastern countries. Panel C, which uses the combined comparison group, produces a similar trend. The estimated decline for an Eastern municipality bordering a Western country is approximately 17%, compared with an implied decline of approximately 3% when the neighboring country is also Eastern. For Western municipalities, the corresponding declines are approximately 1% along West–West borders and 10% along borders with Eastern countries.

Overall, the evidence suggests that border closures had more severe economic effects along East–West borders than along borders within the same broad European region. This pattern is evident on both sides of the border. The eastern enlargement of the EU created an integrated labor market connecting countries with substantial differences in economic development, wages, employment opportunities, and labor-market institutions (Kahanec and Pytliková, 2017). Cross-border commuting, shopping, and access to services may therefore be particularly important in these regions and more difficult to replace when mobility is restricted.

A useful example of a relatively symmetric West–West border is the Germany–Austria border. The neighboring regions are economically similar, and pre-pandemic cross-border mobility included commuting, business travel, tourism, shopping, leisure, and social interaction. The Germany–Austria border is not unique in this respect. Other highly integrated West–West border regions exhibit similarly broad forms of economic and social integration. In the Danish–German border region, for example, cross-border integration encompasses employment, consumption, family relationships, cultural institutions, and social life (Tarvet and Klatt, 2022). When borders were temporarily restricted, some expenditure and activity that would otherwise have taken place across the border may have been redirected toward domestic shops, services, and leisure alternatives. These forms of reallocation may have mitigated the economic effects of border closures along borders within the same broad European region, contributing to the comparatively small declines observed there, including the near-zero estimate for West–West municipalities relative to interior areas in Panel A.

Table 3: Regional Heterogeneity in the Effects of Border Closures

	Eastern	Western	Eastern	Western
Panel A				
Border × Closure	−0.193***	−0.005	−0.316***	0.009
	(0.015)	(0.006)	(0.018)	(0.006)
Border × Closure × EasternNeighbor			0.183***	−0.145***
			(0.014)	(0.015)
Treated	Internal Border	Internal Border	Internal Border	Internal Border
Control	Interior	Interior	Interior	Interior
Observations	79,495	408,933	79,495	408,933
Within R^2	0.3976	0.3140	0.4011	0.3144
Panel B				
Border × Closure	−0.025	−0.241***	−0.148***	−0.226***
	(0.017)	(0.011)	(0.020)	(0.011)
Border × Closure × EasternNeighbor			0.182***	−0.155***
			(0.014)	(0.015)
Treated	Internal Border	Internal Border	Internal Border	Internal Border
Control	External Border	External Border	External Border	External Border
Observations	80,193	151,587	80,193	151,587
Within R^2	0.4010	0.3165	0.4044	0.3179
Panel C				
Border × Closure	−0.078***	−0.018***	−0.174***	−0.010**
	(0.010)	(0.005)	(0.013)	(0.005)
Border × Closure × EasternNeighbor			0.142***	−0.085***
			(0.011)	(0.012)
Treated	Internal Border	Internal Border	Internal Border	Internal Border
Control	External Border & Interior	External Border & Interior	External Border & Interior	External Border & Interior
Observations	135,054	646,490	135,054	646,490
Within R^2	0.4173	0.3071	0.4189	0.3072
FE: LAU	✓	✓	✓	✓
FE: Year–Month	✓	✓	✓	✓
Neighbor Type	All	All	Eastern Neighbor	Eastern Neighbor

Notes: The dependent variable is the natural logarithm of monthly nighttime light intensity. Each section reports estimates using a different comparison group. Panel (A) compares municipalities located along internal borders with interior municipalities. Panel (B) compares municipalities located along internal borders with municipalities bordering non-Schengen countries. Panel (C) uses both municipalities bordering non-Schengen countries and interior municipalities as the comparison group. Within each section, the first two columns report the average effect of border closures separately for Eastern and Western Europe, while the last two columns additionally distinguish municipalities according to whether the nearest municipality across the border is located in Eastern Europe. The coefficient on *Border × Closure × Neighbor* captures the differential effect for municipalities whose nearest neighboring municipality lies in Eastern Europe. All specifications include municipality (LAU) and year–month fixed effects. Robust standard errors are reported in parentheses. Statistical significance is denoted by $^*p < 0.10$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

