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

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**Abstract**

We study how a sharp expansion in Colombian cocaine production propagated internationally through global trade networks, generating substantial social costs. In Colombia, the production surge increased homicide rates by 41% in port areas and by 26% in cocaine-producing municipalities. Violence then spilled across the border into Ecuador, a transit hub with negligible cocaine production but dense maritime trade links, contributing to a nearly five-fold increase in homicide rates. 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 cocaine seizures linked to these origins, lower retail prices, a 60% rise in cocaine consumption in port cities, and 5% higher violent crime in port provinces. Together, these results show that shocks in illicit markets propagate internationally through the same trade networks as legal trade shocks, concentrating violence at contested 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 often propagate through production and trade networks, generating economic and social consequences far beyond their point of origin. A large literature documents these dynamics in legal markets, showing how local disruptions reshape employment, prices, and political outcomes across connected economies, but far less is known about whether shocks in illicit markets propagate in similar ways.[1] 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. Unlike legal markets, where shocks are absorbed through prices and contractual reallocation, illicit markets adjust through shifts in control over non-contractible infrastructure, making violence a central margin of competition. This paper studies how a large expansion 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. Beginning in the mid-2010s, Colombia experienced a sharp and persistent expansion in coca cultivation and cocaine production capacity (Prem et al., 2023; United Nations Office on Drugs and Crime, 2024; Du et al., 2026). An important catalyst was a May 2014 policy announcement that occurred during peace negotiations with the Revolutionary Armed Forces of Colombia (FARC), which outlined future crop-substitution incentives for coca-growing farmers (Prem et al., 2023). Following this announcement, coca cultivation increased rapidly, and production capacity continued to expand in subsequent years, aided by contemporaneous supply-side changes. This produced a sustained increase in cocaine supply that underpins the analysis in this paper.

Building on this expansion, we treat 2015 as the onset of a large and persistent cocaine supply shock originating in Colombia and exploit pre-shock differences in exposure across locations to trace its propagation. The organization of the global cocaine market allows us to follow how the shock moves through space: 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 respond as it moves through the network.

We document three main findings. First, in Colombia, the expansion of cocaine production coincides with a sharp increase in homicide rates, 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 differentially by roughly 26 percent in coca-producing areas and by 41 percent in port municipalities. Second, violence spilled across

[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).

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 homicide rate rose sharply in port areas following the expansion of cocaine trafficking, contributing to a nearly five-fold increase nationally over the subsequent decade. 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 differential rise in cocaine consumption in port cities (as measured by novel data based on chemical wastewater analysis), 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 where control is fragmented, 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.

While the framework clarifies where rents arise in the trafficking network, it does not imply that expanded supply mechanically generates violence everywhere. Instead, violence depends on how those rents are contested. Where trafficking is governed by stable, monopolistic control, increased supply can be absorbed with little change in violence. By contrast, where control is fragmented and multiple organizations have the capacity to compete, expanded rents induce violent entry and territorial contestation (Battiston et al., 2024). This distinction is empirically central. In Colombia, homicide rates rise sharply only in coca-producing areas exposed to pre-existing armed-group competition, while areas historically dominated by a single organization exhibit muted responses. In Ecuador, violence emerges only after centralized criminal control fractures several years after the initial supply shock. Across contexts, violence functions as a mechanism of market entry and reallocation rather than a mechanical response to scale.

Our findings make three primary 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, but with violence replacing prices and contracts as the primary

margin of adjustment.

## 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 Supply Expansion

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 played a central role in these negotiations because, following the dismantling of Colombia's major drug cartels in the early 1990s, FARC had become directly involved in cocaine production and trafficking. Reflecting this involvement, FARC was designated a foreign terrorist organization by the U.S. government in October 1997.

In May 2014, after reaching a partial agreement on drug policy, the joint government–FARC delegation announced that, once a final peace accord was signed, the state would implement a National Program for the Integral Substitution of Illicit Crops. The program offered material incentives to coca-growing farmers who voluntarily replaced coca with alternative crops, explicitly targeting historically coca-growing and economically disadvantaged regions.[2] Following this announcement, Colombia experienced a sharp and sustained expansion in coca cultivation and cocaine production capacity.[3] Prem et al. (2023) document that the announcement triggered a large anticipatory response by farmers, particularly in ecologically suitable areas and in municipalities with higher predicted eligibility for the substitution program. Using cross-sectional variation in coca suitability and predicted eligibility, they show that the announcement led to large relative increases in coca cultivation immediately after 2014.[4]

The anticipation effect generated by the announcement can account for the timing of the initial expansion. As illustrated in Figure 1, between 2015 and 2016, Colombia's cocaine pro-

[2]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 peasant communities who live in poverty and currently obtain their subsistence from such crops (...).'

Dispatch No. 36, Havana, May 16, 2014. Our translation from the original Spanish text. Available at https://www.eltiempo.com/archivo/documento/CMS-13998996 (last accessed 09/04/2025).

[3]Recent work by Du et al. (2026) documents related downstream consequences of this production expansion for opioid overdose mortality in the United States. Our focus differs in both mechanism and scope: we study how the same sustained supply expansion propagates through illicit trade networks to shape violence, trafficking, and consumption across source, transit, and destination markets.

[4]Specifically, a municipality one standard deviation above the mean in coca suitability experienced an increase in coca area equal to 109 percent of the pre-announcement mean, while a municipality with predicted eligibility ten percentage points above the mean experienced an increase of 49 percent of the pre-announcement mean.

duction potential increased by approximately 62 percent. Following the signing of the peace agreement, the implementation of the substitution program provided a further boost to production. Even if the program reduced coca cultivation among individually targeted beneficiaries, Ladino et al. (2021) show that it generated a net increase in aggregate production, driven by the behavior of non-targeted plots in the municipalities of the beneficiaries. By 2023, potential output had risen more than seven-fold relative to a decade earlier.

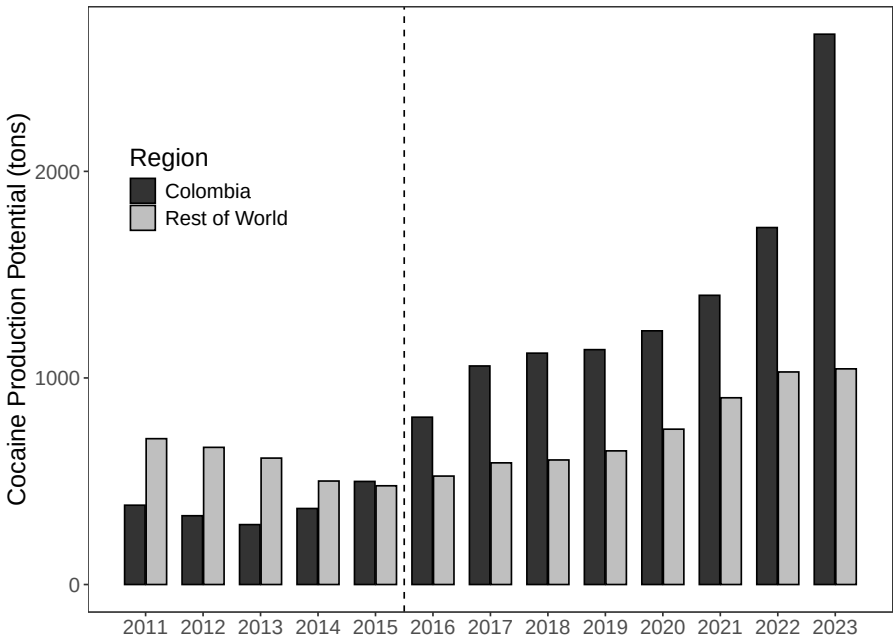



Figure 1: Global Cocaine Production

*Notes*: Potential manufacture of 100 percent pure cocaine, 2011–2023 (tons). Yearly figures are computed by converting areas under coca cultivation into cocaine hydrochloride using standard assumptions on yields and processing efficiency. "Potential" production does not refer to cocaine actually produced but to the amount of 100 percent pure cocaine that could be produced from the cultivated area. Source: United Nations Office on Drugs and Crime (2024).

