Cocaine Goes Bananas: Global Spillovers from an Illicit Supply Shock*

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Abstract

We study a large, unintended, policy-induced increase in Colombian cocaine production and trace how it propagated internationally through global trade networks with substantial social costs. In Colombia, expanded cocaine production and trafficking increased homicide rates by about one-third, with substantially larger effects in port areas. Violence then spilled across the border into Ecuador, a transit hub with negligible cocaine production but dense maritime trade links, where homicide rates increased nearly five-fold. The shock traveled through criminal supply chains that exploit legitimate perishable export routes, notably bananas, concentrating activity at maritime chokepoints. In Europe, countries with stronger pre-shock trade ties to Colombia and Ecuador experienced sharp increases in origin-linked cocaine seizures, lower retail prices, a 60 percent rise in cocaine consumption in port cities, and 5 percent higher violent crime in port provinces. Together, these results show that shocks in illicit markets propagate internationally through the same trade networks as legal shocks, concentrating violence at logistical bottlenecks and expanding downstream drug markets.

Keywords: Illicit trade; International spillovers; Violence; Trade networks
JEL codes: F14, K42, O17, D74

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1 Introduction

Shocks can propagate through production networks, turning local disruptions into aggregate economic and social outcomes.[1] Globalization amplifies these dynamics by expanding cross-border linkages and concentrating activity and rents at key bottlenecks (Antràs, 2020). Far less is known about whether shocks in illicit markets propagate in similar ways. Although production, trafficking, and consumption of illegal goods are likewise organized through global supply chains, these networks are deliberately opaque and difficult to observe, leaving their broader consequences poorly understood. This paper studies how a large, unintended, policy-induced increase in Colombian cocaine production propagated internationally through illicit supply chains that piggyback on legal trade networks, and the social costs it generated along the way.

Our setting is the global cocaine market, in which Colombia accounts for the majority of world supply and has long been a dominant source for both the United States and Europe. In May 2014, during peace negotiations with the *Revolutionary Armed Forces of Colombia* (FARC from the Spanish acronym), the Colombian government announced a future crop-substitution program that would provide material incentives to coca-growing farmers who voluntarily eradicated their crops; coca leaves are the main natural input in the manufacturing of cocaine. Anticipating these transfers, farmers sharply expanded coca cultivation, triggering a large and persistent supply shock: coca cultivation nearly quadrupled and cocaine production potential increased several-fold in the years following the announcement (Prem et al., 2023; United Nations Office on Drugs and Crime, 2024). This represents an unprecedented expansion of Colombia's role in the global cocaine market.

We treat 2015 as the onset of a positive and persistent cocaine supply shock induced by anticipatory farmer responses to the announced policy. The organization of the global cocaine market allows us to trace how this shock propagated through space: cocaine production is concentrated in specific regions of Colombia, export flows are funneled through a limited set of maritime ports, trafficking routes pass through neighboring transit hubs, and downstream markets differ in their pre-existing trade connectivity to source countries. We follow the shock along three linked stages—source (Colombia), transit (Ecuador), and destination (Europe)—to examine how violence, trafficking activity, and consumption responded as it moved through the network. To do so, we assemble new data spanning the supply, trafficking, and demand sides of the global cocaine economy. On the supply side, we use municipal-level homicide records from Colombia and Ecuador to study violence in producing areas and port-adjacent municipalities. At the trafficking stage, we draw on confidential country-to-country cocaine seizure data from European ports that identify shipment origins. On the demand side, we use harmonized wastewater analysis for 79 European cities across 20 countries to measure local cocaine consumption, complemented by country-level drug price data and provincial crime

[1] Seminal contributions on the propagation of shocks through production networks include Gabaix (2011) and Acemoglu et al. (2012), with subsequent advances by Boehm et al. (2019) and Baqaee and Farhi (2020). Empirical work on international trade shocks shows how local exposure reshapes employment, prices, and political outcomes across connected economies, beginning with Autor et al. (2013) and extending through Dauth et al. (2014), Balsvik et al. (2015), Donoso et al. (2015), Autor et al. (2016), Malgouyres (2017), Traiberman (2019), Autor et al. (2020), De Lyon and Pessoa (2021), Citino and Linarello (2021), and Che et al. (2022).

statistics.

Our empirical strategy relies on difference-in-differences and event-study designs that compare more and less exposed locations before and after the Colombian production surge. In South America, we compare port to inland municipalities and coca-producing to non-producing areas, capturing the two primary nodes of the trafficking network. In Europe, we classify countries as treated if they had strong pre-2016 trade ties with Colombia and Ecuador. This yields Spain, Belgium, the Netherlands and Germany as the most exposed markets.

We document three main findings. First, in Colombia, the expansion of cocaine production and trafficking led to a sharp increase in homicide rates following the shock, with violence concentrating in coca-producing and cocaine-manufacturing municipalities as well as in port areas that serve as export gateways. Relative to pre-shock levels, homicide rates rose by roughly 26 percent in producing areas and by 41 percent in port municipalities. Second, violence spilled across the border into Ecuador, a neighboring transit hub with negligible coca cultivation but close proximity to Colombia's main producing regions and dense maritime trade links. Ecuador's national homicide rate increased nearly five-fold in the medium run, reaching levels comparable to some of the most violent countries in the region. Third, in Europe, countries with strong pre-shock trade connections to Colombia and Ecuador experienced sharp increases in cocaine seizures linked to these origins, declines in retail prices, a roughly 60 percent rise in cocaine consumption in port cities, and a 5 percent increase in violent crime in port provinces.

We interpret these results through the lens of a trade network conceptual framework in which cocaine is concealed and flows along legal maritime routes connecting production zones, export ports, and import hubs. In practice, criminal organizations piggyback on high-volume perishable export chains, most notably bananas, to conceal shipments within legitimate maritime trade. Nodes with dense traffic and weak enforcement, particularly major ports, act as chokepoints where profits concentrate. A supply expansion increases the value of controlling these nodes, intensifying violent contestation in places with criminal competition, in both source and transit countries. Ports are few and capacity-constrained in the short to medium run, while inland routes are numerous and substitutable, explaining why violence and economic spillovers localize in coca-growing and port municipalities. In import hubs, ports with pre-shock trade connectivity experience higher seizures, lower prices, and increased consumption and crime, consistent with their role as key entry chokepoints in the global cocaine network.

Our findings make three contributions. First, we extend research on global production shocks from legal to illicit markets, providing systematic evidence that a supply shock in an illegal commodity can generate international spillovers mediated by trade networks. Second, we advance the literature on the domestic and regional effects of drug trafficking (Dell, 2015; Mejía and Restrepo, 2016; Castillo et al., 2020) by demonstrating how a production shock in one country can destabilize neighboring transit states and reshape violence and crime far downstream in consumer markets. Third, we link work on infrastructure, trade, and market access (Donaldson, 2018; Feyrer, 2019) to show that legal shipping networks and port capacity shape where rents accumulate, where violent contestation emerges, and where drug availability expands. Together, our findings show that shocks in illicit markets propagate through global supply chains much as shocks in legal markets do, concentrating violence and economic spillovers

at key network nodes and reshaping downstream crime and consumption across borders.

2 Context

This section contextualizes our empirical setting and results by highlighting three interlinked developments in the cocaine trade: the resurgence of production in Colombia (Section 2.1), the spillover of trafficking and violence into Ecuador (Section 2.2), and the growing importance of European markets combined with increasingly sophisticated smuggling technologies (Section 2.3). Together, these dynamics close the circuit of supply, transit, and demand that underpins our empirical analysis.

2.1 Colombia and the Cocaine Shocks

Seeking to end a half-century of armed conflict, formal peace negotiations between the Colombian government and the FARC began in Havana in October 2012 and concluded with the signing of the final peace accord in August 2016. Drug policy was central to these talks because FARC had become directly involved in the production and trafficking of cocaine after the dismantling of Colombia's major drug cartels in the early 1990s.[2] In May 2014, after reaching a partial agreement on drug policy, the joint government-FARC delegation in Havana announced that, once a peace accord was signed, the state would implement a new program offering material incentives to coca-growing farmers who voluntarily replaced coca with alternative crops, explicitly targeting historically coca-growing, poor regions.[3]

According to Prem et al. (2023), this announcement was the immediate catalyst for the surge in Colombian cocaine production. Figure 1 previews this core pattern: after 2015, Colombian cocaine production surges far faster than the rest of the world, setting in motion the global spillovers we trace in this paper.[4] Prem et al. (2023) estimate that the actual implementation of the crop-substitution program reduced coca growing only for targeted beneficiaries, while further increasing it in nearby plots within the same municipalities. Indeed, Ladino et al. (2021) conclude that the net effect of the program's implementation was negative. Figure 1

[2]In recognition of this involvement, FARC was designated a foreign terrorist organization by the U.S. government in October 1997.

[3]The statement read:

> '(...) we have agreed that the National Government will create and implement a new National Program for the Integral Substitution of Illicit Crops (...) with the goal of generating the material and intangible welfare conditions for the people affected by illicit crops, particularly for the peasant communities who live in poverty and that currently obtain their subsistence from such crops (...)" (Dispatch No. 36. Havana, May 16, 2014).

Source: our translation from the original Spanish text. Available from: https://www.eltiempo.com/archivo/documento/CMS-13998996 (last accessed 09/04/2025).

[4]The authors exploit the timing of the May 2014 press release and two forms of cross-sectional variation: a continuous, time-invariant ecological index of coca suitability that captures how differences in growing conditions shaped responsiveness to expected rewards, and predicted eligibility based on municipalities' historical coca cultivation and poverty. They find that the announcement triggered a large relative expansion of coca cultivation in ecologically favorable municipalities and in those with higher predicted eligibility. After the press release, a municipality one standard deviation above the mean on the coca-suitability index saw coca area increase by 24 percent of a standard deviation (109 percent of the pre-announcement mean), and a municipality with a predicted eligibility 10 percentage points above the mean experienced an increase of 11 percent of a standard deviation (49 percent of the pre-announcement mean).

shows that between 2015 and 2016, Colombian production increased by 62 percent and by 2023 potential output had risen more than seven-fold compared to a decade earlier.

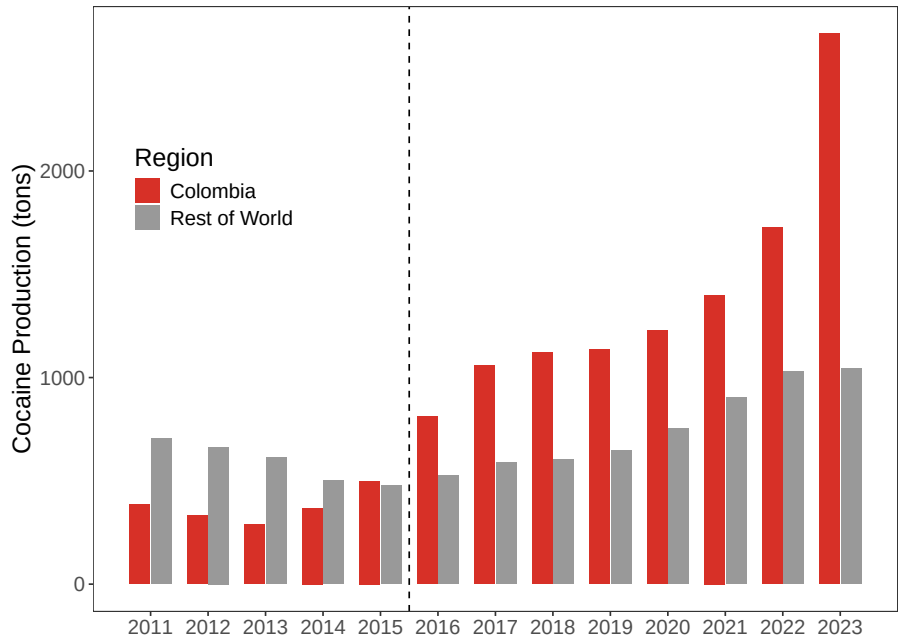


Figure 1: Global Cocaine Production

Notes: Potential manufacture of 100 per cent pure cocaine, 2011-2022 (tons). Yearly figures are computed by converting areas under coca cultivation into cocaine hydrochloride, taking into account yields and cocaine laboratory efficiency into account. "Potential" cocaine production does not refer to the cocaine actually produced but to the amount of 100 per cent pure cocaine that *could* be produced from the cultivated area. Source: United Nations Office on Drugs and Crime (2024).

A second, independent shock further boosted production in coca-producing areas near the Venezuelan border. In early 2016, Venezuela devalued its currency, reducing the price of gasoline that cartels on the Colombian side of the border smuggled and used as a key input to transform coca leaves into cocaine. According to Beeder (2023), cheaper access to this precursor in border areas generated sharp increases in coca cultivation and a 40–50 percent rise in homicide rates, illustrating how both policy-induced incentives and input-cost reductions can generate violent spillovers in cocaine markets.[5]

2.2 Spillovers into Ecuador

As Colombian production grew, trafficking routes shifted southward, propelling Ecuador into the cocaine trade despite its almost non-existent domestic coca cultivation. Many of Colombia's coca-producing municipalities are concentrated along the southern border with Ecuador (Appendix Figure A.1), which facilitated this reorientation of flows. Geography and trade infrastructure, especially the port of Guayaquil, made Ecuador a strategic transit hub once

[5]The suspension of aerial spraying of coca bushes mandated by Colombia's Constitutional court citing the negative effects of glyphosate on human health is a third potential shock. However, while Prem et al. (2023) estimate that the announcement of future compensations to coca growers doubled the amount of coca growing relative to the pre-announcement mean in more coca suitable areas, Raffo (2023) suggests that the effect of the aerial spraying banning is just 6% of the pre-policy mean.

flows adjusted after 2015, lowering marginal trafficking costs relative to alternative routes. Recent estimates suggest that around one-third of Colombia's cocaine production now flows into Ecuador.[6]

Criminal networks exploited Ecuador's dollarized economy, porous borders, and weak port enforcement which enabled seamless money laundering through export cash flows as traffickers increasingly concealed cocaine within legitimate exports such as bananas and shrimp. Guayaquil emerged as one of the principal exit points for Europe-bound shipments, accounting for over 60 percent of such seizures (United Nations Office on Drugs and Crime, 2023).

The security implications have been dramatic. Ecuador's national homicide rate rose substantially since the beginning of the 2020s, becoming one of the most violent countries in South America. Violence has concentrated in key transit cities: Durán, adjacent to Guayaquil's port, now ranks among the world's deadliest urban areas, a likely symptom of port-driven criminal competition.[7] Violence lagged until 2020-2021, when the assassination of Los Choneros' gang leader 'Rasquina' fragmented Ecuador's criminal ecosystem—from monopoly to fierce competition among groups such as Los Lobos, Los Tiguerones, and others–triggering the homicide explosion.

2.3 European Markets and Smuggling Technology

European demand completes the circuit of the global cocaine trade. European ports have become critical entry points, with cocaine often concealed alongside legitimate goods in shipping containers (United Nations Office on Drugs and Crime, 2023). The convergence of legal and illegal trade is facilitated by traffickers' exploitation of legitimate shipping networks: in some instances, major global shipping firms have unwittingly transported large cocaine shipments, revealing structural vulnerabilities in international trade infrastructure (Bloomberg, 2022).