On the other hand, regions along the borders connecting Western and Eastern Europe experienced a large and statistically significant decline in nighttime light intensity relative to interior municipalities. These regions often depend on cross-border labor supply and service provision from lower-income neighboring countries. In such settings, border closures disrupt *productive* cross-border interactions that function as inputs into local production, leading to pronounced economic losses.

Qualitative evidence from the German–Czech borderland supports this interpretation. Interviews with forty Czech cross-border commuters employed in Germany show that the first wave of the pandemic was characterised by uncertainty, rapidly changing information, and weak coordination between national authorities (Novotný and Böhm, 2022). Even where commuting remained formally possible, border controls, documentation requirements, reduced crossing opportunities, and uncertainty about future restrictions made routine mobility considerably more difficult. These findings illustrate how border restrictions can disrupt economically functional cross-border relationships without eliminating cross-border movement altogether.

Related evidence comes from the Neisse–Nisa–Nysa Euroregion, which covers parts of Germany, Czechia, and Poland. Pandemic restrictions disrupted established movements of workers, consumers, and goods and exposed weaknesses in the institutional resilience and coordination capacity of cross-border cooperation structures (Böhm et al., 2024). These qualitative findings are consistent with the negative estimates for municipalities located along East–West borders in Table 3, where cross-border mobility is typically closely integrated. More broadly, the pandemic-related introduction of border restrictions has been described as "covidfencing," highlighting how the sudden emergence of border frictions disrupted long-standing processes of cross-border integration and deterritorialization (Medeiros et al., 2021). At the same time, these broader consequences extend beyond what nighttime luminosity can capture, as the measure reflects changes in the location and intensity of local economic activity rather than wider social and institutional effects. Consequently, the comparatively smaller declines observed along some same-region borders should be interpreted as evidence of greater resilience in measured economic activity, rather than as evidence that border restrictions were beneficial. Even where some spending and activity were redirected toward domestic alternatives, border restrictions reduced individual choice, disrupted commuting, family and social relationships, and increased uncertainty.

Overall, the estimates in Table 3 suggest systematic differences by border orientation. Across all three comparison groups, Eastern municipalities were more adversely affected when bordering Western rather than Eastern countries, while Western municipalities were more adversely affected when bordering Eastern rather than Western countries. This pattern is consistent with the view that border closures imposed greater local costs where economically functional cross-border mobility connected complementary economies across relatively asymmetric East–West borders. The next subsection examines this mechanism more directly by exploiting information on the pre-pandemic purpose of cross-border mobility.

To assess whether these findings extend beyond the Schengen context, we conduct a robustness analysis focusing on Romania, which was an EU member but not part of the Schengen Area during the pandemic. Romania provides a useful setting because its borders differed substantially in their pre-pandemic degree of openness and cross-border integration. Although crossings to the EU member states Hungary and Bulgaria remained subject to identity checks, EU citizens could travel using national identity cards or passports, and economic exchange took place within the EU Single Market. By contrast, Romania's borders with Moldova, Serbia, and Ukraine formed part of the EU's external border and were subject to stricter immigration and customs controls.

The results in Appendix B, Table 2, indicate that municipalities along the borders with Hungary and Bulgaria experienced a slightly less favorable, although statistically insignificant, trajectory relative to interior municipalities during the restriction period. In contrast, municipalities bordering Moldova, Serbia, and Ukraine exhibited a positive and statistically significant relative change in nighttime luminosity. One interpretation consistent with our framework is that the market-access shock was smaller where cross-border mobility and economic integration had already been more limited before the pandemic. Border-related activities such as freight transport, customs, warehousing, and border management may also have remained active or even intensified under tighter controls, while some local spending may have shifted to the Romanian side of the border.