Additional contemporaneous shocks further reinforced this supply expansion in specific regions. In early 2016, Venezuela sharply devalued its currency, lowering the price of gasoline smuggled across the border and used as a key input in cocaine processing. Beeder (2023) shows that cheaper access to this precursor generated substantial increases in coca cultivation in Colombian municipalities near the Venezuelan border, illustrating how input-cost reductions can amplify supply-side shocks. A third potential contributor was the suspension of aerial spraying of coca crops following a Constitutional Court ruling citing health risks associated with glyphosate. However, while Prem et al. (2023) estimate that the announcement of future compensation more than doubled coca cultivation in suitable areas, Raffo (2023) find that the spraying ban explains only a small fraction of the pre-policy mean (6%).

Taken together, these developments generated a large and persistent increase in cocaine supply originating in Colombia. While the precise combination of anticipatory behavior, program implementation, and input-cost shocks shaping the expansion is not the focus of our analysis, the resulting supply surge provides the foundation for the global spillovers we study in the

remainder of the paper.[5]

### 2.2 Spillovers into Ecuador

As cocaine production surged in Colombia, trafficking routes progressively shifted southward, drawing Ecuador into the cocaine trade despite virtually no domestic coca cultivation. Many of Colombia's coca-producing municipalities are concentrated along the southern border with Ecuador (Appendix Figure A.1), facilitating this geographic reorientation of trafficking flows. Ecuador's geography and trade infrastructure, most notably the port of Guayaquil, made the country a natural transit hub once routes adjusted.This role was further reinforced by Ecuador's prominence in the export of perishable commodities, particularly bananas. Ecuador accounts for roughly 30 percent of global banana exports, with the European Union as its primary destination (FAO, 2019). Perishable goods such as bananas are subject to rapid port turnover and limited storage times, reducing the scope for prolonged inspections and offering logistical advantages for concealment. Consistent with these mechanisms, recent reporting estimates that approximately one-third of Colombia's cocaine production now transits through Ecuador.[6] 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 sharply beginning in the early 2020s, making the country one of the most violent 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, plausibly reflecting intensified competition over control of port-adjacent trafficking infrastructure.[7] Notably, this violence response lagged the initial Colombian supply expansion. Until 2020, criminal governance in Ecuador remained relatively centralized, limiting overt conflict despite rising trafficking activity. Following the assassination of 'Los Choneros' gang leader Jorge Luis Zambrano ("Rasquiña") in December 2020, this centralized control fractured, giving rise to rival groups such as Los Lobos and Los Tiguerones. The resulting shift from monopolistic control to fragmented competition coincided with a sharp escalation in homicide rates, consistent with violence emerging once contestation over trafficking rents intensified.

### 2.3 European Markets and Smuggling Technology

European demand completes the circuit of the global cocaine trade, reflecting the integration between Ecuador-Colombia trade routes and European ports–particularly regarding perishable agricultural products–creating high-volume container traffic between the two regions. This

[5] While the peace process forms an important part of the institutional backdrop, it does not by itself explain the patterns of violence we document. By the time coca cultivation expanded sharply after 2014, Colombia's cocaine economy already featured substantial heterogeneity in criminal organization. In some producing regions, FARC exercised relatively centralized control, while in others coca production and trafficking were contested by multiple armed actors. As we show below, this pre-existing variation in market structure plays a key role in shaping how violence responds to the supply expansion: areas characterized by monopolistic control exhibit muted responses, whereas areas with fragmented control experience sharp increases in violence.

[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).

dense connectivity has made European ports critical entry points for cocaine, which is 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. In 2021, EU police and customs officers seized a record 303 tonnes of cocaine, a fivefold increase over a decade. 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.

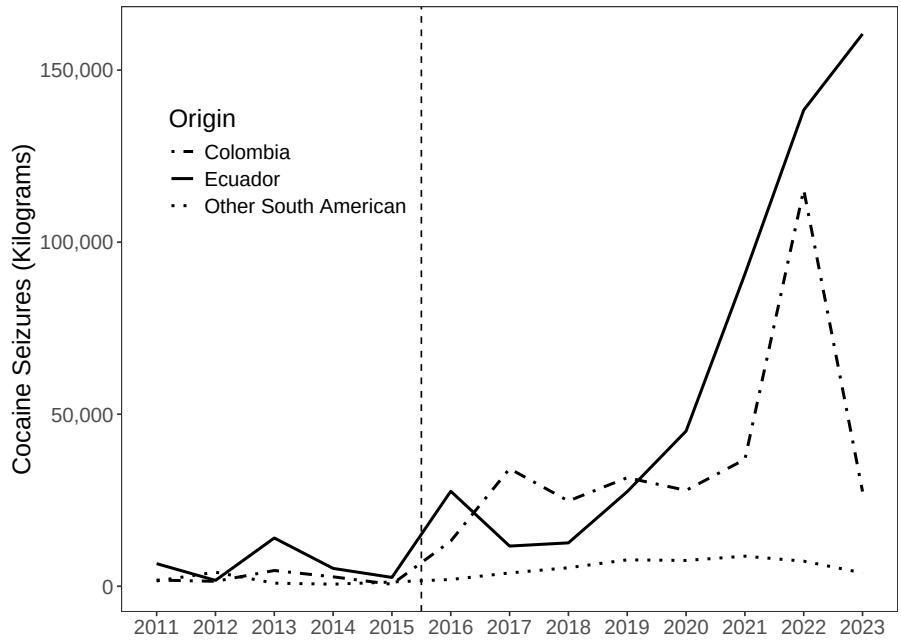



Figure 2: Cocaine Seizures in Europe that originate in South America

*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.

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 after loading onto vessels. Drugs are disguised within legitimate products or infused 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 infused 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 algorithms, 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 on Colombia's Pacific coast or Guayaquil in Ecuador), and destination ports (European entry points such as Rotterdam or Antwerp). Traffickers piggyback on legal maritime shipping routes, concealing cocaine within legitimate cargo. Within this network, certain locations function as chokepoints: relatively scarce nodes where large volumes of trade converge, access is difficult to substitute, and enforcement is limited. Controlling these nodes yields strategic advantages because high flows are funneled through a limited number of locations. This framework combines insights from production-network models of shock propagation with research on illicit markets, where access and control are enforced through violence rather than contracts (Chimeli and Soares, 2017; Battiston et al., 2024).

A sudden increase in Colombian cocaine production injects additional supply into this network. This increases the volume of flows passing through existing bottlenecks, raising the value of controlling access to those locations. Criminal organizations respond by competing for control of these strategic nodes (Dube and Vargas, 2013). Because the market is illegal and property rights are unenforceable, such competition is resolved through coercion and violence, particularly where state authority is weak and multiple groups have the capacity to contest

control. Interior transport routes, by contrast, are numerous and easily substituted. No single inland corridor is sufficiently scarce to warrant sustained violent contestation, even when overall trafficking activity increases.

Transit countries such as Ecuador adjust more slowly, as traffickers must first develop the organizational capacity, corruption networks, and logistical infrastructure needed to exploit new flows (Berg and Bledsoe, 2024).[8] In destination markets such as Europe, the same logic applies. Ports with strong pre-existing trade links to Colombia and Ecuador receive the earliest and largest cocaine inflows. Although increased supply puts downward pressure on retail prices, entry ports become more valuable strategic positions as gateways into downstream markets. Distribution costs that rise more than proportionally with distance imply that cocaine remains cheapest near these ports, generating stronger consumption responses locally, while inland areas experience more muted effects. Ports already infiltrated by organized crime adjust fastest, amplifying local trafficking activity, crime, and violent contestation over time.

This framework generates five 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).

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

5. Conditional on exposure, increases in violence are largest where control over trafficking rents is contested, either through the presence of multiple armed groups or through pre-existing organized criminal infiltration at ports (Sections 6.1, 6.2, and 7).

Appendix Section C formalizes this intuition in a network model of trade and conflict. The empirical patterns we document closely 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. Appendix Table B.1 summarizes all data sources and their units of aggregation.