The rapid growth of the European cocaine market has placed substantial strain on law enforcement and public health systems. In 2021, EU police and customs officers seized a record 303 tonnes of cocaine—a fivefold increase over a decade—suggesting that interdiction efforts struggle to keep pace with expanding flows. Figure 2 shows that after 2015, seizures from Colombia and Ecuador rose sharply, while those from other South American countries remained relatively flat, underscoring how the Colombian supply shock and Ecuador's emergence as a transit hub directly fueled Europe's expanding market. In parallel, the European Union Drugs Agency reports that cocaine detections in wastewater have increased steadily across European cities, documenting a sustained uptrend in consumption.

The resulting influx has also contributed to a rise in violent crime, particularly in northwest Europe, where the multi-billion-euro cocaine trade has ignited turf wars among rival criminal organizations and where a large share of homicides is now drug-related (Jütten, 2024). At the same time, traffickers have upgraded their smuggling methods, especially at sea. The use of shipping containers has expanded in both scale and sophistication: cocaine can now be introduced into the supply chain before containers reach the port, during transit, or even

[6] See https://insightcrime.org/investigations/ecuador-a-cocaine-superhighway-to-the-us-and-europe/, last accessed (01/26/2026).

[7] See https://americasquarterly.org/article/latin-americas-murder-rates-reveal-surprising-new-trends/, last accessed (01/26/2026).

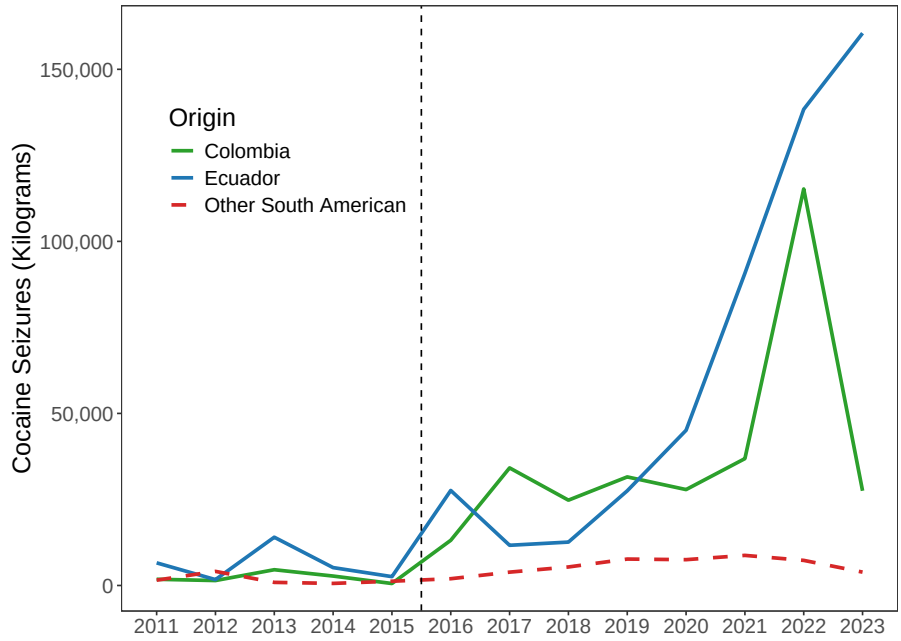


Figure 2: Cocaine Seizures in Europe that originate in South America

Notes: Cocaine seizures (kg) in European ports by reported country of origin. "Other South American" aggregates South American countries with positive seizures in the pre-2016 period (excluding Colombia and Ecuador) by averaging annual seizure volumes across those origins.

after loading onto vessels. Drugs are disguised within legitimate products, especially perishable ones like fruit, or impregnated into fabrics and other materials. This strategy often relies on "piggy-backing" onto legitimate shipments and requires collusion by port workers, truck drivers, and corrupt customs officials (United Nations Office on Drugs and Crime, 2023). These reports again support our emphasis on perishable export routes as particularly attractive concealment opportunities.

To process cocaine disguised in materials, traffickers have begun setting up extraction laboratories in Europe itself, modeled directly on Colombian facilities. Dutch police, for example, have uncovered large labs built with technical drawings from South America and staffed by Colombian chemical experts but organized by European crime groups. In parallel, advances in navigation technology allow traffickers to chart more efficient maritime routes and evade detection; ship-to-ship transfers using speedboats, fishing vessels, and ferries have become routine in West Africa, the Caribbean, and the Pacific, with container ships sometimes dropping consignments for pickup before reaching port. These are tactics widely used for shipments bound for the Netherlands and Belgium (United Nations Office on Drugs and Crime, 2023).

A persistent challenge for European customs authorities is that containers are rarely shipped directly from producing countries to their final European destination. Instead, they are frequently transshipped through regional hubs such as Panama or reloaded in intermediate European ports like Antwerp (Europol, 2023; Roks et al., 2021). Traffickers exploit this structural weakness by using transshipment hubs, container re-stuffing, and false declarations of goods to obscure provenance. Enforcement agencies must therefore rely on risk-based selection algo-

rithms, cross-checking of origin and dispatch data, and intelligence sharing (European Commission, Taxation and Customs Union, 2025), consistent with our emphasis on the interaction between trade infrastructure, information, and enforcement capacity.

3 Conceptual Framework

We posit that the global cocaine economy can be thought of as a network connecting three types of locations: production zones (coca-growing/cocaine producing areas in Colombia), transit ports (such as Buenaventura in the Colombian Pacific coast or Guayaquil in Ecuador), and destination ports (European entry points like Rotterdam or Algeciras). Traffickers piggyback on legal maritime shipping routes, hiding cocaine in legitimate cargo. In this network, certain locations act as chokepoints, which are relatively scarce, highly profitable locations where large volumes of trade converge but enforcement is limited. These are the places where controlling the flow generates the biggest rents because high volumes pass through a limited number of nodes. This framework combines insights from production-network models of shock propagation with research on illicit markets in which rents are enforced through violence rather than contracts.

A sudden increase in Colombian cocaine production injects more supply into this network. The value of controlling chokepoints rises because they now handle larger flows and bigger profits. Criminal groups respond by contesting control more fiercely, and since the market is illegal, this competition often turns violent, especially where state authority is weak. Interior transport routes, by contrast, are numerous and easily substituted, so no single one is worth fighting over with the same effort. Transit countries like Ecuador adjust more slowly as traffickers build the necessary corruption networks and logistics, a process documented by Berg and Bledsoe (2024).[8]

In destinations like Europe, the same logic concentrates effects at entry points. Ports with strong pre-existing trade links to Colombia and Ecuador receive the first and largest cocaine inflows. Illicit distribution costs that grow more than proportionally with distance imply cocaine stays cheapest near these ports, driving the strongest consumption response there while inland areas see more muted effects. Ports already infiltrated by organized crime adjust fastest, amplifying local trafficking, crime, and contestation over time.

This framework generates four testable predictions that guide our empirical analysis:

1. In Colombia, violence increases disproportionately in coca-producing municipalities and export ports, with weaker effects along interior trafficking routes (Sections 6.1 and 6.3).

2. In Ecuador, violence rises with a delay following the Colombian supply shock and concentrates in port-adjacent areas rather than inland regions (Sections 6.2 and 6.3).

3. In Europe, countries and ports with stronger pre-shock maritime trade links to Colombia and Ecuador experience larger increases in cocaine seizures, consumption, and violent crime (Section 7).

[8] See also https://apnews.com/article/ecuador-bananas-cocaine-europe-drug-trafficking-6d6529e2b1d8f3cbd16aea74a (last accessed 11/05/25).

4. Within destination countries, these effects are strongest in port areas and attenuate with distance from major entry ports (Section 7).

Appendix Section C formalizes this intuition in a network model of trade and conflict. The empirical patterns we document strongly match these predictions.

4 Data

We organize the description of the data sources and measurement into four categories: trade connectivity, cocaine seizures and prices, wastewater consumption, and violence outcomes. Table B.1 summarizes all data sources and their units of aggregation.

4.1 Trade Connectivity

The Shipping Bilateral Connectivity Index (SBCI) from the United Nations Conference on Trade and Development (UNCTAD) measures maritime transport connectivity and efficiency between country pairs using five components: number of transshipments required to reach one country from the other (indicating route directness); number of shared direct connections (capturing global trade integration); common one-transshipment links (reflecting indirect linkages); largest route vessel capacity; and presence of competing carriers. We use it to quantify pre-shock legal shipping connectivity between South America (distinguishing between producers/transit countries versus other origins) and European destinations, which traffickers exploit for concealment.

We complement SBCI with proprietary annual port-to-port data on scheduled container capacity in twenty-foot equivalent units (TEU), which captures actual containerized trade volumes between specific South American and European ports, allowing us to proxy likely trafficking routes and test for heterogeneity by trade intensity (Appendix Figure A.2). All trade connectivity measures are constructed using data from the pre-2015 period.

4.2 Cocaine Seizures and Prices

Our primary seizure data come from confidential annual country-to-country records provided by the World Customs Organization (WCO) for all European countries. These granular data record quantities of cocaine intercepted at ports, including the origin country of the container, enabling us to reconstruct trafficking routes from Colombia/Ecuador or other origins to specific European destinations and test origin-specific responses.[9]

We complement these data with aggregate drug seizure data from the United Nations Office on Drugs and Crime (UNODC), which are disaggregated by drug type but lack detailed origin information. UNODC also provides country-year retail/wholesale cocaine prices.

[9] Although seizures may be subject to detection bias, our analysis exploits within-destination and within-year variation by country of origin, which mitigates this concern.

4.3 Wastewater Consumption

The European Union Drugs Agency (EUDA) coordinates annual wastewater analysis across 88 European cities in about 20 countries.[10] Samples, collected in a standardized period to ensure comparability (Thomas et al., 2012; Zuccato et al., 2008; Van Nuijs et al., 2011), measure cocaine metabolites such as benzoylecgonine to estimate community-level cocaine use (in mg/1,000 population/day). Validated against surveys (e.g., higher weekend/holiday peaks), this objective measure avoids self-report bias. While widely used in epidemiology and public health, wastewater-based measures have seen limited use in economics, and we use it to trace consumption responses in port versus inland cities in Europe.

4.4 Violence Outcomes

Yearly homicide data at the municipal/cantonal- level for Colombia and Ecuador comes from official registries that include demographics that vary across the two sources, which limits cross-country comparisons for specific gender and age-brackets but does not affect within-country analyses (see Policía Nacional de Colombia, 2025; Instituto Nacional de Estadística y Censos (INEC), 2025).[11] These capture violence dynamics in cocaine production/transit nodes. We also collect similar statistics from other Latin American countries used in placebo analyses.

To measure the geographic presence of criminal groups and the degree of territorial contestation in Colombia, we use the violence dataset originally compiled by Restrepo et al. (2004). We construct a dummy for pre-shock FARC presence, where the indicator equals one if at least one violent event attributed to the FARC occurred in a municipality between 2011 and 2014, prior to the cocaine production shock. The FARC was the largest and longest-standing insurgent organization in Colombia and played a central role in cocaine production following the dismantling of the major cartels (see Section 2). Following Acemoglu et al. (2015) and Prem et al. (2022), we capture territorial contestation by interacting analogous presence indicators for other criminal groups with a spatial decay function that assigns greater weight to groups operating in closer proximity to municipalities with FARC presence.

Finally, to track downstream violence impacts along trafficking routes, we rely on European violent crime statistics from Eurostat NUTS-3 regions (equivalent to provinces). These data allow us to study potential violent spillovers in downstream consumption markets by contrasting provinces located near major ports with inland provinces within treated European markets.

5 Empirical Strategy

Our empirical strategy proceeds in two steps. Section 5.1 defines treated and control units in South America (Colombia and Ecuador) and in Europe, based on locations' positions within the global cocaine supply chain. Given these definitions, Section 5.2 outlines the difference-in-differences and event-study framework that constitutes our main empirical approach.

[10] See https://www.euda.europa.eu/publications/html/pods/waste-water-analysis_en, (last accessed 01/26/2026).

[11] Unfortunately, granular data on homicides in Ecuador are available only starting in 2014, which limits the pre-shock period that we can use in our analysis.

5.1 Treated and Control Units

South America

We examine violence along the cocaine supply chain at production and transit nodes in Colombia and Ecuador. In both countries, we classify municipalities located within 50 kilometers of an international port as port-adjacent and compare them to inland municipalities.[12] In Colombia, we additionally classify municipalities with above-median pre-shock coca cultivation as coca-producing and compare them to non-producing areas. These two dimensions capture key nodes of the cocaine supply chain: production zones and export ports.

In supplementary analyses, we also consider municipalities located along shortest-path routes connecting coca-producing areas to export ports. These routes represent potential trafficking corridors but are more easily substitutable than ports and therefore play a less clearly defined role as strategic nodes.

Europe

To study downstream effects in destination markets, we compare European countries with high and low pre-shock maritime trade exposure to Colombia and Ecuador. Our measure of trade exposure is based on scheduled container shipping capacity prior to the supply shock, using country-level data on maritime connections. Appendix Figure A.2 reports this measure for all European countries with at least some pre-shock trade links to the source nations.

We define treated countries as those with above-median pre-shock maritime trade exposure to Colombia and Ecuador, a measure determined prior to the cocaine production surge and unaffected by contemporaneous European drug policies. This classification identifies Germany, Belgium, the Netherlands, and Spain as the most exposed destination markets. Between 2006 and 2016, these countries accounted for over 40 million TEUs of scheduled shipping capacity from Colombia and Ecuador.[13] A substantial share of this trade consists of perishable goods, such as bananas and shrimp, which are difficult to inspect thoroughly and therefore relevant for concealment within legitimate cargo flows.

5.2 Difference-in-Differences and Event-Study Designs

We estimate the dynamic effects of the Colombian production shock using the following event-study specification:

$$Y_{it} = \sum_{\tau \neq 2015} \beta_\tau \times \left(\text{Treated}_i \times 1\{t = \tau\}\right) + \mu_i + \lambda_t + \epsilon_{it}, \tag{1}$$

where Y_{it} is an outcome in unit i (municipalities, European provinces (NUTS3), or countries depending on the specification and the data availability) at time t, Treated_i is defined in 5.1 and it is defined exclusively using pre-2015 characteristics, μ_i are unit fixed effects, λ_t are year fixed effects, and errors are clustered at the unit level. The β_τ trace the effects relative to 2015, the last pre-shock year. The identifying assumption is that, absent the cocaine production shock,

[12] We explore alternative distance thresholds in robustness analyses.

[13] The classification is similar when excluding 2016.

the outcomes of interest would have evolved similarly in treated and control units. Because this is a counterfactual statement, the assumption in practice requires coefficients for the years prior to 2015 to be close to zero and statistically insignificant. We present the full set of pre-trend coefficients and confidence intervals in all event-study figures.

To examine average differential effects, we also estimate the following parametric difference-in-differences specification:

$$Y_{it} = \beta(\text{Treated}_i \times \text{Post}_t) + \mu_i + \lambda_t + \epsilon_{it}, \tag{2}$$

where $\text{Post}_t = 1$ for $t \geq 2016$ and β captures the differential pre-post-shock change in the outcome of interest in treated units relative to controls.