The contrast becomes clearest in Column (4), which directly compares Romanian municipalities along the EU borders with Hungary and Bulgaria to those along the non-EU borders with Serbia, Moldova, and Ukraine. Municipalities bordering the EU experienced a decline in nighttime luminosity during the restriction period relative to those bordering non-EU countries. This finding is in line with the view that Romania's EU borders supported more intensive pre-pandemic economic and mobility links, despite the continued presence of identity checks, whereas its non-EU borders were already subject to stricter customs and immigration controls. As a result, the additional disruption caused by pandemic-related restrictions was likely greater along the EU borders.

Although the Romanian analysis does not identify the precise mechanisms and the two types of border regions may differ along other dimensions, it provides complementary evidence that the local consequences of border restrictions depend on the pre-existing intensity and economic function of cross-border relationships.

5.3 Cross-Border Mobility Purposes and Economic Mechanisms

The heterogeneity documented above suggests that the economic effects of border closures may depend on the role that cross-border mobility plays in local economies. In this subsection, we provide complementary evidence on the potential mechanisms by examining whether the economic response to border closures varies with the pre-pandemic purpose of cross-border mobility. Building on the theoretical framework in Section 2.1, we distinguish between *productive mobility* or input-driven mobility, which directly supports production and consumption (e.g. work, services, shopping, business and work related mobility), and *discretionary mobility*, which reflects choice-driven activities such as leisure and social visits. This distinction is analytical rather than normative. Social and family visits are classified as discretionary because they are less directly connected to contemporaneous production and market transactions, not because they are unimportant to the individuals undertaking them. Qualitative studies of European twin towns and border regions show that restrictions on such movements disrupted everyday routines, family relationships, education, cultural activities, and established cross-border social ties (Kajta and Opiłowska, 2022; Tarvet and Klatt, 2022).

Table 4 reports estimates from separate regressions in which the border-closure treatment is interacted with the pre-pandemic share of cross-border trips undertaken for each purpose, derived from the Interreg A Cross-Border Cooperation surveys. The interaction coefficients indicate whether the closure-period differential was more or less favorable in border areas where a particular purpose accounted for a larger share of pre-pandemic cross-border mobility.

Border areas characterized by higher shares of economically functional cross-border mobility, such as work-, service-, shopping-, and business-related travel, experienced statistically significant declines in nighttime light intensity following border closures. The largest negative effect is observed for service-related mobility, followed by shopping-, business-, and work-related travel. These findings are consistent with the view that border closures disrupted cross-border interactions supporting employment, market access, consumption, and service provision. Accordingly, municipalities that relied more heavily on these interactions before the pandemic experienced larger declines in nighttime light intensity.

The estimates also align with the qualitative evidence discussed in Section 5.2. Interviews with Czech workers commuting to Germany document uncertainty, changing entry conditions, administrative requirements, and weak coordination between national authorities (Novotný and Böhm, 2022). Comparative evidence from several German border regions similarly shows that rapidly introduced restrictions created difficulties for cross-border workers and that the effectiveness of subsequent solutions depended on pre-existing coordination

Table 4: Purpose of Cross-Border Mobility

Mobility Purpose	Coefficient	Std. Error
Closure × Discretionary mobility		
Social (Family & Friends)	0.052***	(0.017)
Leisure	0.225***	(0.020)
Closure × Productive mobility		
Services	-0.421***	(0.043)
Shopping	-0.138***	(0.017)
Business & Work	-0.077**	(0.037)
Observations	252,467	
Within R^2	0.32 -0.34	
FE: LAU	✓	
FE: Year-Month	✓	

Notes: The dependent variable is the natural logarithm of monthly nighttime light intensity. The mobility-purpose measures capture the pre-pandemic share of respondents in the relevant cross-border area reporting the indicated activity as their primary reason for undertaking a cross-border trip. Each row reports the coefficient from a separate regression in which the border closure treatment is interacted with the corresponding mobility-purpose share. Mobility purposes are grouped into *discretionary* mobility (social visits and leisure) and *productive* mobility (services, shopping, business- and work-related travel). All regressions include municipality (LAU) fixed effects and year–month fixed effects. Robust standard errors are reported in parentheses. Statistical significance is denoted by *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$.

between national and regional institutions (Blauberger et al., 2023).