## 4.1 Trade Connectivity

We use proprietary annual port-to-port data on scheduled container capacity in twenty-foot equivalent units (TEU), which captures actual containerized trade volumes between specific

[8] See also https://apnews.com/article/ecuador-bananas-cocaine-europe-drug-trafficking-6d6529e2b1d8f3cbd16aea74a last accessed 11/05/2025.

South American and European ports, allowing us to proxy likely trafficking routes and test for heterogeneity by trade intensity (Appendix Figure A.2). 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. All trade connectivity measures are constructed using data from the pre-2015 period. We complement those data with 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.

### 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.

### 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. This approach also distinguishes cocaine consumption from direct disposal in wastewater (European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) and Europol, 2016). 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

[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.

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

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. Appendix Table B.2 provides baseline summary statistics for Colombia and Ecuador.

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.

## 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.

[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.

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

**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.

Our baseline definition of treated countries includes those with pre-shock maritime trade exposure to Colombia and Ecuador, as shown in Figure A.2. This measure is determined prior to the surge in cocaine production and is therefore unaffected by contemporaneous European drug policies. We exclude only countries with very limited and discontinuous trade connections i.e. Poland, Sweden, Greece, Estonia, and Ireland, which are assigned to the control group.

We then consider alternative treatment definitions that differentiate countries by the intensity of their trade ties. In particular, the group of highly connected countries, Germany, Belgium, the Netherlands, and Spain, accounted for the vast majority of maritime trade with Colombia and Ecuador between 2006 and 2016. A substantial share of this trade consists of perishable goods, such as bananas and shrimp, which are difficult to inspect thoroughly and therefore especially 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 $t$, $\text{Treated}_i$ is defined in 5.1 and it is defined exclusively using pre-2015 characteristics, $\mu_i$ are unit fixed effects, $\lambda_t$ are year fixed effects, and errors are clustered at the unit level. The $\beta_\tau$ trace the effects relative to 2015, the last pre-shock year. The identifying assumption is that, absent the cocaine production shock, 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 $\beta$ 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 $\text{Treated}_c$ identifies treated countries (Colombia and Ecuador in the broader Latin America context, and ports in connected countries in the European one).[13] $\text{Port}_i$ 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 $\beta_\tau$ 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, a neighboring transit hub. Our analysis is guided by three predictions that follow directly from a trade-network view of illicit markets. First, violence should concentrate at strategic trafficking nodes where rents are both 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. Because port capacity and territorial control are limited in the short to medium run, 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 less developed. When absorbing increased flows requires the buildup of organizational capacity, criminal infiltration, or the emergence of competing groups, 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.

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

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. Violence in port areas exhibits a near-linear increase up to 2024. This pattern closely mirrors the rise in cocaine production shown in Figure 1, consistent with violence increasing at trafficking chokepoints in proportion to the quantity of contested illegal resources.

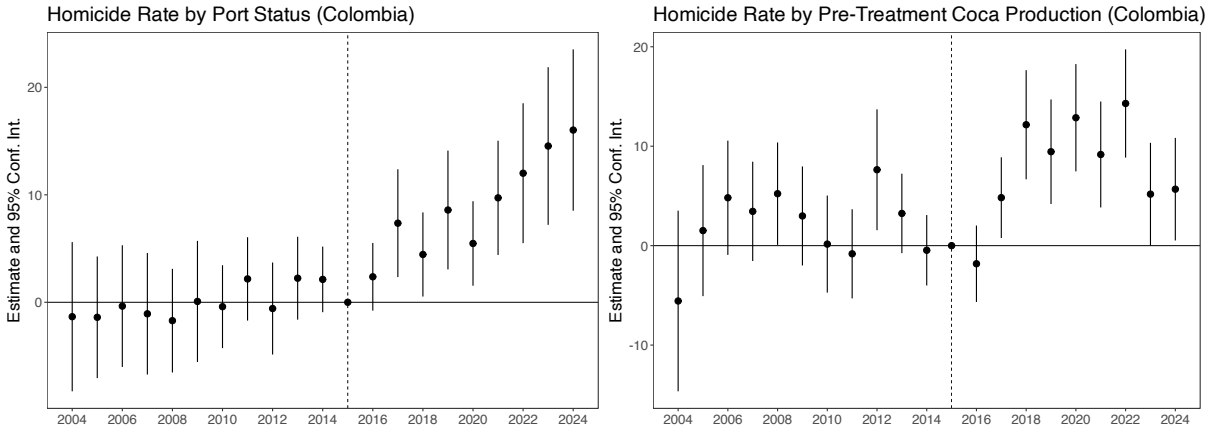



Figure 3: Dynamic Impacts on Homicide Rates at Strategic Nodes in Colombia

*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 by estimating 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 | -18.28 | | |
| | (15.54) | | |
| Coca-Producing × Post × Other Armed Groups | | 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. In particular, the Colombian production shock 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 trafficking chain was relatively centralized in 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

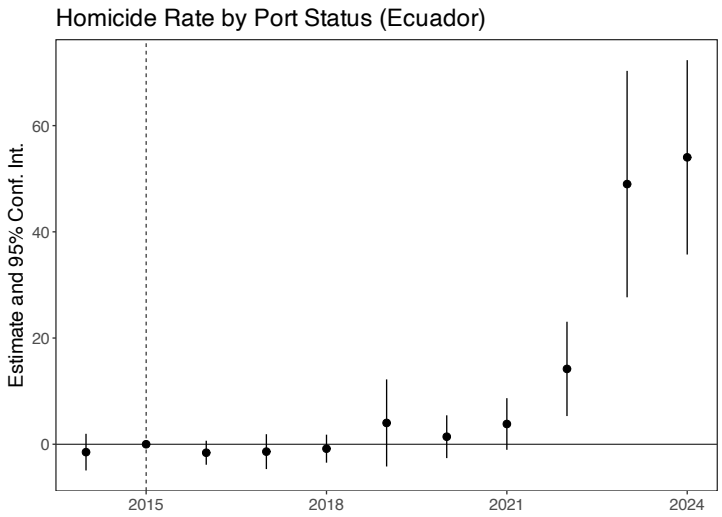



Figure 4: Dynamic Impacts on Homicide Rates in Port Municipalities of Ecuador

*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.

splinter groups, including Los Lobos and Los Tiguerones, emerged, and competition intensified both within and outside the prison system. This transition is mirrored in Appendix Figure A.3.

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.[14] 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.3. 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.

While these patterns seem to contrast sharply with Colombia, where the response to the same supply shock is immediate, the evidence of both countries suggests that production shocks generate little violence in areas with monopolistic criminal control, but produce 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

[14] See 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/.

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.4 and B.5 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.6 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.

## 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.6.

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). The respective descriptive

statistics are reported in Appendix Table B.7.

### 7.1 Seizures by Origin and Trade Exposure

As described in Section 5.1, treated destinations are European countries with 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 exposure countries, while seizures from other South American origins remain relatively flat.[15] This pattern aligns with the idea that the shock propagated along pre-existing maritime trade links and that Ecuador emerged as a key transit hub. However, Appendix Figure A.7 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.