In the cases where data availability allows us to compare sub-national units in treated and controls countries, we can estimate a triple-differences variant that compares port versus inland areas in treated versus control countries. This allows us to further clean our estimates from differential temporal changes in port versus other areas within countries. In particular, we estimate for the case of violence in South America and cocaine consumption in Europe, we estimate:

$$Y_{ict} = \sum_{\tau \neq 2015} \beta_\tau \left[\text{Treated}_c \times \text{Port}_i \times \mathbf{1}\{t = \tau\} \right] + \alpha_i + \gamma_{c \times t} + \varepsilon_{ict} \tag{3}$$

where Treated_c identifies treated countries (Colombia and Ecuador in the broader Latin America context, and Germany, Belgium, the Netherlands and Spain in the European one).[14] Port_i indicates proximity to ports, and $\gamma_{c \times t}$ are country×time fixed effects, which flexibly control for country–level shocks (such as national policy changes, macroeconomic conditions, or measurement differences). Standard errors are clustered at the municipality level. The triple interaction coefficients β_τ capture how the dynamic effects of the shock differ between port and inland areas in treated countries relative to controls.

This design exploits the timing of the production surge and cross-sectional variation in network exposure, letting us trace violence, seizures, consumption, and crime from source to destination while controlling flexibly for unit-specific trends and common shocks. Event-study coefficients test whether there are differential pre-trends, and we report 95% confidence intervals throughout. Moreover, unlike in Colombia and Ecuador, where exposure to the shock is more sharply localized, cocaine in Europe eventually diffuses across the continent, from ports in treated countries to inland regions and to other countries. Therefore, in the European setting, our identification exploits variation in exposure *intensity*: port areas receive the earliest and largest inflows, while other regions are affected later and more diffusely.

6 Upstream Supply Shock Impacts (Colombia and Ecuador)

We begin by examining how the cocaine supply shock affected violence in the country of origin, Colombia, and in Ecuador. Our analysis is guided by three predictions that follow directly

[14] Based on data availability, control countries in Latin America include Brazil, Dominican Republic, Guatemala, Honduras, Panama, and Chile.

from a trade-network view of illicit markets. First, violence should concentrate at strategic trafficking nodes where rents are scarce and contestable. In the cocaine trade, these nodes include coca-producing and processing areas in Colombia, as well as international export ports in both Colombia and Ecuador. A positive supply shock raises the value of controlling these chokepoints, intensifying competition and increasing violence locally. Second, adjustments may occur with a delay in settings where trafficking networks are initially underdeveloped. When absorbing increased flows requires organizational capacity, criminal infiltration, or the emergence of competition, violence may rise only after these conditions materialize. Consistent with this mechanism, we expect comparatively immediate effects in Colombia, where trafficking networks were already entrenched, but potentially lagged responses in Ecuador. Third, violence should not diffuse broadly along interior trafficking routes; where multiple alternative paths exist, traffickers can reroute shipments without engaging in sustained territorial conflict, limiting spillovers to inland municipalities.

6.1 Strategic Nodes and Competition in Colombia

Figure 3 reports event-study estimates for Colombia using two complementary definitions of strategic nodes: (i) proximity to international ports (within 50 km), and (ii) coca-growing municipalities (above-median coca cultivation in the pre-shock period). Both panels show a sharp post-2015 increase in violence in treated areas, with limited evidence of differential pre-trends. The dynamics are immediate and persistent, consistent with a setting in which trafficking rents expand quickly when supply increases and contestation over chokepoints is already feasible.

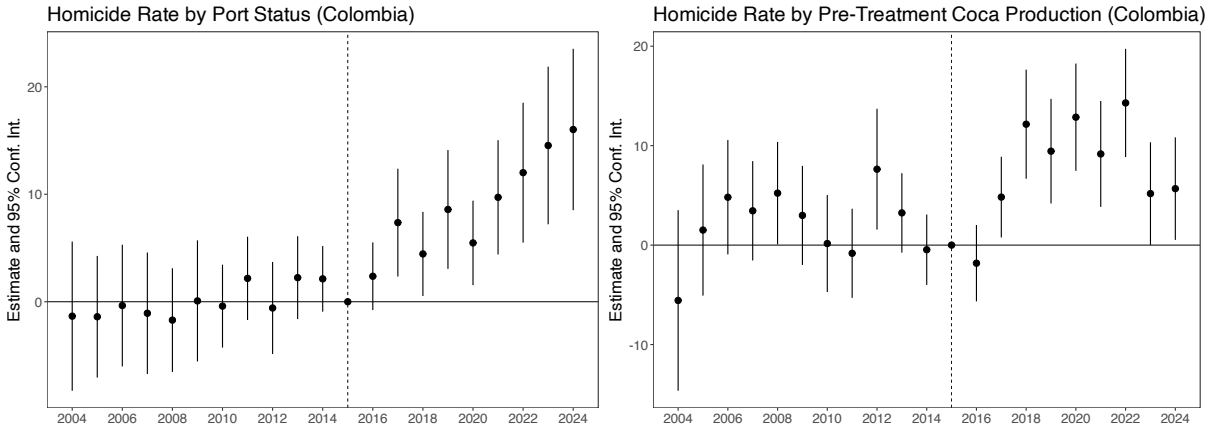


Figure 3: Dynamic Impacts on Homicide Rates at Strategic Nodes in Colombia

Notes: Event-study estimates based on Equation (1). The left panel defines treatment as municipalities within 50 km of an international port; the right panel defines treatment as above-median coca-producing municipalities (2010–2015). Outcomes are homicides per 100,000 inhabitants. Standard errors clustered at the municipality level.

Table 1 summarizes the corresponding average effects from the parametric specification in Equation 2. Column (1) compares port municipalities to inland areas, restricting the latter to non–coca-producing municipalities. Port areas experience a differential post-2015 increase of 11.37 homicides per 100,000 inhabitants relative to inland controls, corresponding to about 44 percent of the pre-treatment mean among the control group (25.66). Column (2) compares coca-growing (and therefore cocaine-producing) municipalities to non-producing areas, restricting the

latter to inland/non-port municipalities. Coca-producing municipalities experience an increase of 6.55 homicides per 100,000 inhabitants, approximately 26 percent relative to the same pre-treatment control mean. Column (3) estimates the effects of the cocaine supply surge on port proximity and coca production jointly, relative to municipalities that are neither port-adjacent nor coca-producing. In this specification, both the estimated port and coca-production effects remain very similar in magnitude. This suggests that both coca-producing areas and ports capture distinct sources of rents within the trafficking network, rather than the same underlying exposure.

Table 1: Average Impacts of Production Shock on Violence at Strategic Nodes in Colombia

	Overall Homicide Rate		
	(1)	(2)	(3)
Port × Post	11.37***		10.45***
	(1.814)		(1.800)
Coca-Producing × Post		6.547***	6.547***
		(1.788)	(1.788)
R^2	0.48540	0.49804	0.49840
Observations	18,186	22,575	23,499
Pre-treatment mean (controls)	25.656	25.656	25.656

Notes: Difference-in-differences estimates based on Equation (2). "Port" denotes municipalities within 50 km of an international port. "Coca-producing" denotes municipalities with above-median coca cultivation during the pre-shock period (2010–2015). "Post" captures the period following the 2016 coca production shock. Outcomes are homicides per 100,000 inhabitants. Standard errors are clustered at the municipality level. The final row reports the pre-treatment mean for the relevant control group in each column. Columns (1) and (2) restrict the sample to non-coca-producing and non-port municipalities, respectively, while Column (3) estimates average port effects across both coca-producing and non-coca-producing areas. In all cases, the omitted category consists of municipalities that are neither port-adjacent nor coca-producing.

Competition in Cocaine Producing Areas

A central implication of the chokepoint mechanism is that expanded trafficking rents should generate larger increases in violence where those rents are more contestable—that is, where multiple armed actors have the capacity to compete for control. In contrast, areas characterized by stable, near-monopolistic control should exhibit more muted responses, even when exposed to the same increase in supply. We test this by studying heterogeneity by pre-existing criminal market structure, distinguishing municipalities historically dominated by a single organization from those exposed to multiple armed groups. Because coca exposure is similar across these municipalities, differential responses can be attributed to variation in contestability rather than scale.

Table 2 implements this test within coca-producing municipalities by exploiting pre-shock variation in armed-group presence. Since the mid-1990s, cocaine production in Colombia has been closely linked to actors in the internal armed conflict, most prominently the FARC (see Section 2), but the extent of territorial overlap with other armed groups varied across producing areas. We classify coca-producing municipalities according to whether FARC operated alone or in the presence of other armed groups prior to the 2015 supply shock (see Section 4.4 for

construction of the exposure measure). The estimates show little or no differential increase in homicides after 2015 in municipalities characterized by exclusive FARC control. In contrast, coca-producing municipalities with pre-existing armed-group competition experienced substantially larger and statistically significant post-shock increases in violence.

This pattern is consistent with intensified competition over trafficking rents when supply expands, and provides direct evidence that the violence response depends not only on exposure to the shock, but also on the structure of criminal competition. Importantly, these differences emerge despite similar baseline exposure to coca production, underscoring the role of competition rather than scale alone, and foreshadowing the delayed violence response observed in Ecuador when centralized control later fractured.

Table 2: Competition and Post-Shock Violence in Coca-Producing Municipalities of Colombia

	Overall Homicide Rate		
	(1)	(2)	(3)
Coca-Producing × Post	6.923***	4.086	4.152**
	(1.785)	(2.630)	(1.798)
Coca-Producing × Post × FARC Presence (2011–12)	-18.28		
	(15.54)		
Coca-Producing × Post × Other Armed Groups (2012–14)		5.437*	
		(3.276)	
Coca-Producing × Post × FARC + Other Groups			11.19**
			(4.932)
R^2	0.49835	0.49837	0.49900
Observations	22,575	22,575	22,575
Pre-treatment mean (controls)	25.656	25.656	25.656

Notes: Difference-in-differences estimates based on Equation (2). The baseline effect is "Coca-Producing × Post"; columns interact this effect with indicators for pre-period armed-group presence as labeled in the table. Outcomes are homicides per 100,000 inhabitants. Standard errors clustered at the municipality level. The final row reports the pre-treatment mean among inland, non-coca municipalities.

6.2 Lagged Adjustment in Ecuador

We next turn to Ecuador, where Figure 4 presents event-study results comparing port-proximate municipalities (within 50 km) to inland areas. Pre-trends are parallel but, unlike Colombia, homicide rates in port municipalities rise sharply only several years after the supply shock. The estimated coefficients remain small in the years immediately following 2015 and then increase markedly after 2020. The divergence is dramatic: port-adjacent areas experience a sustained differential increase relative to non-ports. Indeed, since 2021 Ecuador's national homicide rate has risen sharply, reaching levels comparable to the region's most violent countries.

Interpreting the Lag

This delayed response is difficult to reconcile with a purely logistical explanation, as trafficking volumes had already increased by the mid-2010s. Instead, it is consistent with a delayed adjustment process rather than an immediate spillover. In particular, the Colombian production shock

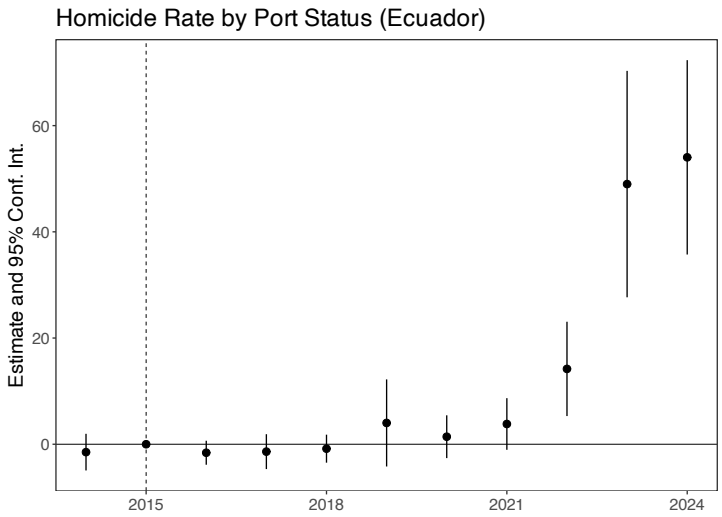


Figure 4: Dynamic Impacts on Homicide Rates in Port Municipalities of Ecuador

Notes: Event-study estimates based on Equation (1), with treatment defined as municipalities within 50 km of an international port. Outcomes are homicides per 100,000 inhabitants. Standard errors clustered at the municipality level. Appendix Figure A.4 re-centers the event study at 2020, highlighting the sharp post-2020 escalation in port municipalities.

immediately increased the value of Ecuadorian transit routes, but widespread violence materialized only after criminal organizations developed the organizational capacity and incentives to contest those rents at scale.

Qualitative evidence suggests that Ecuador's criminal ecosystem underwent a discrete structural shift around 2020-2021. Prior to this period, criminal governance along the internal cocaine traffic chain was relatively centralized at the hands of the gang 'Los Choneros', with violence largely contained despite growing trafficking activity. Following the killing of the gang's leader Jorge Luis Zambrano ("Rasquiña") in late 2020, this centralized control fractured. Rival splinter groups, including 'Los Lobos' and 'Los Tiguerones', emerged, and competition intensified both within and outside the prison system. This fragmentation coincided with coordinated prison massacres and escalating turf wars, particularly in coastal and port-adjacent areas, marking a transition from relatively stable criminal control to open competition.[15]

In this context, the delayed violence response in Ecuador is consistent with a setting in which rents rise first, but violence follows only once organizational capacity and contestation emerge. Consistent with this interpretation, we estimate a two-bin specification that separates the early post-shock period of market concentration (2016–2020), from the later period of market fragmentation ($\geq$2021). The corresponding estimates are reported in Appendix Table B.2. As in the event study, we find little evidence of an early post-2016 increase in Ecuadorian port areas, while the post-2021 effect is large and statistically significant (an increase of 468% relative to non-ports in the pre-shock period). In a similar vein, Appendix Figure A.4 re-centers the event study at 2020, highlighting the sharp post-2020 escalation in port municipalities.

[15]See contemporary reporting by InSight Crime and the Global Initiative Against Transnational Organized Crime documenting the breakdown of prison governance and the emergence of inter-gang violence beginning in 2020–2021: https://insightcrime.org/news/ecuador-confronts-unprecedented-levels-prison-violence/; https://globalinitiative.net/analysis/ecuadors-criminal-crisis/.

While these patterns seem to contrast sharply with Colombia, where the response to the same supply shock is immediate, the evidence of both countries does suggest that production shocks generate little immediate violence in areas with monopolistic criminal control, but produce rapid violence where competition is either already present or develops over time.

6.3 Diffusion of Violence along Interior Routes

In our framework, violence should not diffuse systematically along parts of the network that are substitutable. This is the case of interior trafficking routes, despite their importance for logistics. To test this we operationalize route-based exposure with two alternative measures that differ in how conservatively potential inland corridors are defined. The first (conservative) measure assigns route exposure to municipalities lying along the shortest path connecting each coca-producing municipality to its nearest export port, based on contiguity in the municipal adjacency network. This definition captures the most direct inland connection between production zones and ports, thus minimizing false positives by restricting the potential of traffic from each producing area to the closest export outlet.