On the other hand, the interaction coefficients for leisure and social mobility, i.e. discretionary mobility, are positive and statistically significant. Thus, border municipalities where cross-border mobility is primarily driven by leisure or social interactions before the pandemic experienced relative increases in nighttime light intensity during border closures. When discretionary cross-border activities are restricted, time and spending are reallocated toward domestic alternatives, which might partially offset the negative market-access shock. This finding should be interpreted as a relative spatial reallocation of measured economic activity, not as evidence that border restrictions benefited the individuals affected. When leisure trips and social visits across the border became more difficult, some accompanying expenditure and use of services may have shifted toward domestic locations. At the same time, the restrictions reduced family and social contact, limited individual choice, and weakened established cross-border relationships (Kajta and Opiłowska, 2022; Tarvet and Klatt, 2022).

Overall, the heterogeneity and mechanism analyses show that the economic effects of internal border closures are highly context-dependent. Local vulnerability depends not only on municipality size and adjustment capacity, but also on economic asymmetries across borders and the functional role of cross-border mobility. Where cross-border interactions primarily support production, border closures generate economic losses; where mobility is largely discretionary, losses are mitigated or even reversed through domestic substitution. As a result, border closures generated uneven local effects depending on the economic relationships and forms of mobility they disrupted.

6 Conclusion

This paper studies the local economic effects of the temporary reintroduction of internal Schengen border controls during the COVID-19 pandemic. Municipalities located along internal Schengen borders experienced a decline in nighttime luminosity of approximately 3–4% relative to interior municipalities. The effects were larger in smaller and less densely populated municipalities and along economically asymmetric East–West borders, which often connect local economies with greater differences in wages, employment opportunities, prices, and service provision. They also depended on the purpose of cross-border mobility: areas relying more strongly on work, business, services, and shopping experienced larger losses, while the results for leisure- and social-related mobility are consistent with greater scope for domestic reallocation.

These findings provide evidence on the benefits of European integration. The removal of routine border controls did more than make travel easier. It allowed labor markets, services, consumption, and everyday economic activity to develop across national borders. The economic losses observed when controls were temporarily restored show that these cross-border links had become important for the functioning of local economies. In this sense, the costs of border closures also reveal the value created by Schengen and by the broader process of European integration.

The paper contributes to the literature by showing that the effects of border restrictions are highly local and cannot be understood from national aggregates alone. Border regions differ in their dependence on cross-border mobility, in the economic asymmetries between neighboring regions, and in their ability to replace cross-border workers, customers, services, and markets with domestic alternatives. The results therefore explain why a common policy shock produced very different outcomes across municipalities.

The findings also have a clear policy implication. Border controls may sometimes be considered necessary during public-health or security crises, but their economic costs are unlikely to be evenly distributed. Where restrictions are introduced, governments should coordinate rules across neighboring countries, preserve essential commuting and business mobility where possible, and provide targeted support to border municipalities with limited domestic alternatives. Clear and stable rules are particularly important, as uncertainty and frequent changes can disrupt cross-border activity even when movement remains formally permitted.

Finally, the estimates capture changes in local economic activity, not the full costs of restricted mobility. Nighttime lights do not measure reduced individual choice, family separation, uncertainty, or the weakening of social and institutional ties across borders. The broader message is, therefore, clear: open internal borders have become an important part of the economic and social infrastructure of Europe. Building resilience without undermining the gains from European integration requires crisis policies that account for the economic and social importance of cross-border relationships.

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Data statement

Data and replication package are available upon request.