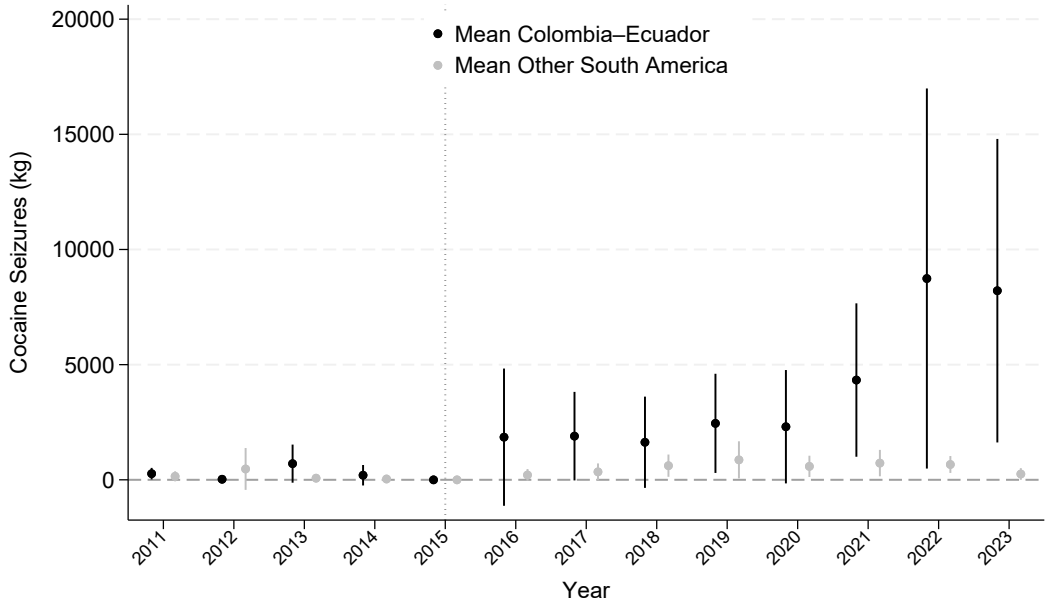



Figure 5: Effects of the Supply Shock on Cocaine Seizures in Treated EU Ports

*Notes*: Event–study estimates based on Equation (1). Treatment corresponds to countries with pre-existing trade connections with Ecuador and Colombia. Outcomes are annual cocaine seizures (kilograms). Standard errors are clustered by destination country. Black dots represent seizures from Colombia and Ecuador; gray dots represent seizures from other South American countries.

We next examine whether the magnitude of the seizure response varies with the intensity of

[15]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).

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.

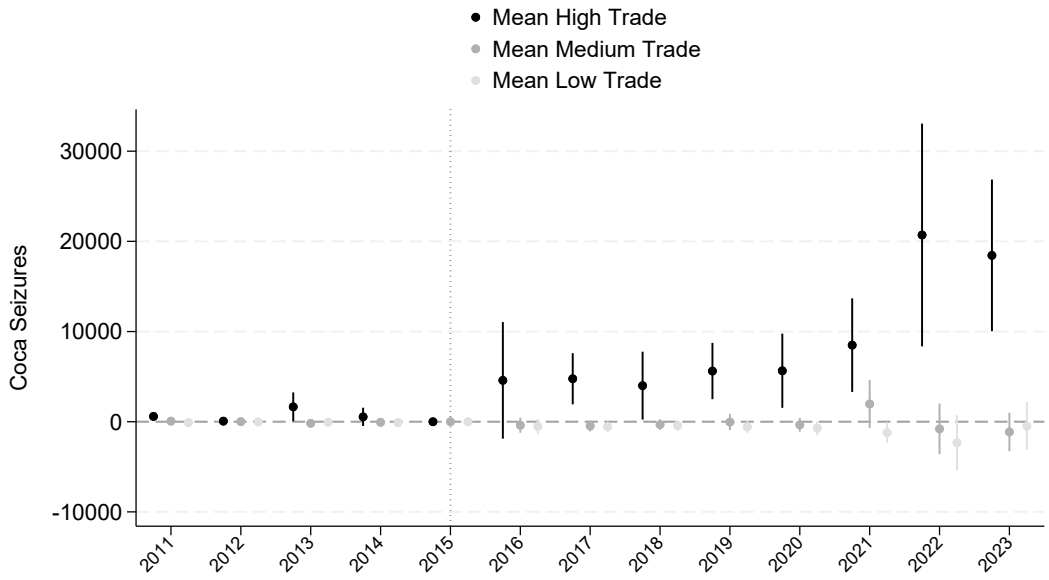



Figure 6: Supply Shock Effects on Seizures by Pre-Treatment Trade with Colombia and Ecuador

*Notes*: Event study estimates based on Equation (1). Outcomes are cocaine seizures in ports in kilograms from shipments originating from Ecuador or Colombia. Standard errors are clustered at the country of destination in Europe. Black dots represent countries with high-trade capacity (Spain, Germany, Belgium, and the Netherlands); dark gray dots countries with medium-trade capacity (Italy, the United Kingdom, and France); light gray dots countries with low-trade capacity (Malta, Portugal, and Ukraine).

Appendix Table B.8 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 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.8 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.9). 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.[16] The control group consists of all other cities in the sample.[17]

Appendix Table B.10 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

[16]This yields, Amsterdam, Antwerp, Barcelona, Valencia, Oostende, and Castellón. It also includes London, a major gateway in a medium-trade country. The results are slightly stronger when excluding London, in line with the location of London with the medium-trade rather than high-trade countries.

[17]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.

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.9 (corresponding to the specification in Column 2 of Table B.10) show no evidence of differential pre-trends and a sustained post-2016 increase in treated cities. Relatedly, Appendix Figure A.10 plots the over-time relationship between wastewater-based cocaine consumption measures and cocaine seizures, distinguishing high-exposure countries from other European countries. Both seizures and consumption increase markedly in high-exposure countries after 2016, while no comparable pattern is observed elsewhere. Importantly, the two measures move closely both before and after 2016. This stability in their correlation provides indirect evidence against changes in detection or enforcement intensity around 2016: had detection improved differentially after the shock, the relationship between seizures and consumption would be expected to change.

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.11 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, 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. We focus on high-trade countries, which account for the

bulk of the estimated effects.[18] Exploiting within-country variation, we estimate difference-in-differences models for provinces in Spain, Belgium, Germany, and the Netherlands.

In Appendix Table B.12, Column (3) shows that violent crime increases in treated provinces in Belgium and the Netherlands starting in 2016, with an estimated effect of approximately 5 percent relative to the mean. No comparable effects are observed in Spain or Germany. The absence of an effect in Germany is consistent with its more limited role as a primary maritime entry point, as discussed in Section 7.2. By contrast, the null result for Spain likely reflects differences in port structure: Spain hosts multiple ports connected to Colombia and Ecuador, whereas Belgium and the Netherlands each rely on a single major port (Antwerp and Rotterdam, respectively). This concentration likely makes ports in Belgium and the Netherlands more exclusive chokepoints for trafficking flows and key gateways to inland Europe, amplifying the scope for violence around these locations. Event-study estimates for the Belgium-Netherlands pair are reported in Appendix Figure A.12. Although only two pre-shock years are available, the estimates 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.

### 7.5 Legal Trade

A related question is whether legal trade flows changed following the post-2016 supply shock in illegal markets. In principle, an expansion of legal trade could reinforce the dynamics described in this paper by increasing commercial activity along major trafficking routes. However, there is no clear a priori reason to expect a systematic increase in legal trade specifically along cocaine trafficking corridors linking Colombia and Ecuador to high-trade European destinations. On the other hand, illegal trafficking itself may generate complementarities with licit commerce. Drug trafficking organizations depend on the infrastructure of legitimate trade, including the creation of front companies designed to resemble lawful exporters, the acquisition or infiltration of existing legal businesses, and the cultivation of relationships with otherwise licit firms willing to be complicit.[19] Such dynamics imply that sustained illegal trade might even reinforce or expand the very commercial channels through which legal goods move.

We explore this possibility in Appendix Table B.13 and Appendix Figure A.13, which report estimates from a triple-difference specification using annual scheduled container capacity (in thousands of TEU) as the outcome. The data form a yearly country-to-country panel linking Latin American exporters to European destinations. The coefficient of interest,

[18] Specifically, in high-trade countries, maritime ports with pre-shock trade connections to Colombia and Ecuador are, in Spain, Bilbao, Valencia, Vigo, A Coruña, Barcelona, Málaga, Algeciras and Tarragona. In the Netherlands, the treated province is Rotterdam. In Belgium, it is Antwerp. In Germany, Hamburg and Bremerhaven.

[19] See: The Independent: Drug cartels: How cocaine and bananas fuel violence in once-peaceful Ecuador

$T \times HighTrade \times Post$, captures differential changes in legal trade between Colombia and Ecuador and high-trade European destinations (Belgium, the Netherlands, Spain, and Germany) after 2016.