The second (broader) measure allows coca-producing municipalities to connect to multiple nearby ports, particularly through the union of shortest paths connecting each coca-producing municipality to its set of nearest export ports. It thus captures a wider set of plausible inland corridors while remaining anchored to geographically proximate export nodes. In both cases, coca-producing and port municipalities are excluded by construction from the control group, isolating the effect of traffic through interior segments of the network.

Consistent with the prediction that violence concentrates at strategic nodes rather than along less valuable parts of the network, where alternative inland paths abound and traffickers can reroute without sustained territorial conflict, Appendix Tables B.3 and B.4 show no evidence of significant increases in homicide rates along interior trafficking routes, under either definition. These null results are precise enough to rule out effects comparable in magnitude to those observed at ports and production nodes.

6.4 Robustness (Triple Difference-in-Differences)

To address the concern that port areas may share common time-varying trends unrelated to the shock, we implement a triple-differences design that benchmarks the ports-vs.-inland comparison in Colombia and Ecuador to the same difference in other Latin American countries. The triple-DID estimates and corresponding event-study dynamics are reported in Appendix Table B.5 and Appendix Figure A.5, and align closely with the baseline DID evidence, reinforcing that the post-2015 increase in violence is concentrated in strategic nodes specific to the cocaine supply chain, and not just a reflection of generic criminal dynamics common to port areas in Latin America.

6.5 Economic Spillovers

While the effect of the cocaine-supply shock on violence is clearly socially detrimental, the associated surge in illicit revenues may galvanize local economies, at least in the short run.

Payments to local labor involved in trafficking, expenditures on transportation and logistics, port service fees, and money-laundering activities may all have stimulated local demand. We test such potential for local economic spillovers in Appendix Table B.6 and Appendix Figure A.6, which show that municipalities near ports experienced sizable increases in economic activity after 2016, as measured by nightlight intensity using the harmonized global dataset from Li et al. (2020).[16] The effects amount to roughly 16% higher luminosity in Colombian and Ecuadorian port municipalities, strengthening gradually after 2016. Taken together with the homicide results, this evidence highlights a stark trade-off: port areas exposed to the cocaine-trade shock experienced both heightened violence and short-run increases in measured economic activity.

7 Downstream Supply Shock Impacts (Europe)

We now turn to the downstream impacts of the Colombian cocaine supply shock in European destination markets. Our conceptual framework predicts that illicit trafficking routes piggyback on existing legal maritime trade networks: traffickers exploit established logistics, concealment opportunities, and corruption along high-volume trade corridors. As a result, European destinations with dense pre-shock maritime connections to Colombia and Ecuador should experience the largest downstream effects following the supply expansion, as suggested descriptively in Appendix Figure A.7.

Our analysis focuses on three sets of outcomes: seizures by origin (the most direct measure of trafficking flows), consumption and prices, and violent crime in port versus inland areas (both of which account for the social downstream costs of the shock).

7.1 Seizures by Origin and Trade Exposure

As described in Section 5.1, treated destinations are European countries with strong pre-shock maritime trade links to Colombia and Ecuador. Our primary outcome is the quantity of cocaine seized at ports in destination country c in year t, observed at the country–origin–year level. These data allow us to distinguish seizures originating from Colombia and Ecuador from those originating in other South American countries. While seizures reflect *interdiction* efforts as well as underlying flows, the origin-by-destination structure of the WCO data allows us to isolate changes specific to post-shock shipments from Colombia and Ecuador.

We first estimate the event-study specification in Equation (1), comparing seizure volumes in treated and control countries across Europe, before and after the 2015 supply shock. Figure 5 plots the event-study estimates. Cocaine seizures linked to Colombia and Ecuador increase sharply and persistently after 2015 in ports of medium- and high-exposure countries, while seizures from other South American origins remain relatively flat.[17] This pattern aligns with the idea that the shock propagated along pre-existing maritime trade links and that Ecuador

[16] Following Li et al. (2020), annual VIIRS radiance values are composited from monthly observations after noise removal, with thresholds applied to exclude aurora and non-human light sources. Raster images have a resolution of 30 arc seconds (approximately 500 m at the equator). We compute municipal nightlight intensity by averaging the brightness of all pixels within each boundary.

[17] The sample is restricted to origin countries with positive seizure activity in European ports prior to 2016 (Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay, and Venezuela).

emerged as a key transit hub. However, Appendix Figure A.8 shows that the increase is present when Colombia and Ecuador are examined separately, indicating that the aggregate effect is not driven by a single source country.

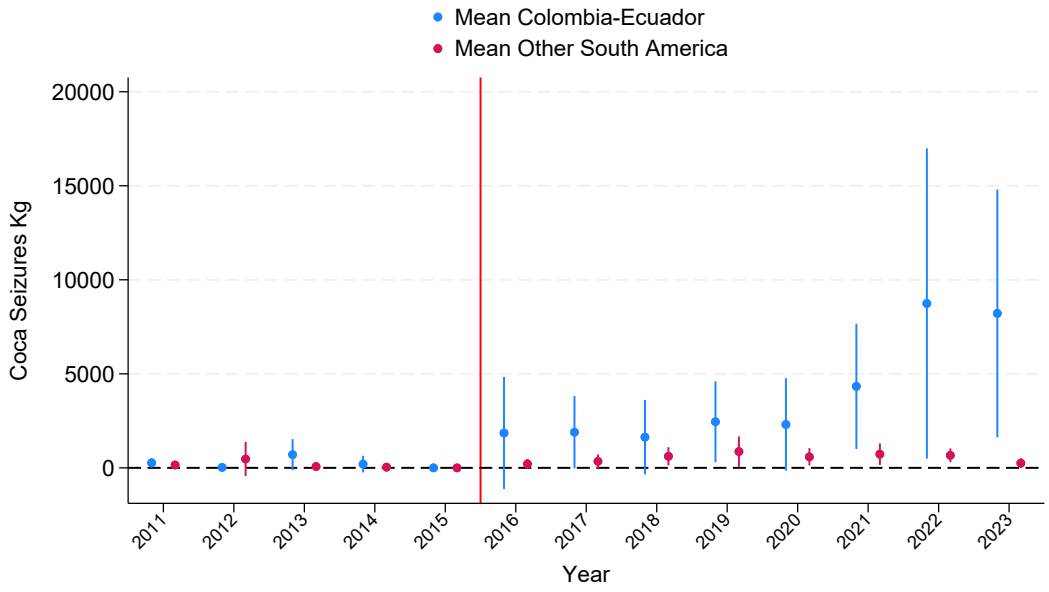


Figure 5: Effects of the Supply Shock on Cocaine Seizures in Treated EU Ports

Notes: Event–study estimates based on Equation (1). Treatment corresponds to countries with above-median pre-existing trade connections with Ecuador and Colombia, namely the United Kingdom, Italy, France, Belgium, Spain, the Netherlands and Germany. Outcomes are annual cocaine seizures (kg). Standard errors are clustered by destination country; 95% confidence intervals shown. Blue dots represent seizures from Colombia and Ecuador; red dots represent seizures from other South American countries.

We next examine whether the magnitude of the seizure response varies with the intensity of pre-shock legal trade exposure. One possibility is that *any* pre-existing trade link is sufficient to facilitate trafficking. Alternatively, trafficking may concentrate disproportionately in destinations with very large trade volumes, where container traffic is dense and concealment is easier. To sharpen this distinction, we classify countries into three discrete groups according to their pre-shock maritime trade capacity with Colombia and Ecuador: low-trade (Malta, Portugal, and Ukraine), medium-trade (Italy, the United Kingdom, and France), and high-trade (Spain, Germany, Belgium, and the Netherlands (see Appendix Figure A.2). Figure 6 shows that the post-2016 surge in cocaine seizures is driven almost entirely by high-trade destinations, while effects in medium- and low-trade countries are small and statistically indistinguishable from zero.

Appendix Table B.7 reports the corresponding parametric difference-in-differences estimates, where the outcome is the quantity of cocaine seized at European ports. Columns (1) and (2) compare seizure volumes in treated ports, defined as ports with above median pre-shock maritime connectivity (i.e., high- and medium-trade countries) to control ports. Column (1) focuses on seizures from containers originating in Colombia and Ecuador, while Column (2) considers seizures from other South American origins. Columns (3)–(5) further disaggregate the analysis by trade intensity, reporting separate estimates for high-, medium-, and low-trade

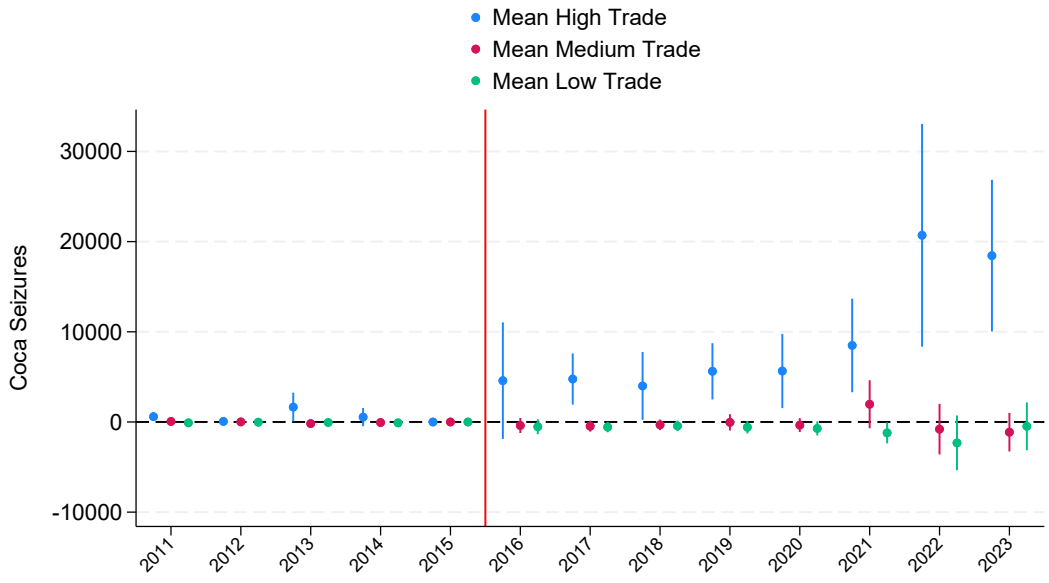


Figure 6: Supply Shock Effects on Seizures by Pre-Treatment Trade with Colombia and Ecuador

Notes: Event study estimates based on Equation (1). Outcomes are cocaine seizures in ports in kg from shipments originating from Ecuador or Colombia. Standard errors are clustered at the country of destination in Europe. Confidence intervals at the 95% level. Blue dots represent countries with high-trade capacity (Spain, Germany, Belgium, and the Netherlands); red dots countries with medium-trade capacity (Italy, the United Kingdom, and France); green dots countries with low-trade capacity (Malta, Portugal, and Ukraine).

destinations. The results show that the post-2016 increase in cocaine seizures is concentrated almost entirely in the most connected ports. For high-trade destinations (Column 3), seizures increase by more than 9,000 kilograms per year on average, indicating a substantively large escalation in trafficked volumes detected at these ports.

Column (6) reports estimates from a complementary triple-difference specification that exploits variation by source country, interacting the post-shock treatment indicator with an indicator for shipments originating in Colombia or Ecuador and restricting the treated group to high-trade destinations. The resulting estimate is similar in magnitude, confirming that the increase in seizures at high-trade ports is specific to post-shock flows from Colombia and Ecuador rather than broader changes in South American trafficking.

7.2 Criminal Infiltration as a Complementary Mechanism

Although these results establish that trafficking flows concentrated in a small set of highly connected countries, they do not imply that all such destinations were affected uniformly. Appendix Figure A.9 presents event-study estimates treating Spain, Belgium, the Netherlands, and Germany separately. The post-2016 increase is pronounced for Spain, Belgium, and the Netherlands, but substantially weaker for Germany.

To assess whether differences in organized-crime penetration are consistent with this heterogeneity, we draw on two sources of descriptive evidence. First, data from Savona and Riccardi (2015) indicate substantial pre-shock organized-crime infiltration in major port regions such as Algeciras and Barcelona (Spain), Antwerp (Belgium), and Rotterdam (Netherlands), but not

in Hamburg, Germany's main container port. Second, media-based measures constructed from Factiva show markedly higher pre-2016 reporting linking organized crime and ports in Belgium, the Netherlands, and Spain than in Germany (Appendix Table B.8). Consistent with these patterns, WCO data indicate that seizures from Colombia and Ecuador were already disproportionately concentrated in Spain, Belgium, and the Netherlands prior to 2016. Together, this evidence suggests that high trade exposure alone may not be sufficient; pre-existing criminal infrastructure appears to be an important complementary condition.

7.3 Consumption and Prices

We next examine whether increased trafficking flows translated into higher cocaine consumption in Europe. Cocaine use provides a direct measure of how the supply shock affected final markets. Using wastewater analysis data from 88 European cities as our most direct proxy for consumption, we estimate the same event-study specification as in Equation (1), with cocaine metabolite residues as the outcome. We classify treated cities mechanically as those hosting major container ports in high-exposure countries, subject to wastewater data availability.[18] The control group consists of all other cities in the sample.[19]

Appendix Table B.9 reports the corresponding average effects. Cocaine consumption increases significantly in treated port cities following the shock, with larger effects when the treatment group is restricted to high-capacity ports only. When country–year fixed effects are included, estimates remain positive but lose precision, reflecting limited within-country variation and the small number of treated cities. Placebo tests assigning treatment to port cities in control countries yield no effect, and alternative specifications using MDMA residues, representing a drug primarily produced within Europe, show no response, supporting a supply-driven interpretation.

Event-study estimates in Appendix Figure A.10 show no evidence of differential pre-trends and a sustained post-2016 increase in treated cities. In later years, effects attenuate, consistent with cocaine diffusing more broadly within countries over time.

We also examine price adjustment in European cocaine markets. In competitive illicit markets, an outward shift in supply should reduce prices, particularly at downstream retail stages. Appendix Table B.10 reports estimates using the most disaggregated available (country–year) data. Retail cocaine prices decline by approximately 10 percent in high-trade countries after 2016, while prices in medium-trade countries show no statistically significant change. Wholesale price estimates are imprecise and not statistically significant.

This pattern is consistent with well-documented structural differences across market tiers. High-level cocaine trafficking and importation are concentrated and entry-restricted activities, dominated by a small number of organized crime groups that control access to international supply routes, logistics infrastructure, and large-scale trafficking operations (Reuter and Kleiman,

[18] This yields, Amsterdam, Antwerp, Barcelona, Valencia, Oostende, and Castellón. It also includes London, a major gateway in a medium-trade country However, results are robust to excluding London.

[19] Cities are included if data are available for at least two years, and results are robust to stricter sample restrictions. While the treated cities include ports in all three countries driving our earlier findings (Belgium, Spain, and the Netherlands), comparable wastewater data are unavailable for treated ports in Germany, Italy, and France. As a result, this analysis compares treated port cities in high- and medium-trade countries to all other European cities in the sample.