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Appendices

A Short-Run Equilibrium

This appendix presents the derivation of the short-run response of local economic activity to increases in mobility costs. Throughout, we interpret the equilibrium as strictly short-run: population stocks, firm locations, and the underlying stock of non-tradable services are fixed, while prices, market access, and the utilization of local services adjust immediately.

Market Access and Economic Activity

Firm and consumer market access are defined as

$$FMA_a \equiv \sum_i \frac{w_i L_i P_i^M}{T_{ai}^{\epsilon-1}}, \qquad CMA_a \equiv \sum_j \frac{n_j p_j P_j^M}{T_{ja}^{\epsilon}}. \tag{4}$$

Short-run real economic activity in municipality a is given by

$$EA_a = \Omega FMA_a^{\theta_1} CMA_a^{\theta_2} H_a^{-1}, \tag{5}$$

where Ω is a function of structural parameters and the common real wage.

Taking logs and totally differentiating with respect to trade costs yields

$$d \ln EA_a = \theta_1 \frac{dFMA_a}{FMA_a} + \theta_2 \frac{dCMA_a}{CMA_a} - \frac{dH_a}{H_a}. \tag{6}$$

Mobility Purpose and the Sign of the Short-Run Response

We derive the sign of the short-run response of local economic activity to increases in mobility costs using the log-differentiated equilibrium condition:

$$d \ln EA_a = \theta_1 \frac{dFMA_a}{FMA_a} + \theta_2 \frac{dCMA_a}{CMA_a} - \frac{dH_a}{H_a}. \tag{7}$$

Throughout, we interpret the equilibrium as short run. Population stocks, firm locations, and the underlying stock of nontradable infrastructure are fixed:

$$\frac{dL_i}{dT} = 0, \qquad \frac{dn_j}{dT} = 0, \qquad H_a = \bar{H}_a \cdot u_a(T),$$

where $\bar{H}_a$ denotes the fixed infrastructure stock and $u_a(T)$ captures its endogenous utilization.

Case 1: Market-access effects. Firm market access is defined as

$$FMA_a = \sum_i w_i L_i P_i^M T_{ai}^{-(\epsilon-1)}. \tag{8}$$

Differentiating with respect to trade costs yields

$$\frac{\partial FMA_a}{\partial T_{ai}} = -(\epsilon-1)\frac{w_i L_i P_i^M}{T_{ai}^{\epsilon}} < 0. \tag{9}$$

Since population and firm locations are fixed in the short run,

$$\frac{dFMA_a}{dT} < 0. \tag{10}$$

Similarly, consumer market access is

$$CMA_a = \sum_j n_j p_j P_j^M T_{ja}^{-\epsilon}, \tag{11}$$

with

$$\frac{\partial CMA_a}{\partial T_{ja}} = -\epsilon \frac{n_j p_j P_j^M}{T_{ja}^{\epsilon+1}} < 0, \tag{12}$$

implying

$$\frac{dCMA_a}{dT} < 0. \tag{13}$$

Thus, increases in mobility costs generate a negative market-access effect common to all municipalities.

Case 2: Productive mobility. When cross-border mobility facilitates productive interactions, such as commuting and business travel, border closures do not shift activity toward local non-tradable sectors. Instead, they reduce effective productive capacity, leaving demand for local non-tradable services unchanged or even lower:

$$\frac{du_a(T)}{dT} \approx 0 \quad \Rightarrow \quad \frac{dH_a}{dT} \approx 0. \tag{14}$$

Substituting into equation (7) yields

$$d\ln EA_a = \underbrace{\theta_1 \frac{dFMA_a}{FMA_a}}_{<0} + \underbrace{\theta_2 \frac{dCMA_a}{CMA_a}}_{<0} - \underbrace{\frac{dH_a}{H_a}}_{\approx 0} < 0. \tag{15}$$