The results do not indicate a general increase in exports from Colombia and Ecuador to Europe, nor a broader rise in imports by high-trade European countries from Latin America. Instead, they point to a selective pattern: following 2016, legal trade between Colombia and Ecuador and high-trade European destinations increases gradually, becoming statistically significant from 2019 onward. The dynamic specification shows a temporary attenuation during the COVID-19 period, followed by a renewed post-pandemic increase. While these estimates do not support strong causal claims, they document a consistent rise in legal trade along the same corridors emphasized in the illegal market analysis.

# 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 prof-

itability 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

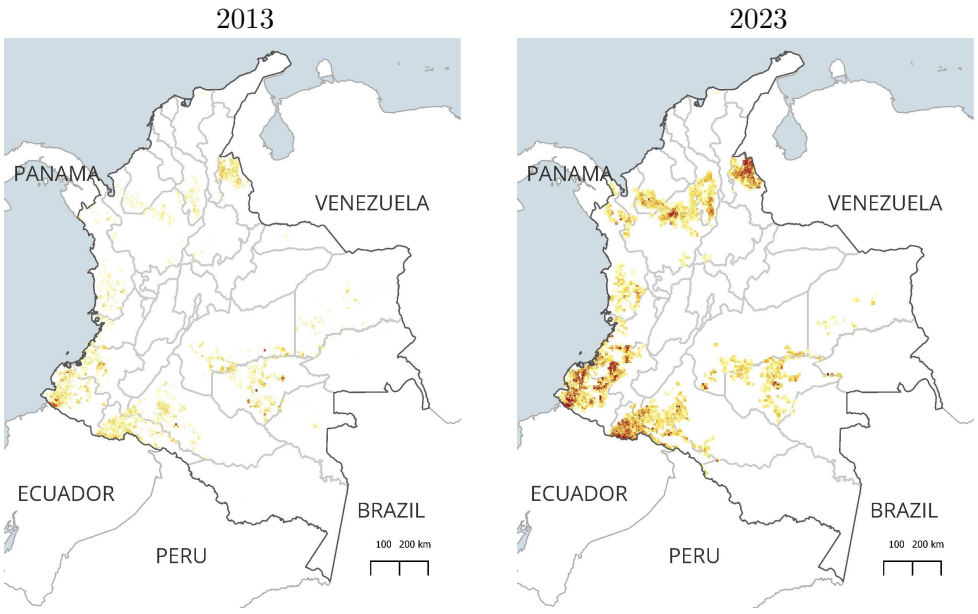



Figure A.1: Coca cultivation density in Colombia: 2013 and 2023

*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).

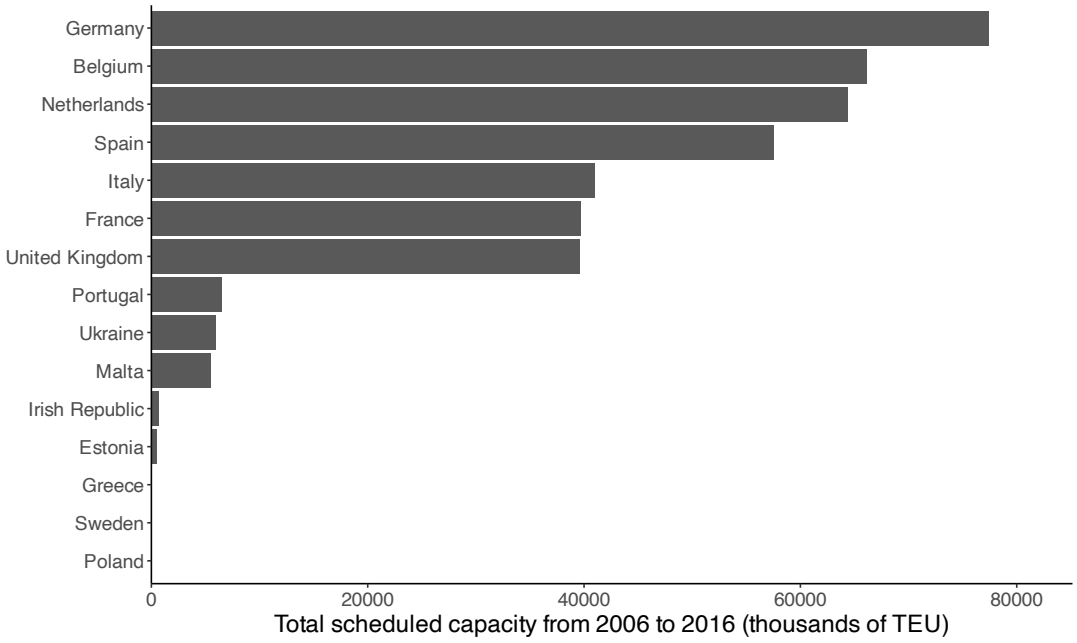
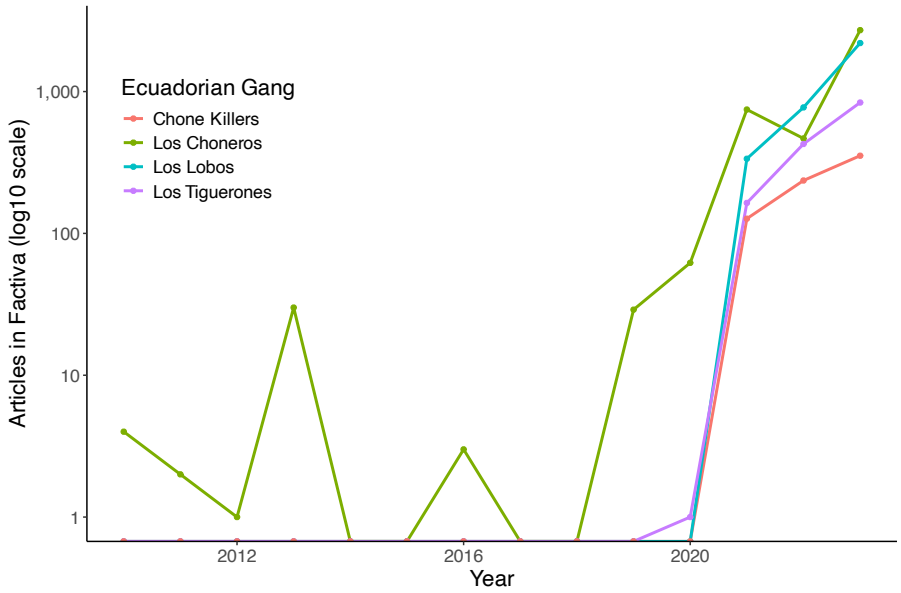



Figure A.2: Scheduled Maritime Trade Capacity from Colombia and Ecuador to Europe

*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: Trends in Ecuadorian Criminal Group Presence




*Notes*: The figure plots the annual number of news articles in the Factiva database that mention the names of major Ecuadorian criminal organizations, shown on a $\log_{10}$ scale. Prior to 2020, only Los Choneros appears with any coverage in the database. Mentions of other groups increase sharply after 2020.

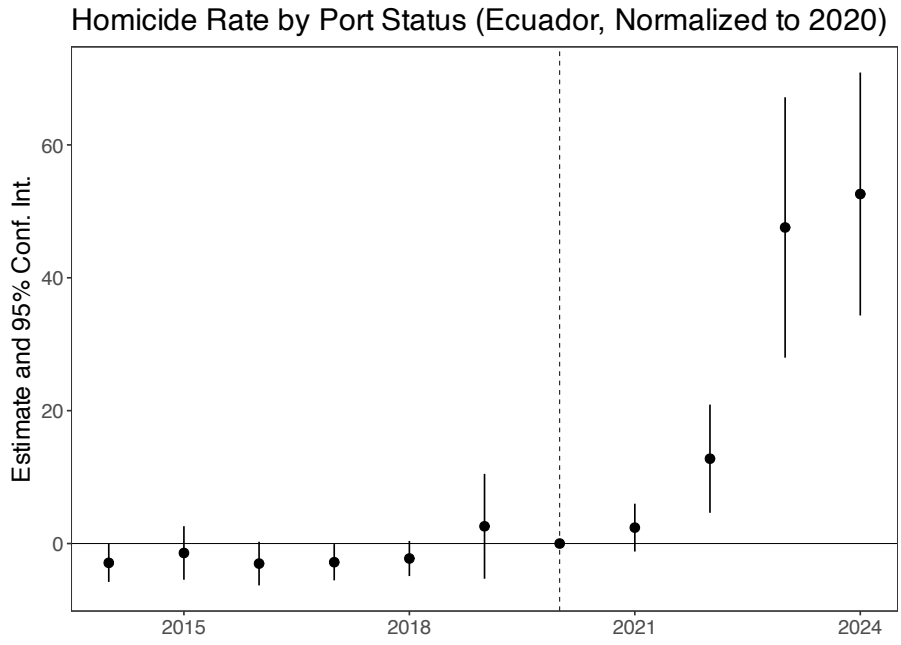



Figure A.4: Dynamic Impacts of Cocaine Shocks on Homicide Rates in Ecuadorian Ports

*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.