1986; Caulkins and Reuter, 1998; Reuter, 2014; UNODC and EUROPOL, 2021). These upstream segments face the highest enforcement risk and entry barriers, generating substantial risk premia and limiting competitive price adjustment at the wholesale level following positive supply shocks. Retail markets, by contrast, are far more fragmented, allowing increased upstream availability to translate into stronger price competition and lower prices. Appendix Figure A.11 illustrates the persistent post-shock decline in retail cocaine prices in high-trade destinations.

7.4 Crime Spillovers

Finally, we examine effects on violent crime in European destination regions. Our framework predicts that major ports become more strategic and contested following a supply expansion, increasing violence in their surrounding areas.

We use Eurostat data on violent crime at the NUTS-3 level and classify provinces as treated if they host a port with pre-2016 maritime trade connections to Colombia or Ecuador. Exploiting within-country variation, we estimate difference-in-differences models for provinces in Spain, Belgium, and the Netherlands. Pre-treatment data limitations shorten the baseline period for some countries, but do not coincide with the timing of the shock. In any case, event-study plots show no pre-trend within the available baseline. Appendix Table B.11, Column (3), shows that violent crime increases in treated provinces beginning in 2016. The estimated effect corresponds to an increase of approximately 5 percent relative to the mean. Event-study estimates in Figure A.12 show no evidence of differential pre-trends.

Taken together, the evidence on seizures, consumption, prices, and crime indicates that the South American cocaine supply shock propagated through Europe along existing maritime trade corridors connected to Colombia and Ecuador. The effects are concentrated in a small set of destinations (Belgium, the Netherlands, and Spain) that combine high trade exposure with established criminal infrastructure. These patterns align with our framework (Appendix Section C) in which illicit supply shocks travel through legal trade networks and intensify at strategic chokepoints with the logistical capacity and institutional conditions to absorb them.

8 Conclusion

This paper provides systematic evidence that production shocks in illicit markets can propagate globally through trade and trafficking networks, paralleling dynamics long studied in legal markets. A policy-induced cocaine supply surge in Colombia–sparked by the 2014 peace-process announcement of future crop-substitution payments–traveled through legal maritime trade routes, concentrating violence at strategic chokepoints while expanding drug availability and crime downstream.

We trace this shock from source to destination: Colombia saw homicide rates rise 26% in coca-producing areas and 41% in port municipalities; Ecuador experienced a dramatic rise in homicide rates–once criminal fragmentation made profits from transit flows violently contested–reaching levels comparable to the most violent countries in the region; and in Europe, high-trade countries (Germany, Belgium, Netherlands, Spain) registered sharp increases in Colombia/Ecuador-

linked seizures, 60% higher cocaine consumption in port cities, falling prices, and 5% more violent crime in port provinces.

A simple trade-network framework helps rationalize these findings. Trafficking rents are not evenly spread across space but are concentrated at strategic chokepoints, ports and production zones, where criminal competition is most intense. By contrast, secondary trafficking corridors see little systematic violence, underscoring how rents reoptimize around nodes that maximize control over flows. The same logic applies downstream: European ports with both dense trade connections to South America and organized crime infiltration absorbed the shock most strongly, amplifying local violence and facilitating corruption.

Our findings contribute to the literature in at least three ways. First, we demonstrate that illicit shocks propagate internationally through the same trade networks as legal ones, with violence concentrating where logistical bottlenecks create contestable rents. Second, we show how production shocks destabilize neighboring transit states and fuel crime far downstream in consumer markets. Third, we reveal how legal shipping infrastructure and organized-crime infiltration jointly determine which ports become cocaine gateways.

Moreover, these results highlight a broader tension of globalization. While increased trade connectivity facilitates legal commerce, it also lowers the cost of smuggling and raises the profitability of illicit trade. As a result, trade liberalization can generate unintended spillovers, strengthening transnational criminal networks and imposing heavy social costs in both origin and far-reaching destination countries. Addressing these challenges requires international coordination: risk-based container screening, intelligence sharing across customs agencies, and strengthened oversight of vulnerable port regions.

Our evidence suggests that, absent politically unfeasible legalization policies, enforcement priorities should focus on high-volume perishable export routes (bananas, shrimp) from Colombia/Ecuador and prioritize risk-based screening at connected European import hubs. Coordinated port-level interventions such as AI container scanning, corruption monitoring, and joint customs operations may offer higher returns than broad interdiction efforts.

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A Additional Figures

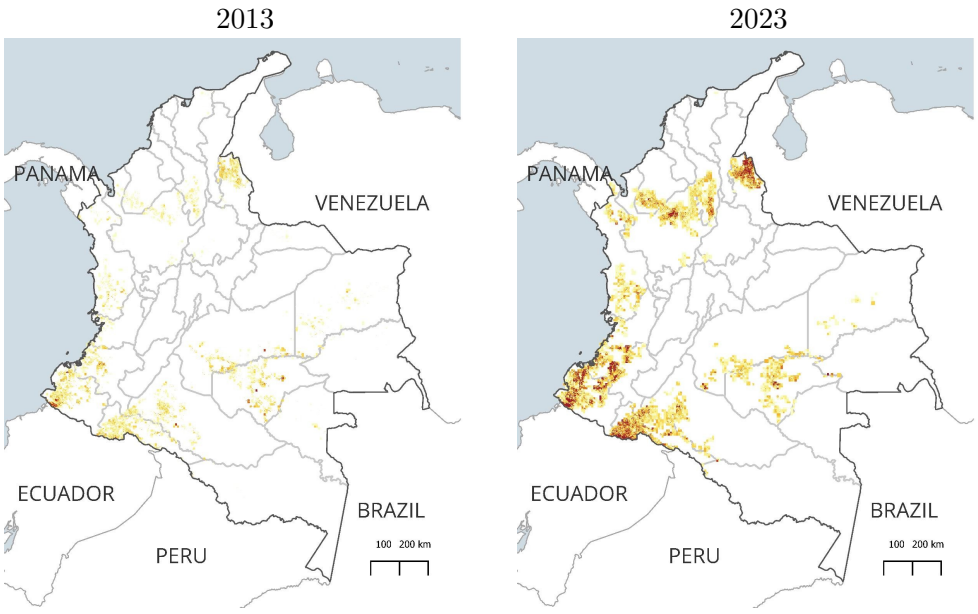


Figure A.1: Coca cultivation density in Colombia: 2013 and 2023

Notes: hectares of land containing coca crops by squared kilometer. Source: United Nations Office on Drugs and Crime (UNODC) - Integrated Illicit Crops Monitoring System (SIMCI) (2025).

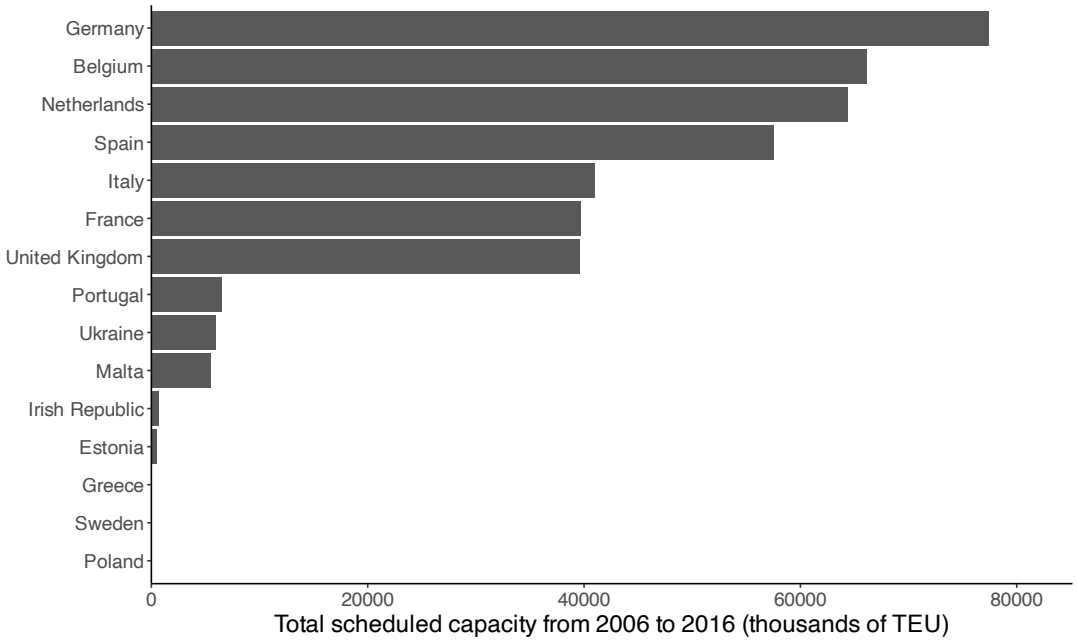
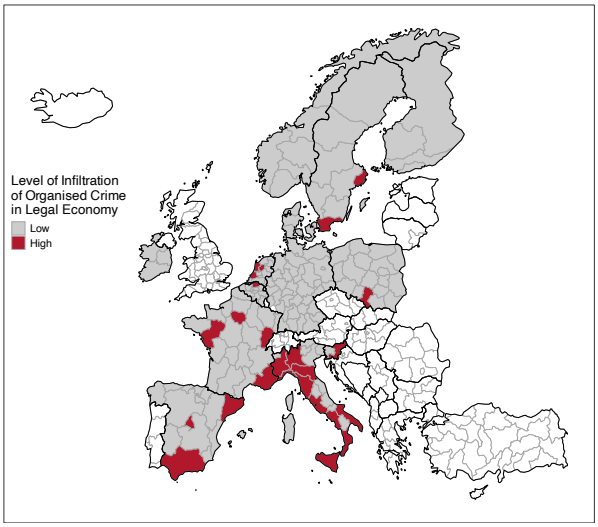


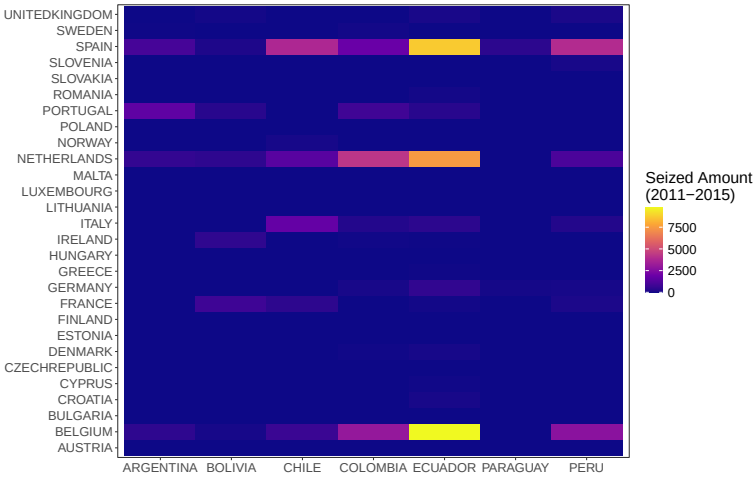
Figure A.2: Scheduled Maritime Trade Capacity from Colombia and Ecuador to Europe

Notes: The figure reports total scheduled maritime trade capacity in thousands of Twenty-foot Equivalent Units (TEU) from Colombia and Ecuador to European destination countries, aggregated over 2006–2016 (the pre-shock period).

Figure A.3: Overview of Organized Crime Presence, and Cocaine Seizures in Europe



(a) Organized crime presence in European port areas



(b) RILO cocaine seizures in EU-LATAM (2011–2015)

Notes: Panel (a) reports the yearly scheduled amount of TEU - containers - moving from Ecuador and Colombia to European ports before 2016. Panel (b) displays the relative level of organized crime investments in the legal economy across EU regions as computed by Savona and Riccardi (2015). Panel (c) reports the heatmap of cocaine seizures in European ports from a selected group of countries of origin in South America in the years before the 2016 shock.

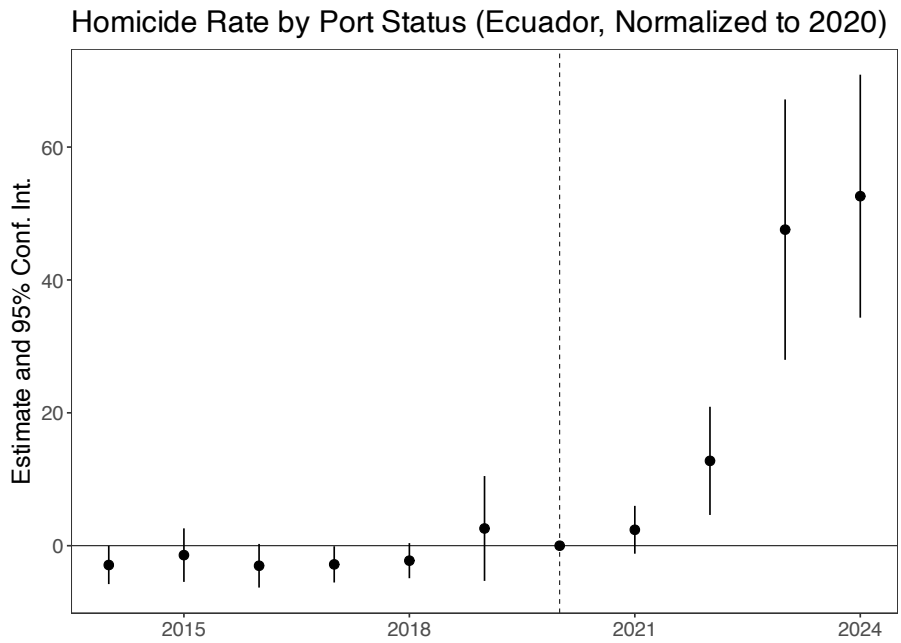


Figure A.4: Dynamic Impacts of Cocaine Shocks on Homicide Rates in Ecuadorian Ports

Notes: Event-study estimates based on Equation (1), with treatment defined as municipalities within 50 km of an international port. Outcomes are homicides per 100,000 inhabitants. Standard errors clustered at the municipality level.

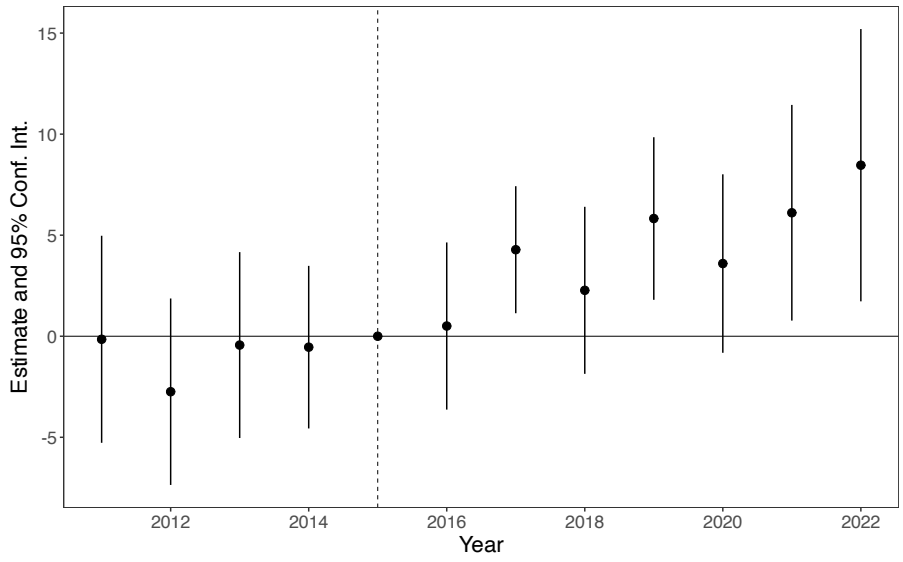


Figure A.5: Homicide Rate – Triple DID – Event Study

Notes: This figure plots the estimated coefficients from a triple-difference event study specification of Equation (3) comparing homicide rates in port municipalities of Colombia and Ecuador to other South American municipalities before and after 2015. The estimates control for municipality and year fixed effects, as well as country-specific year shocks, and are clustered at the municipality level. The vertical line marks the year before the shock (2015), which is the omitted reference period. Dashed lines denote 95% confidence intervals.