Hence,

$$\frac{dEA_a}{dT} < 0. \tag{16}$$

Case 3: Discretionary mobility. When cross-border mobility is primarily discretionary, such as leisure or social visits, higher mobility costs redirect consumption toward locally provided nontradable services. Although the infrastructure stock $\bar{H}_a$ is fixed, its utilization increases:

$$\frac{du_a(T)}{dT} > 0 \quad \Rightarrow \quad \frac{dH_a}{dT} < 0. \tag{17}$$

Substituting into equation (7) gives

$$d \ln EA_a = \underbrace{\theta_1 \frac{dFMA_a}{FMA_a}}_{<0} + \underbrace{\theta_2 \frac{dCMA_a}{CMA_a}}_{<0} + \underbrace{\left(-\frac{dH_a}{H_a} \right)}_{>0}. \tag{18}$$

If the increase in local nontradable utilization is sufficiently strong, the positive demand reallocation term can offset the negative market-access effects:

$$-\frac{dH_a}{H_a} \;\geq\; \left| \theta_1 \frac{dFMA_a}{FMA_a} + \theta_2 \frac{dCMA_a}{CMA_a} \right|. \tag{19}$$

In this case,

$$\frac{dEA_a}{dT} \geq 0. \tag{20}$$

In a short-run equilibrium with fixed population, firm locations, and infrastructure stocks, the sign of the local economic response to border closures depends on whether cross-border mobility supplies productive interactions or discretionary consumption. This distinction determines whether changes in local nontradable utilization amplify or offset the market-access shock.

B Summary Statistics

Table 1: Summary Statistics

Variable	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
Population density (per km^2)	4,158,672	190.39	681.31	0	27,380.66
Area (km^2)	4,207,168	31.42	57.05	0.02	2,524.13
Population (2016)	4,158,672	4,538.32	32,127.71	0	3,520,031
Log nighttime lights	3,852,814	-0.68	1.82	-4.61	6.37
Social mobility share	2,096,864	0.36	0.18	0	1.05
Leisure mobility share	2,096,864	0.57	0.16	0	1.00
Services mobility share	2,096,864	0.11	0.07	0	0.50
Shopping mobility share	2,096,864	0.36	0.19	0	1.00
Business mobility share	2,096,864	0.15	0.08	0	0.53
Border municipality	4,167,576	0.46	0.50	0	1
Western municipality	4,207,168	0.81	0.39	0	1
Eastern municipality	4,207,168	0.19	0.39	0	1
West partner	4,207,168	0.33	0.47	0	1
East partner	4,207,168	0.16	0.36	0	1
Treatment (Post)	601,024	0.50	0.50	0	1
Alternative treatment (Post$_2$)	901,536	0.33	0.47	0	1
Year	4,207,168	2019	2.29	2018	2020
Month	4,207,168	4.0	2.0	1	7

Notes: This table reports summary statistics for the main variables used in the analysis. The unit of observation is a municipality (LAU)–month.

Table 2: Border closure effects across Romanian border regions

	(1)	(2)	(3)	(4)
Border × Closure	0.048**	-0.034	0.124***	-0.290***
	(0.019)	(0.022)	(0.024)	(0.043)
Observations	22,630	17,020	17,368	4,209
R^2 (within)	0.115	0.135	0.115	0.168
FE: Municipalities	✓	✓	✓	✓
FE: Year-Month	✓	✓	✓	✓
Treated	Borders	EU Borders	Non-EU Borders	EU Borders
Control	Interiors	Interiors	Interiors	Non-EU Borders

Notes: The dependent variable is ln(*ntl*). All specifications are estimated using municipality fixed-effects regressions with municipality and month–year fixed effects. Column (1) reports estimates for the full sample of Romanian municipalities. Column (2) restricts the sample to Romanian municipalities bordering Hungary and Bulgaria (EU borders). Column (3) restricts the sample to Romanian municipalities bordering Serbia, Moldova, and Ukraine (non-EU borders). Column (4) compares municipalities bordering Hungary and Bulgaria with municipalities bordering Serbia, Moldova, and Ukraine. Robust standard errors are reported in parentheses. Statistical significance is denoted by $^{*}p < 0.10$, $^{**}p < 0.05$, and $^{***}p < 0.01$.