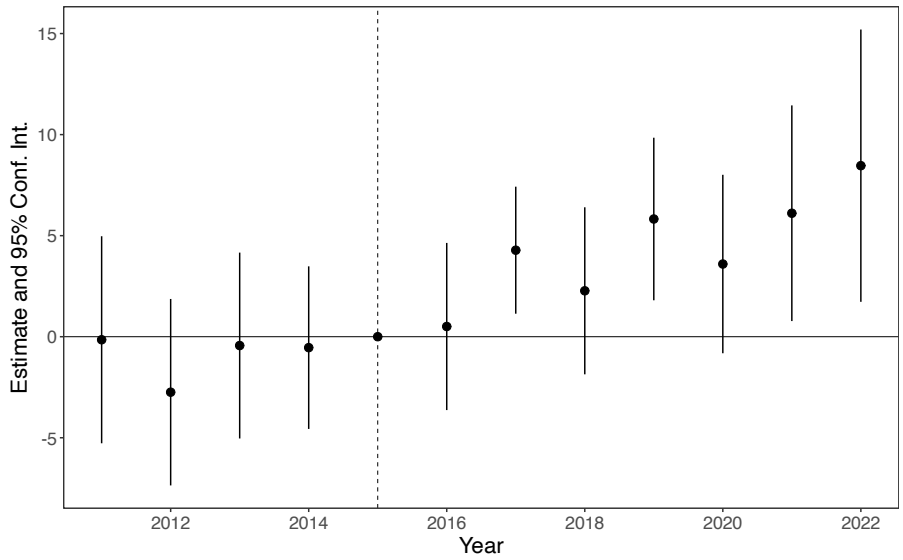



Figure A.5: Homicide Rate – Triple DID – Event Study

*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.

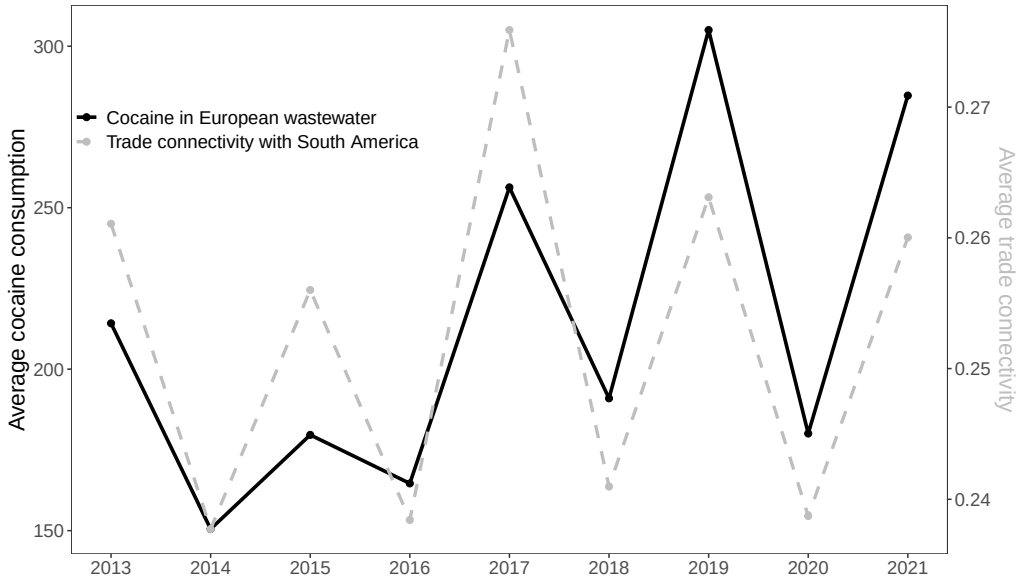



Figure A.6: Trade Connectivity and Cocaine Consumption in Europe ($\rho = 0.83$)

*Notes*: Each observation in the data 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.

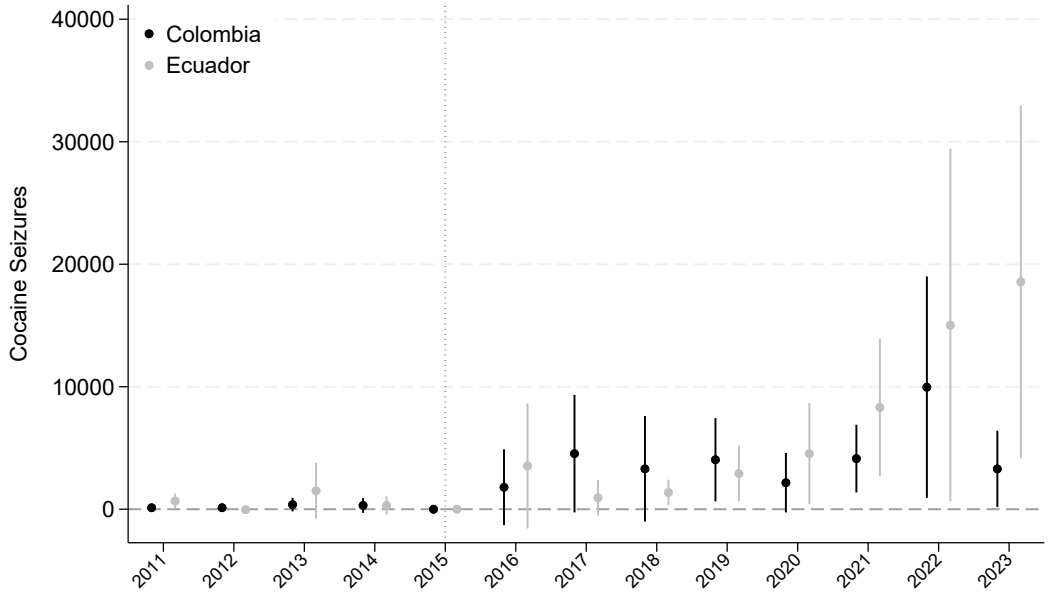



Figure A.7: Supply shock effects on seizures in EU treated countries - separating Ecuador and Colombia

*Notes*: Event study estimates are based on Equation (1). Outcomes are cocaine seizures in ports in kilograms. Standard errors are clustered at the country of destination in Europe.

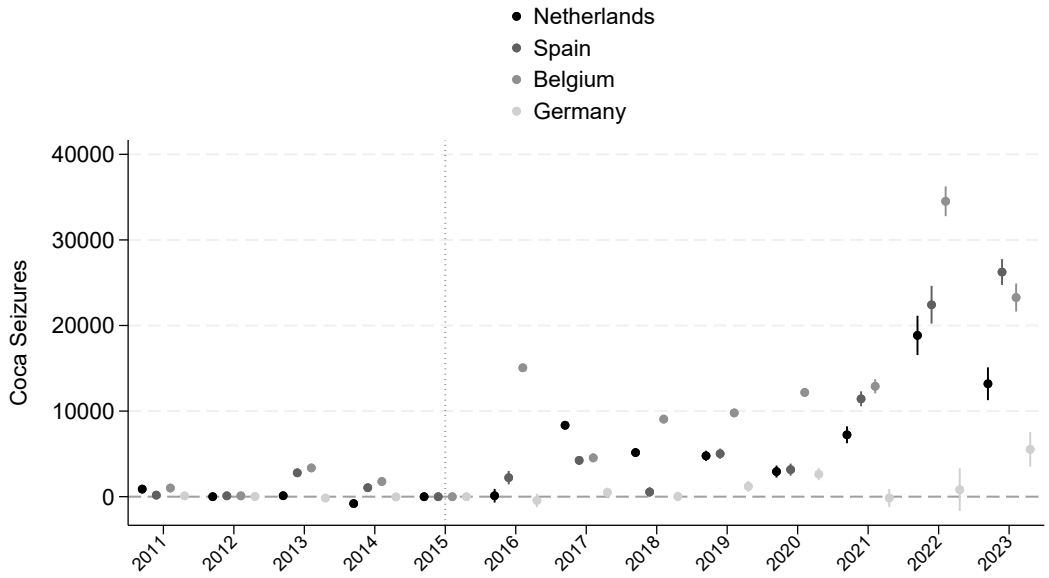



Figure A.8: Supply shock effects on seizures in EU treated countries - Heterogeneity among high-trade countries

*Notes*: Event study estimates are based on Equation (1). Outcomes are cocaine seizures in ports in kilograms. Standard errors are clustered at the country of destination in Europe.