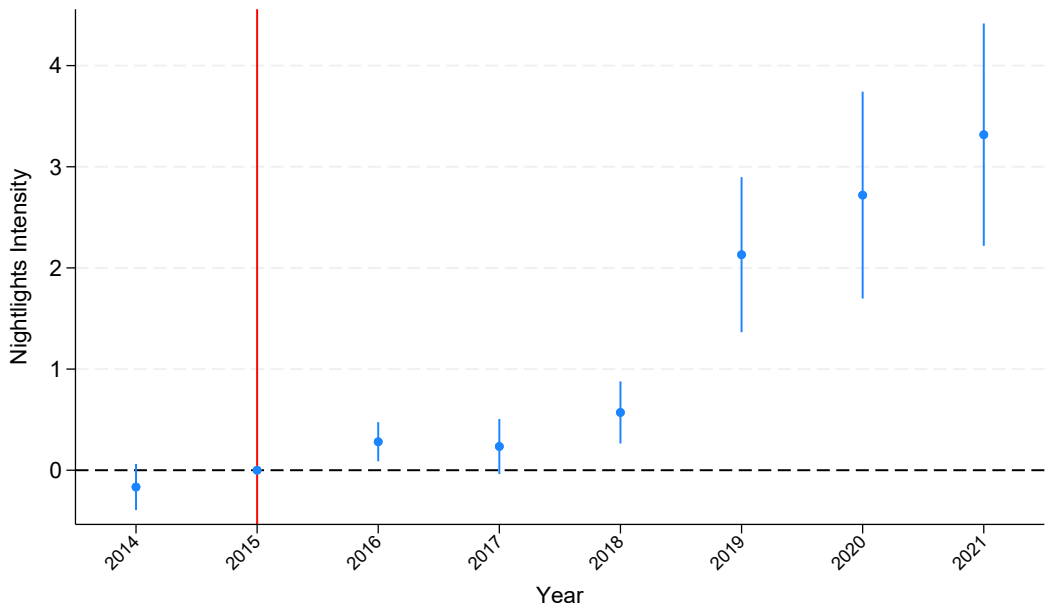


Figure A.6: Effects on Nightlights Intensity

Notes: Each panel displays event-study coefficients from estimating (1) which compares nightlights intensity in port municipalities of Colombia and Ecuador to other municipalities within Colombia and Ecuador before and after 2015. The estimates control for municipality and year fixed effects, as well as country-specific year shocks, and are clustered at the municipality level. The vertical line marks the year before the shock (2015), which is the omitted reference period. Dashed lines denote 95% confidence intervals.

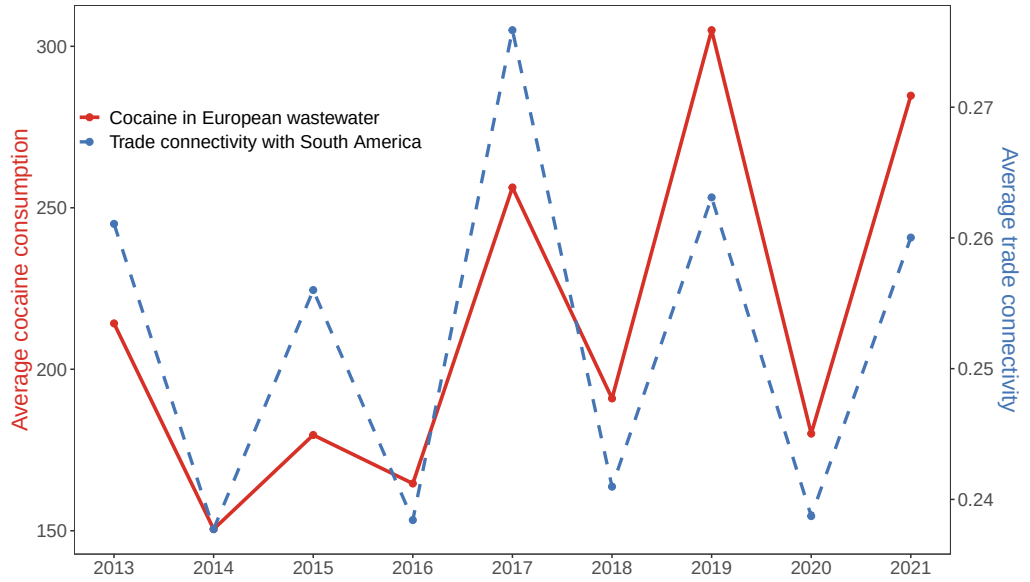


Figure A.7: Trade Connectivity and Cocaine Consumption in Europe ($\rho = 0.83$)

Notes: Each observation represents a South America–EU country pair. Legal trade connectivity is measured as the average maritime trade intensity between each South American exporter and its European Union partners in a given year. Cocaine consumption is measured by wastewater residues in European cities. The strong correlation indicates that trafficking routes align closely with legitimate trade flows.

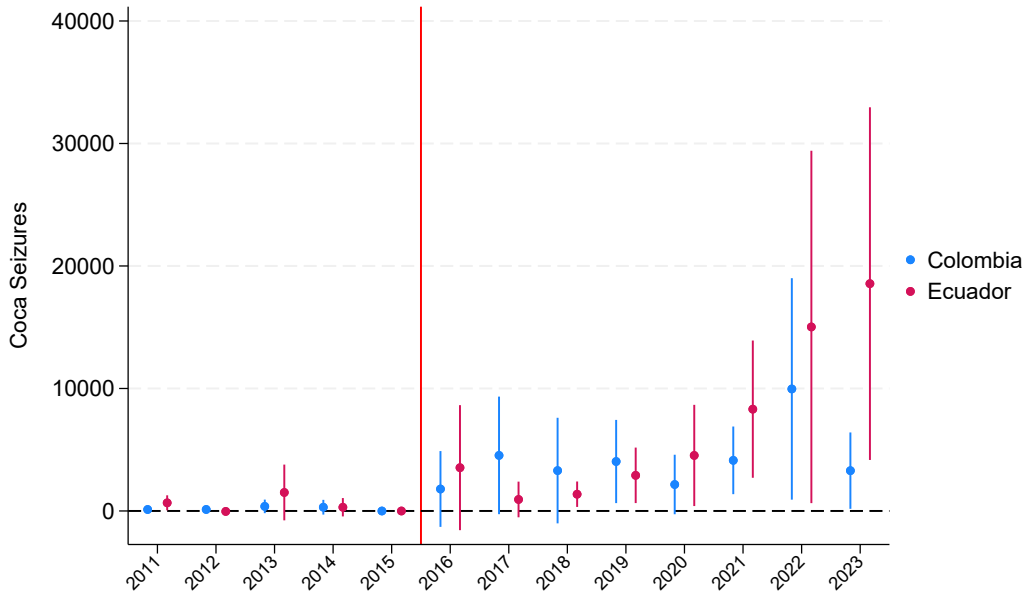


Figure A.8: Supply shock effects on seizures in EU treated countries - separating Ecuador and Colombia

Notes: Event study estimates based on Equation (1), where treatment are ports in Belgium, Spain and the Netherlands. Outcomes are cocaine seizures in ports in kg. Standard errors are clustered at the country of destination in Europe. Confidence intervals at the 95% level. Blue dots represent average seizures from Colombia and Ecuador; red dots represent average seizures from other South America countries.

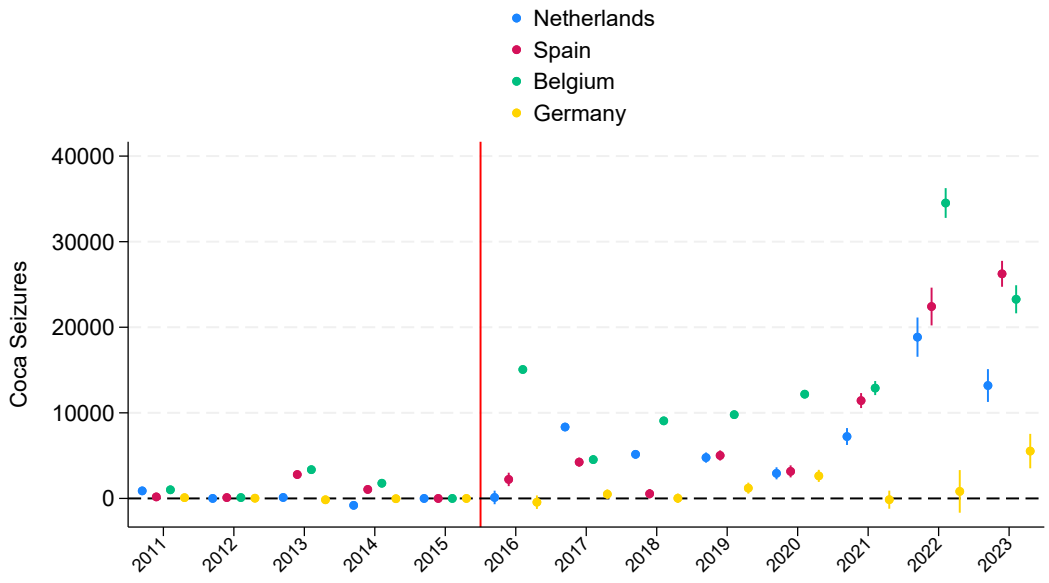


Figure A.9: Supply shock effects on seizures in EU treated countries - Heterogeneity among high-trade countries

Notes: Event study estimates based on Equation (1), where treatment are ports in Belgium, Spain and the Netherlands. Outcomes are cocaine seizures in ports in kg. Standard errors are clustered at the country of destination in Europe. Confidence intervals at the 95% level. Blue dots represent average seizures from Colombia and Ecuador; red dots represent average seizures from other South America countries.

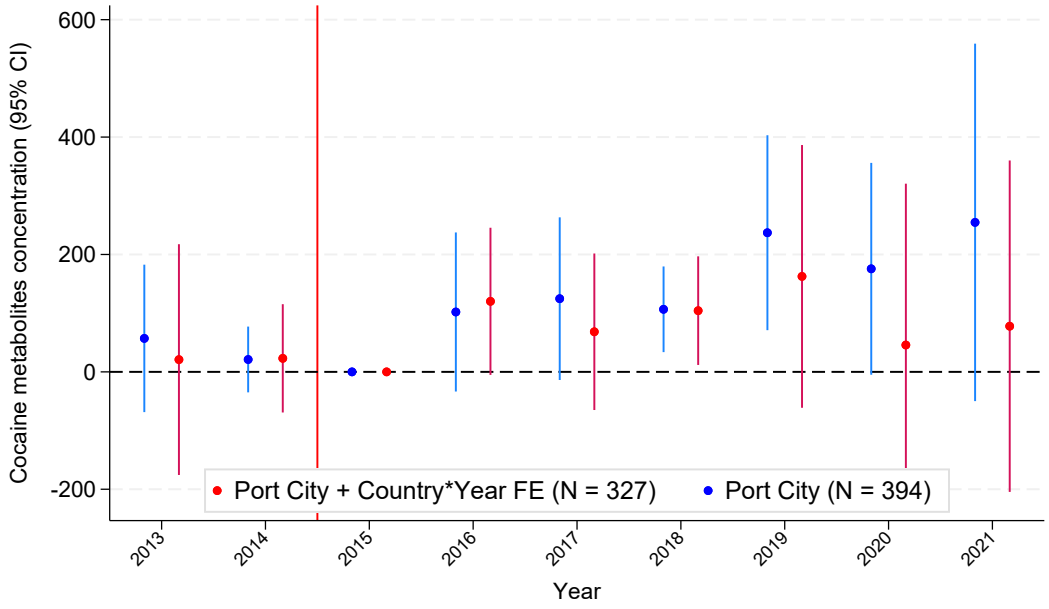


Figure A.10: Effects of the Supply Shock on Cocaine Consumption in Treated EU Cities

Notes: Event–study estimates based on Equation (1). Treatment corresponds to ports in Belgium, Spain, and the Netherlands. Outcome is cocaine concentration in wastewater. Standard errors clustered by destination country; 95% confidence intervals shown.

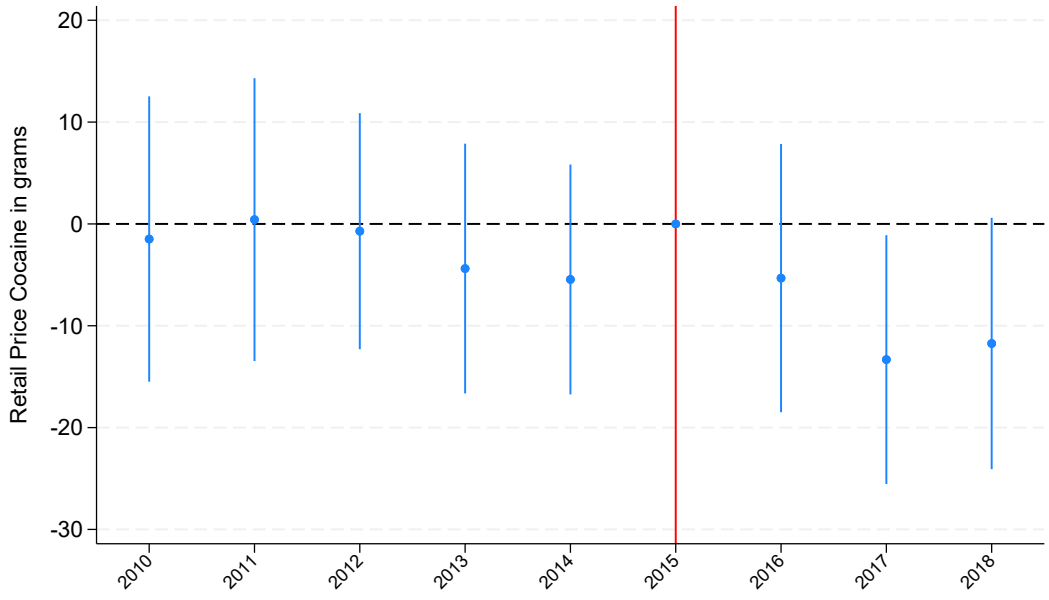


Figure A.11: Supply shock effects on cocaine prices in Europe - country level

Notes: Event study estimates based on Equation (1), where treatment are Belgium, Spain and the Netherlands. Outcomes are cocaine prices in USD dollars. Standard errors are clustered at the country of destination in Europe. Confidence intervals at the 95% level.