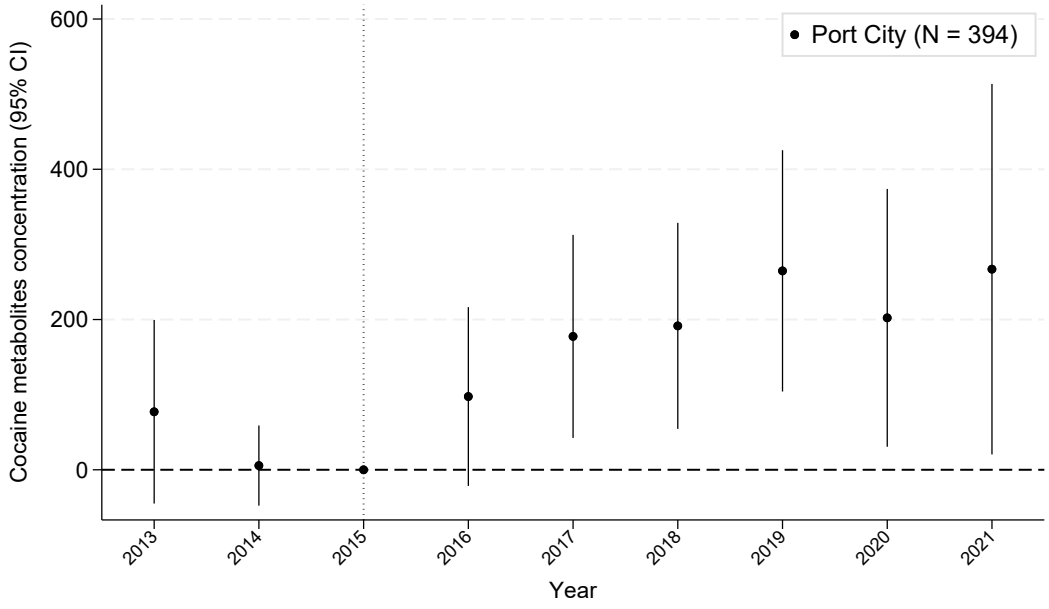



Figure A.9: Effects of the Supply Shock on Cocaine Consumption in Treated EU Cities

*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.

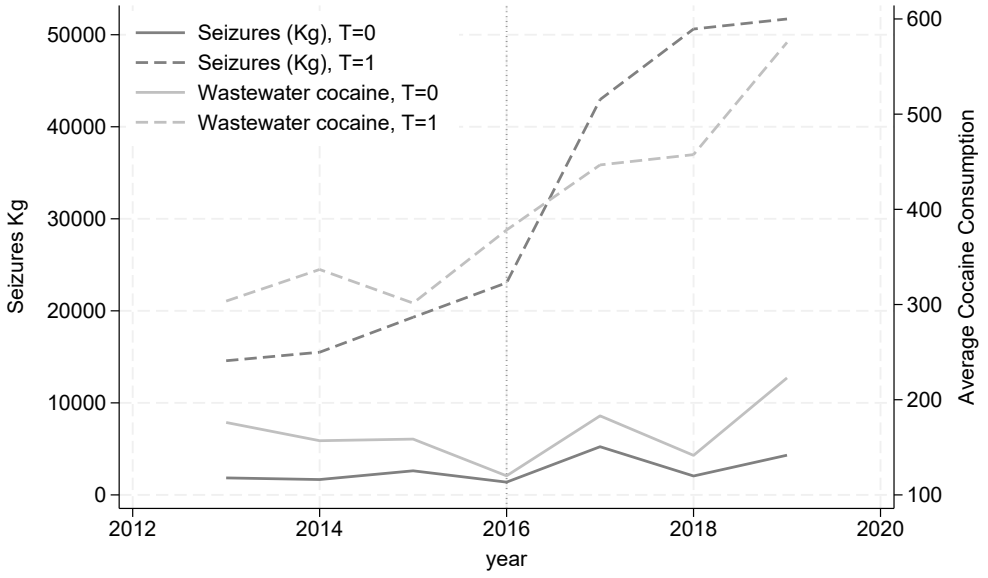



Figure A.10: Cocaine Seizures and Cocaine Consumption in Europe

*Notes*: The figure shows the overall correlation across Europe between cocaine seizures and cocaine consumption, measured by wastewater residues in European cities. T =1 includes high-trade countries driving our findings (Belgium, The Netherlands and Spain), while T =0 includes all other European countries in the sample.

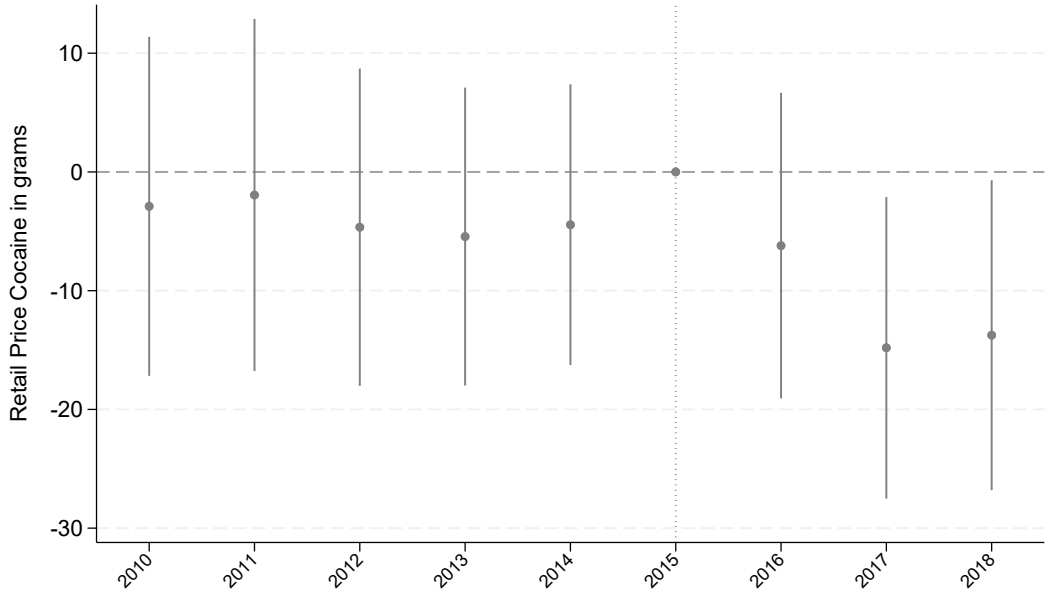



Figure A.11: Supply shock effects on cocaine prices in Europe - country level

*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.

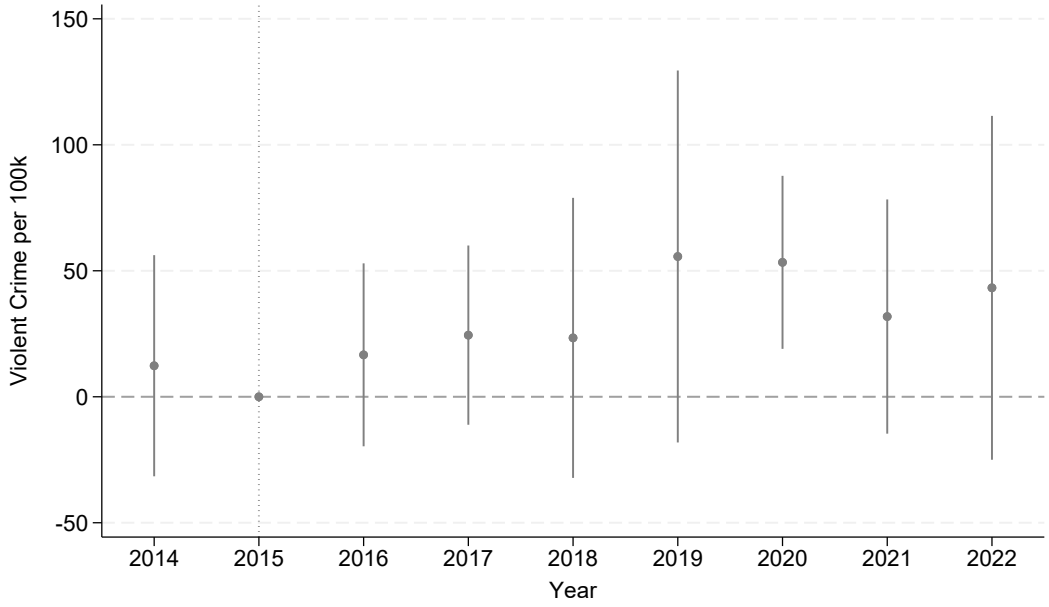



Figure A.12: Supply shock effects on violent crime rates - province level - Belgium and the Netherlands

*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.

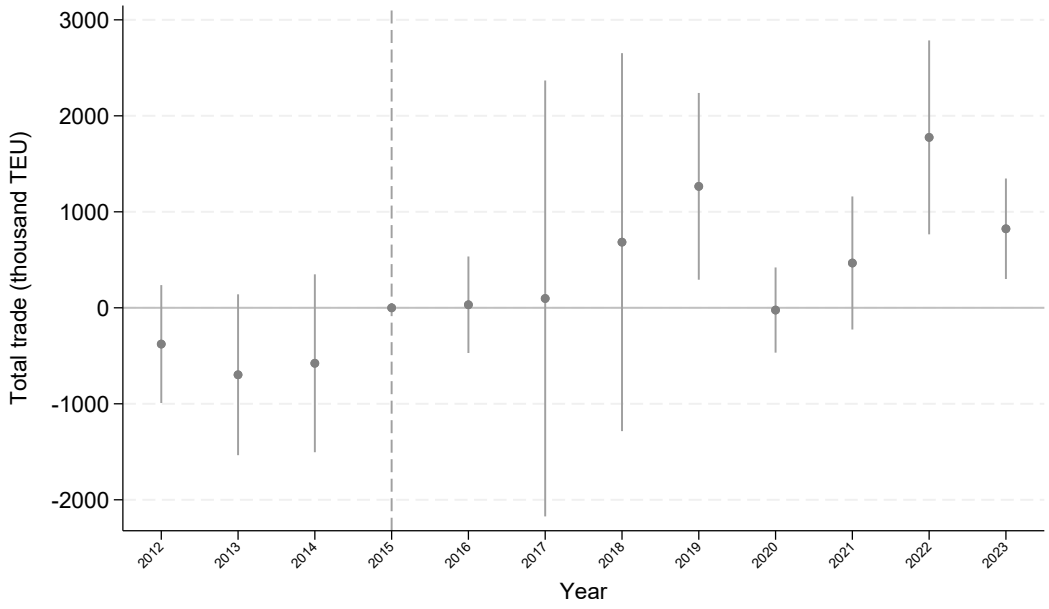



Figure A.13: Supply shock effects on bilateral legal trade - triple differences

*Notes*: The figure reports coefficient estimates from a triple difference-in-differences specification interacting treatment status ($T = 1$ for Colombia and Ecuador), $HighTrade$, and year indicators, with 2015 as the omitted baseline year. The outcome is annual scheduled container capacity (TEU, thousands). The regression includes country-pair fixed effects ($C1 \times C2$) and year fixed effects. Standard errors are clustered at the exporter country level. 95% Confidence Intervals.

# 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: Baseline Municipality Characteristics for Colombia and Ecuador (Pre-Shock)

| Country | Port | Municipalities | Homicide Rate | Coca_Pre (Ha) | FARC Only | Other Only | FARC and Other |
|---|---|---|---|---|---|---|---|
| Colombia | Non-port | 1075 | 29.58 | 30.66 | 0.02 | 0.35 | 0.08 |
| Colombia | Port | 44 | 19.56 | 16.72 | 0.00 | 0.61 | 0.05 |
| Ecuador | Non-port | 194 | 5.94 | | | | |
| Ecuador | Port | 22 | 8.79 | | | | |

*Notes*: Homicide rates are municipality-level averages over the pre-shock period. Coca cultivation and armed-group indicators are defined using pre-period data (Colombia only). The Colombia sample is from 2004 to 2014, and the Ecuador sample is from 2014 to 2019.

Table B.3: 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.4: 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.5: 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.6: 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 $\beta$ 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.7: Summary Statistics for European Analysis

| **Variable** | **Mean** | **Std. Dev.** | **N** | **Unit** |
|---|---|---|---|---|
| Year Kg Seizure (EU): Colombia–Ecuador Origin | 812.772 | 3249.054 | 533 | Dyads |
| Year Kg Seizure (EU): Other Lat. Am. Origin | 117.718 | 426.635 | 533 | Dyads |
| Year Kg Seizure (EU): Colombia Origin | 604.571 | 2701.631 | 533 | Dyads |
| Year Kg Seizure (EU): Ecuador Origin | 1020.973 | 4544.090 | 533 | Dyads |
| Cocaine Wastewater | 236.330 | 246.321 | 394 | City |
| MDMA Wastewater | 68.986 | 78.891 | 308 | City |
| Violent Crime Rate | 225.263 | 185.902 | 12,365 | NUTS-3 |
| Retail Price per g ($) | 94.553 | 31.276 | 247 | Country |
| Wholesale Price per kg ($) | 46,808.103 | 17,561.368 | 167 | Country |
| Trade Capacity (1,000 TEU) | 3389.436 | 6746.900 | 1765 | Dyads |

*Notes*: Summary statistics for the dependent variables used in Section 7.

Table B.8: 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.9: 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.10: 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.11: 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.12: 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. *** $p < .01$, ** $p < .05$, * $p < .1$.

Table B.13: Triple Diff - Change in Legal Trade

| | (1)<br>Thousands TEU |
|---|---|
| T×Post | 1,719 |
| | (977.4) |
| Post×High Trade | 51.59 |
| | (185.2) |
| T×Post×High Trade | 1,373** |
| | (616.1) |
| Observations | 1,810 |
| R-squared | 0.947 |
| Country Orig. - Country Dest. FE | YES |
| Year FE | YES |
| Mean Depvar | 2855 |

*Notes*: Estimates report the effect of the post-2016 supply shock on bilateral trade, measured as annual scheduled container capacity (TEU, thousands), between Latin America and European countries. $T = 1$ for Colombia and Ecuador. *High Trade* equals 1 for Spain, the Netherlands, Belgium, and Germany. Standard errors are clustered at the country level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

# 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 $\varphi_n$ (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 $\gamma_n$ 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 $\gamma_n$ 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 $\lambda$ 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 $\pi_j$ 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 $\pi_j$ 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 $\phi_j$ is the per-kilogram markup and $\gamma_j$ 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 $\ell_I$ according to

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

where $\ell_I$ 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 $\kappa_I$ and $\eta_I$ 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 $\gamma_j$ is strong. Even holding $I_{j,t}$ and $\gamma_j$ 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 $\ell_T$:

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

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 $\theta$ 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. **Role of state capacity.** Stronger governance or enforcement capacity ($\gamma_j$ or $\Phi^N$) 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.