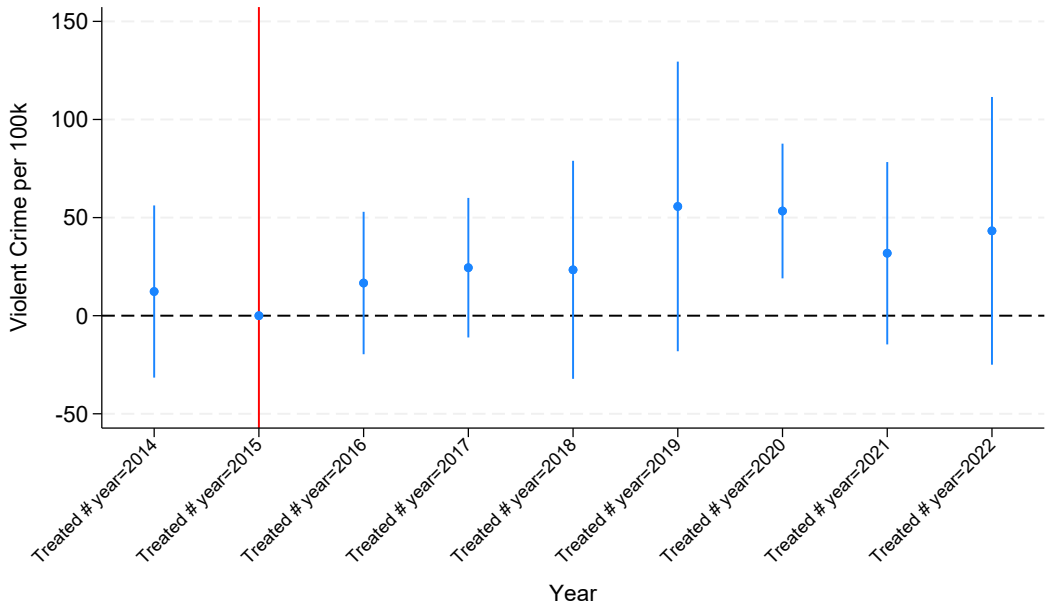


Figure A.12: Supply shock effects on violent crime rates - province level - Belgium and the Netherlands

Notes: Event study estimates based on Equation (1), where treatment are provinces in Belgium and the Netherlands with port connections to Colombia or Ecuador before 2016. Outcomes are violent crimes per 100,000 inhabitants. Standard errors are clustered at the country of destination in Europe. Confidence intervals at the 95% level.

B Additional Tables

Table B.1: Summary of Data Sources and Level of Aggregation

Dataset	Description	Level of Aggregation
UNCTAD Shipping Bilateral Connectivity Index (SBCI)	Measures maritime transport efficiency between country pairs using five components (transshipments, direct connections, semi-direct connections, vessel capacity, and carrier competition). Used to quantify legal shipping routes between South America and Europe.	Country–country (quarterly)
Annual Scheduled Capacity (TEU)	Proprietary port-to-port data capturing scheduled container capacity, providing granular information on actual maritime flows.	Port–port (annual)
WCO Cocaine Seizures	Confidential records of cocaine seizures at ports, including quantity, form, and the origin country of the container, enabling reconstruction of trafficking routes.	Port–country (only ports) (annual)
UNODC Drug Seizures & Prices	Aggregate drug seizure quantities by type and country-year, plus retail/wholesale drug prices. Does not include origin information.	Country (annual)
Wastewater Cocaine Consumption (EUDA)	Annual standardized wastewater samples from 88 European cities measuring benzoylecgonine (BE) metabolites to estimate community-level cocaine use.	City (annual)
South American Homicide Data	Official registries of intentional homicides at the municipal level in Colombia and Ecuador, including demographics and complete annual coverage.	Municipality (annual)
European Crime Data (Eurostat)	Reported crimes across European NUTS-3 regions used to study downstream violence effects along trafficking routes.	NUTS-3 region (annual)

Table B.2: Average Impacts of Cocaine Shocks on Violence in Ecuador (Ports)

	Overall Homicide Rate	
	Baseline Post Effect	Delayed Effects (Bins)
	(1)	(2)
Port municipality × Post-2016	14.37***	
	(2.496)	
Port municipality × 2016–2020		1.064
		(1.245)
Port municipality × 2021+		31.00***
		(5.508)
R^2	0.45469	0.48359
Observations	2,376	2,376
Pre-treatment mean (non-ports)	6.6276	6.6276

Notes: Estimates correspond to Equation (2). Treatment is defined as proximity to an international port (within 50 km). Reported coefficients capture differential effects for the post-2016 period (2016–2020) and the post-2021 period. Outcomes are homicides per 100,000 inhabitants. Standard errors are clustered at the municipality level. *** $p < .01$, ** $p < .05$, * $p < .1$.

Table B.3: Average Impacts of Cocaine Shocks on Violence in Colombia (Interior Routes)

	Overall Homicide Rate	
	(1)	(2)
Treated Route (closest port) x Post	0.3333	
	(2.079)	
Treated Route (k-nearest ports) x Post		1.208
		(1.837)
R^2	0.48546	0.48550
Observations	17,472	17,472
Dependent variable mean	23.711	23.711

Notes: Estimates report difference-in-differences effects of exposure to inland trafficking routes on homicide rates (per 100,000 inhabitants). Route exposure is defined using two alternative measures: a conservative definition based on municipalities lying along the shortest path from coca-producing areas to the nearest export port, and a broader definition based on the union of shortest paths to multiple nearby ports (k = 5). Coca-producing and port municipalities are excluded by construction, isolating interior segments of the network. Standard errors are clustered at the municipality level. *** $p < .01$, ** $p < .05$, * $p < .1$.

Table B.4: Average Impacts of Trafficking Routes on Violence in Ecuador (Interior Routes)

	Overall Homicide Rate	
	(1)	(2)
Treated Route (closest port) x Post	1.333	
	(2.514)	
Treated Route (k-nearest ports) x Post		0.1762
		(1.735)
R^2	0.42723	0.42718
Observations	2,134	2,134
Dependent variable mean	11.080	11.080

Notes: Estimates report difference-in-differences effects of exposure to inland trafficking routes on homicide rates (per 100,000 inhabitants). Route exposure is defined using two alternative measures: a conservative definition based on municipalities lying along the shortest path from border entry cantons to the closest export port, and a broader definition based on the union of shortest paths to multiple nearby ports (k = 5). Port municipalities are excluded by construction, isolating interior segments of the network. Standard errors are clustered at the municipality level. *** $p < .01$, ** $p < .05$, * $p < .1$.

Table B.5: Effects on Homicides – Triple Differences-in-Differences

	Homicide Rate
	(1)
Port × Post-2015	-0.4605
	(0.7402)
Treated × Port × Post-2015	4.100***
	(1.219)
R^2	0.562
Observations	82,521
Dependent variable mean	19.5

Notes: This table presents the β coefficients from estimating the average effects version of Equation (3). The Treated indicator identifies municipalities in Colombia and Ecuador, and the Port indicator identifies municipalities close to a port (50 km). Municipality fixed effects and country–by–year fixed effects are included, and standard errors are clustered at the municipality level. The sample is all municipalities in South America. Outcomes are homicides per 100,000. *** $p < .01$, ** $p < .05$, * $p < .1$.

Table B.6: Effects on Nightlights Intensity

	(1) Nightlights	(2) Nightlights
Port Area × Post2015	1.719***	1.591***
	(0.439)	(0.360)
Country	Ecuador	Colombia
Observations	1,672	8,848
R-squared	0.977	0.987
Mean dep. var.	10.69	7.285

Notes: The table reports difference-in-differences results from estimating Equation (2). Therefore, all regressions include municipality (canton) and year fixed effects. Standard errors are clustered at the canton level. Nightlights intensity is measured at the municipal-year level. Standard errors clustered at the municipal level. *** $p < .01$, ** $p < .05$, * $p < .1$.

Table B.7: Effects on cocaine seizures in ports across Europe

	(1) Origin: EC-COL	(2) Origin: Oth. S.Am.	(3) Origin: EC-COL	(4) Origin: EC-COL	(5) Origin: EC-COL	(6) Origin: All
Treatment×Post	3,689**	387.2*	8,463***	-155.7	-800.6	
	(1,571)	(226.3)	(2,246)	(526.7)	(533.8)	
Treatment×Post×Origin						7,523***
						(2,076)
Treated	Medium-High	Medium-High	High	Medium	Low	High
Observations	533	533	533	533	533	6,396
R-squared	0.542	0.490	0.627	0.486	0.487	0.343
EU country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Mean Depvar	38.27	34.80	38.27	38.27	38.27	31.41

Notes: Estimates report the effect of the supply shock (after 2016) in European treated ports in terms of cocaine seizures. Treated ports are defined as having medium-high connections (Columns 1 and 2); high connections (Column 3); medium (Column 4) and low connections (Column 5). Standard errors clustered at the municipality level. *** $p < .01$, ** $p < .05$, * $p < .1$.

Table B.8: EU Trade Partners data on Organized Crime and Cocaine Seizures

Country	**Organized Crime in Port Region**	**% EU Seizures in Ports**	**% EU Seizures Entire Country**	**News OC - ports**	**News per-capita OC - ports**
Netherlands	YES	17,8%	16,8%	7.07	1.35
Belgium	YES	17,7%	15,7%	15.96	2.88
Spain	YES	28,2%	33,2%	7.08	5.82
Germany	NO	1,3%	3,0%	0.76	0.54

Notes: Data on organized crime and cocaine seizures for countries with high trade connections to Ecuador and Colombia during 2010-2015. Column 1 is a dummy variable indicating the presence of significant organized crime in the main port areas of a country (Savona and Riccardi, 2015). Column 2 reports the country's share of EU cocaine seizures across ports during 2010-2015. Column 3 shows the same share, but for all seizures within the country. Column 4 presents the news rate on organized crime and ports per 100,000 articles in Factiva, relative to the total number of news articles for each country in 2010-2015. Column 5 presents the same news rate, but normalized by the country's total population.

Table B.9: Difference-in-Differences effects on cocaine wastewater residues

	(1) Cocaine	(2) Cocaine	(3) Cocaine	(4) Cocaine	(5) MDMA
Treatment×Post	141.0***	174.7***	79.93	-32.25	-7.900
	(52.44)	(47.44)	(49.81)	(37.86)	(10.13)
Treated	Medium-High	High	High	Control Ports	High
Observations	394	394	327	335	276
R-squared	0.897	0.901	0.959	0.870	0.885
City FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Country-Year FE	NO	NO	YES	NO	NO
Mean Depvar	214.9	214.9	230.5	129.7	62.16

Notes: Estimates report the effect of the supply shock (after 2016) in terms of cocaine wastewater residues. Standard errors clustered at the city level. *** $p < .01$, ** $p < .05$, * $p < .1$.

Table B.10: Difference-in-Differences effects on cocaine prices - country level

	(1) Retail	(2) Retail	(3) Wholesale	(4) Wholesale
Treatment×Post	-8.692*	10.77	2,655	-6,966
	(5.020)	(8.578)	(3,040)	(7,750)
Treated	High	Medium	High	Medium
Observations	247	247	161	161
R-squared	0.778	0.778	0.657	0.661
Country FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Mean Depvar	84.35	84.35	45543	45543

Notes: Estimates report the effect of the supply shock (after 2016) in European treated countrieson cocaine prices in USD dollars measured at the year-country level, at the retail level in column 1 (high-trade countries) and column 2 (medium-trade countries), at the wholesale level in column 3 (in high-trade countries) and column 4 (medium-trade countries). Standard errors clustered at the country level. *** $p < .01$, ** $p < .05$, * $p < .1$.

Table B.11: Difference-in-Differences effects on violent crimes

	(1) Violent Crime	(2) Violent Crime	(3) Violent Crime
Treatment×Post	-0.259	-5.994	32.16***
	(7.570)	(7.727)	(11.53)
Treated	High Trade	DE-ES	BE-NE
Observations	8,808	8,808	8,808
R-squared	0.983	0.983	0.983
Country FE	YES	YES	YES
Year FE	YES	YES	YES
Country-Year FE	YES	YES	YES
Mean Depvar	214	214	214

Notes: Estimates report the effect of the post-2016 supply shock on cocaine seizures in European high-trade ports. Treated ports are defined as provinces (NUTS-3) hosting major ports with strong pre-shock maritime trade links to Colombia and Ecuador (Bilbao, Valencia, Pontevedra, A Coruña, Barcelona, Málaga, Algeciras, Tarragona, Hamburg, and Bremerhaven). Standard errors are clustered at the country level. *** $p < .01$, ** $p < .05$, * $p < .1$.

C A Network Trade Model with Contested Chokepoints

This appendix develops a stylized network trade model that rationalizes the heterogeneous propagation of the Colombian cocaine supply shock across production, transit, and destination nodes. The framework embeds illicit trafficking within a legal maritime trade network, where control over key logistical chokepoints with differential state capacity is contested among criminal groups.

Network and Routing

Let $\mathcal{G} = (\mathcal{N}, \mathcal{E})$ denote a directed graph of potential trafficking connections. Each node $n \in \mathcal{N}$ is either a production node or a port, each edge $e \in \mathcal{E}$ is a possible trade connection. A subset $\mathcal{L} \subseteq \mathcal{E}$ represents *legal* maritime trade links (scheduled/container routes).

Drug traffickers exploit the legal trade infrastructure for concealment, so feasible trafficking paths $p \in P_L$ are restricted to those embedded in legal flows, so $p \subseteq \mathcal{L}$.

Each feasible path p from origin o to destination d has per–kg transport cost

$$c_p = \sum_{e \in p} \big[\tau_e(T_e) + \phi_e\big],$$

where $\tau_e(T_e)$ decreases in legal trade volume T_e (denser schedules, more containers, *more concealment*), and $\phi_e \geq 0$ bundles corruption/brokerage/coordination costs along edge e.

For a shipment of size q_p routed along p, the expected per–kg payoff is

$$\Pi_p = P^D - c_p - \kappa \Pr(\text{interdiction} \mid p),$$

with $\kappa > 0$ scaling expected loss upon seizure. Interdiction risk depends on traits of nodes n and edges e–collectively indexed by j–traversed:

$$\Pr(\text{interdiction} \mid p) = f\big(\{T_j, I_j, E_j\}_{j \in p}\big), \qquad f_T < 0,\ f_I < 0,\ f_E > 0,\ \ f_{TI} < 0,$$

where T_j is legal trade volume, I_j is the level of criminal infiltration (reducing enforcement effectiveness), and E_j measures formal enforcement intensity. Moreover, $f_{TI} < 0$ imposes complementarity: trade connectivity and infiltration jointly reduce interdiction, so ports combining high trade volumes (T_j) and high infiltration (I_j) become key trafficking gateways.

Given total origin supply S, traffickers allocate quantities across feasible paths $\{q_p\}_{p \in P_L}$ to minimize total expected cost:

$$\min_{\{q_p \geq 0\}} \sum_{p \in \mathcal{P}_L} q_p \left[\, c_p + \kappa f(\cdot) \,\right] \quad \text{s.t.} \quad \sum_{p \in \mathcal{P}_L} q_p = S.$$

Equilibrium *node flows* are $\{F_n = \sum_{p \ni n} q_p\}$. An increase in S expands aggregate feasible shipments $\sum_p q_p$, shifting outward the effective supply reaching Europe, lowering wholesale prices.

Let $K_n > 0$ be node's n effective capacity (physical throughput, concealment/logistics bandwidth); and $\mathbf{K} = \{K_m\}_{m \in \mathcal{N}}$ the vector of capacities across ports. Any path using n faces a

node-level congestion term $g(F_n; K_n)$, with $g_F > 0$, $g_{FF} > 0$, and $g(F; K) \approx 0$ for $F \ll K$. Then the effective path cost is $c_p + \kappa f(\cdot) + \sum_{n \in p} g(F_n; K_n)$, so marginal costs rise steeply as $F_n \to K_n$, which drives marginal flows to second-bets nodes when major ports are capacity constrained.

Node Value, Contestation, and Violence

Controlling node n yields per–kg markup φ_n (fees, rents, or preferential access). With total flow F_n passing through the node, its contestable value is $V_n = \varphi_n F_n$. We model violent competition over n via a contest intensity function:

$$\mathcal{C}_n = \Psi(V_n, \gamma_n), \qquad \Psi_V > 0,\ \Psi_\gamma < 0,$$

where $\mathcal{C}_n$ is total effort (or resources) devoted to violent competition over node n, and γ_n denotes effective state capacity (law enforcement, governance strength).

Observed violence is then a monotonic transformation of contest intensity:

$$H_n = h(\mathcal{C}_n), \qquad h' > 0.$$

Hence a positive supply shock $S \uparrow$ raises flows F_n, so node values V_n, contest intensity $\mathcal{C}_n$, and violence H_n increase most where γ_n is weak and $F_n \leq K_n$.

Why Ports and Coca Areas (Not Interior Routes)

Ports are *network chokepoints*: they are few, capacity-constrained, and difficult to substitute. Coca-growing areas are analogous upstream bottlenecks, where rents accrue from local taxation or processing. In contrast, interior routes are numerous and substitutable, diluting their strategic value. Formally,

$$\frac{\partial F_{\text{port}}}{\partial S} \gg \frac{\partial F_{\text{route}}}{\partial S} \implies \frac{\partial V_{\text{port}}}{\partial S} \gg \frac{\partial V_{\text{route}}}{\partial S} \implies \Delta H_{\text{port}} \gg \Delta H_{\text{route}}.$$

Hence, violence concentrates in coca and port municipalities after a supply shock, while interior routes show limited change.

Ecuador and Lagged Adjustment

Following the Colombian production surge, traffickers re–optimized routes to minimize interdiction risks, seeking ports (indexed by j) with high legal trade volumes (T_j) and infiltration potential (I_j). Guayaquil–Ecuador's largest port–was a good fit, but fixed costs and time are required to assemble corruption/logistics. With time denoted by t, let infiltration accumulate as

$$I_{j,t+1} = (1 - \delta_I) I_{j,t} + i_{j,t}, \qquad \delta_I \in (0, 1),$$

where $i_{j,t}$ represents infiltration efforts (see dynamics subsection below for an explicit modeling of this margin and its costs). This generates a a delayed but sharper increase in F_j, V_j, and H_j at Ecuadorian ports once networks mature.

Economic Spillovers

A fraction λ of illicit rents $\varphi_n F_n$ circulates locally (labour, logistics, laundering), implying an increase in economic activity. Nightlight intensity at node n satisfies:

$$\text{Nightlights}_n = \alpha F_n + \eta_n,$$

so increases in trafficking flows through ports raise measured luminosity, consistent with post–shock evidence from Colombia and Ecuador.

European Ports: Treatment Definition, Seizures, and Consumption Gradient

Downstream effects in Europe depend critically on pre-shock trade integration with South America. We therefore define treated European countries as those having positive trade volumes with Colombia and Ecuador prior to the supply shock. Ports without such links serve as controls.

This definition captures exposure to the global cocaine supply shock through established shipping routes. Conditional on treatment, the magnitude and timing of responses vary with port-specific characteristics—most notably pre-shock trade intensity (which provides variation in the intensive margin of the treatment), pre-shock criminal infiltration I_j (which provides variation in efficiency of concealment), and local enforcement.

Two related mechanisms operate downstream.

Seizures at entry ports. First, the expansion of cocaine supply from South America increases trafficking flows F_j into treated ports. These flows generate higher seizures originating from Colombia and Ecuador, reflecting greater volumes transiting through established entry points rather than changes in enforcement. Formally,

$$\text{Seizures}_j = F_j \cdot \pi_j, \qquad \pi_j = \pi\big(T_j, I_j, E_j\big), \;\; \pi_T < 0, \; \pi_I < 0, \; \pi_E > 0,$$

where π_j denotes the detection rate, i.e. the fraction of trafficked cocaine that authorities intercept. Holding detection constant, higher trafficking volumes ($F_j \uparrow$) mechanically increase seizures at treated ports.[20]

Heterogeneity in seizure responses across treated ports reflects differences in pre-shock trade intensity and criminal infiltration, which jointly affect both the scale of trafficking flows and the efficiency of concealment.

Wholesale and retail prices. Second, price responses differ across stages of the distribution chain. At treated entry ports, cocaine is sold wholesale by a small number of importing organizations with substantial market power. Wholesale prices therefore reflect strategic pricing and coordination among importers and may exhibit limited pass-through of supply shocks. As a result, increases in supply can be absorbed primarily as higher wholesale rents, leaving wholesale prices largely unchanged.

[20] In the empirical analysis, port and year fixed effects, absorb variation in π_j so that estimated coefficients primarily capture changes in F_j induced by the global supply shock.

Downstream retail markets, by contrast, are highly atomized and competitive. Retailers purchase cocaine at the wholesale price and incur convex transportation and distribution costs that rise with distance from entry ports. Let $p(x)$ denote the local street price at distance x from the nearest treated port, with $p'(x) > 0$. Retail prices are lowest near entry ports and increase inland as redistribution costs accumulate.

Because retail competition limits markups, reductions in scarcity and distribution frictions following a supply expansion translate into lower retail prices even when wholesale prices do not adjust. Local consumption therefore responds most strongly near treated ports:

$$c(x) = \chi \left[p(x)\right]^{-\varepsilon}, \qquad \varepsilon > 0.$$

Hence, when global supply S rises, consumption increases differentially in treated port regions relative to inland locations, and retail prices fall more sharply near ports despite common upstream exposure.

Taken together, these mechanisms imply that European ports with pre-shock trade links to Colombia and Ecuador experience the largest post-shock increases in seizures and local consumption, as well as decreases in the reteal price of cocaine. Variation in criminal infiltration and post-shock trade intensity governs the magnitude and timing of these effects. All effects attenuate with distance from entry ports, consistent with convex redistribution costs along the European supply chain.

Dynamic adjustment within treated European ports

Dynamically, European countries may respond to the persistent supply shock by establishing new (and expanding existent) trade flows with Colombia and Ecuador and by criminally infiltrating ports. However, these margins are not symmetric. Everything else equal, it is easier and faster to expand criminal infiltration at ports that already handle South-America trade than to activate new South-America trade links. This asymmetry generates heterogeneous and staggered responses among treated ports.

To formalize this dynamic adjustment, let $c(j)$ denote the country of port j and let $T_{j,t}$, $I_{j,t}$, $F_{j,t}$, and E_j denote, respectively, time-varying trade connectivity, infiltration, illicit flow, and enforcement as defined above. Recall that ϕ_j is the per-kilogram markup and γ_j is local (port-level) state capacity, while $\Gamma_{c(j)}$ denotes national or federal capacity. Higher $\Gamma_{c(j)}$ therefore makes national institutions harder to infiltrate and trade policy harder to distort.

At each period t, criminal organizations operating at port j may invest along two margins.

(i) Infiltration investment. Criminal organizations may invest $i_{j,t} \geq 0$ to expand local infiltration. Infiltration accumulates with lag ℓ_I according to

$$I_{j,t+\ell_I} = (1 - \delta_I) I_{j,t} + i_{j,t},$$

where ℓ_I is assumed without loss of generality to be $\ell_I = 1$ and $\delta_I \in (0, 1)$ is the depreciation rate of criminal influence due to enforcement or organizational turnover.

The associated cost function is

$$C_j^I(i_{j,t}; I_{j,t}, \gamma_j, T_{j,0}) = \frac{\kappa_I(1+\gamma_j)}{(1+I_{j,t})(1+T_{j,0})}\, i_{j,t} + \frac{\eta_I}{2} i_{j,t}^2,$$

where κ_I and η_I are cost parameters. Infiltration is therefore cheaper when pre-existing infiltration $I_{j,t}$ is high (learning-by-doing) and when baseline trade connectivity $T_{j,0}$ is large, but more expensive when local state capacity γ_j is strong. Even holding $I_{j,t}$ and γ_j fixed, it is easier to corrupt and coerce locally at ports that already handle South-America trade.

(ii) Expansion of South-America trade links. Treated ports may also expand the scale of South-America-specific trade relationships, shipping channels, and brokerage. Let $a_{j,t} \geq 0$ denote investment along this margin, which updates trade connectivity with lag ℓ_T:

$$T_{j,t+\ell_T}^{SA} = (1-\delta_T) T_{j,t}^{SA} + a_{j,t},$$

where $\ell_T \geq 2$ captures longer implementation lags associated with regulatory approval, shipping coordination, and policy manipulation.

Expanding South-America trade entails a national fixed cost component:

$$\Phi_j^N = \bar{\Phi}\, \frac{1+\Gamma_{c(j)}}{1+\theta\, I_{j,0}}, \qquad \bar{\Phi} > 0,\ \theta \in [0,1],$$

where $\bar{\Phi}$ is the baseline cost of influencing trade policy and θ captures the extent to which pre-existing local criminal infiltration lowers the cost of national intervention.

The total cost of expanding South-America trade connectivity is therefore

$$C_j^T(a_{j,t}; T_{j,0}, I_{j,0}, \Gamma_{c(j)}) = \Phi_j^N \cdot \mathbf{1}\{T_{j,t}^{SA} = 0\} + \frac{\kappa_T(1+\Gamma_{c(j)})}{1+T_{j,0}}\, a_{j,t} + \frac{\eta_T}{2} a_{j,t}^2,$$

reflecting the fact that initiating or scaling trade with South America requires national-level corruption and regulatory manipulation, which is harder when national capacity $\Gamma_{c(j)}$ is strong, though partially mitigated by local criminal presence.

Port value and criminal optimization. The contestable value of controlling port j at time t is

$$V_{j,t} = \phi_j F_{j,t},$$

where illicit flows satisfy

$$F_{j,t} = F_j(S_t, T_{j,t}, I_{j,t}; E_j, \mathbf{K}), \qquad \mathbf{K} = \{K_1, \ldots, K_n\},$$

with $F_T > 0$, $F_I > 0$, and $F_{TI} > 0$. Criminal organizations choose investment paths $\{i_{j,t}, a_{j,t}\}_{t \geq 0}$ to maximize net port value:

$$\phi_j F_{j,t} - C_j^I(\cdot) - C_j^T(\cdot).$$

Optimal infiltration investment satisfies

$$\phi_j \frac{\partial F_{j,t}}{\partial I_{j,t}} \geq \frac{\kappa_I(1+\gamma_j)}{(1+I_{j,t})(1+T_{j,0})} + \eta_I i_{j,t},$$

so that the entry condition for initiating infiltration is

$$\phi_j \frac{\partial F_{j,t}}{\partial I_{j,t}} \geq \frac{\kappa_I(1+\gamma_j)}{(1+I_{j,t})(1+T_{j,0})}.$$

Similarly, expanding South-America trade connectivity satisfies

$$\phi_j \frac{\partial F_{j,t}}{\partial T_{j,t}} \geq \frac{\kappa_T(1+\Gamma_{c(j)})}{1+T_{j,0}} + \eta_T a_{j,t} \quad \text{if } T^{SA}_{j,t} > 0,$$

while if $T^{SA}_{j,t} = 0$ the entry condition is

$$\phi_j \frac{\partial F_{j,t}}{\partial T_{j,t}} \geq \Phi^N_j.$$

Dynamic heterogeneity and timing. Following a positive supply shock $S \uparrow$, all treated ports experience an increase in potential flows. Ports with high baseline trade connectivity $T_{j,0}$ but low initial infiltration $I_{j,0}$ adjust rapidly by expanding infiltration ($i_{j,t} > 0$), raising flows and seizures after one period ($t+1$). Ports with lower baseline trade connectivity face higher national fixed costs and longer lags when expanding South-America trade, and therefore respond more gradually unless the shock is sufficiently large or national capacity $\Gamma_{c(j)}$ is weak.

Because both $I_{j,t}$ and $T^{SA}_{j,t}$ accumulate gradually and depreciate over time, heterogeneous initial conditions generate staggered and amplifying responses among treated ports. Over time, these dynamics lead to delayed but eventually strong increases in flows $F_{j,t}$, port value $V_{j,t}$, and violence $H_{j,t} = h\big(\Psi(V_{j,t}, \gamma_j)\big)$. This adjustment mechanism rationalizes the empirically observed second-wave expansion of trafficking and violence from core European entry ports to secondary ones.

Empirical Mapping and Testable Predictions

The theoretical framework maps directly to our empirical design. The event–study specification in Equation (1) captures the dynamic effect of rising node value V_n after the surge in Colombian cocaine production ($S \uparrow$), while the difference-in-differences and triple-difference specifications isolate variation across ports, coca-drowing areas, and interior municipalities. The model yields the following testable predictions:

1. **Concentration at chokepoints.** Following a positive supply shock in Colombia, violence rises contemporaneously in coca-growing regions and in Colombian port chokepoints where capacity constraints bind, while interior routes remain largely unaffected.

2. **Lagged diffusion through the trafficking network.** Transit hubs such as Ecuador experience a lagged but sharper escalation in violence once infiltration and logistics networks mature.

In Europe, ports adjust sequentially: those with pre-existing South America trade connectivity (high $T_{j,0}$, low $I_{j,0}$) react first through increased seizures, whereas ports with entrenched organized crime but limited trade links (high $I_{j,0}$, low $T_{j,0}$) respond later as new routes are established.

3. **Heterogeneity by concealment capacity.** Port-level effects scale with legal trade volume (T_j) and criminal infiltration (I_j). Ports combining both characteristics show the strongest response in seizures and local crime.

4. **Destination-market outcomes.** In Europe, increases in cocaine flows translate into higher seizures, lower street prices and stronger local consumption and crime responses near entry ports, consistent with transport-cost gradients.

5. **Economic spillovers.** Ports with higher trafficking flows $F_{j,t}$ also experience greater nightlight intensity and ancillary economic activity, alongside higher violence.

6. **Role of state capacity.** Stronger governance or enforcement capacity (γ_j or Φ^N) mitigates contestation and violence, while weak capacity amplifies both. Effects are strongest where port capacity K_j is near binding.

Key model parameters map into observed outcomes as follows:

- $H_{j,t}$ corresponds to homicides;
- $F_{j,t}\pi_{j,t}$ to cocaine seizures;
- $c(x)$ to local consumption or wastewater proxies.

These implications directly guide our empirical strategy.