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Detecting Money Laundering Through Trade Flow Analysis

An Empirical Case Study on Money Laundering in the Belgium Cocaine Trade

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Abstract

Europe has seen an increase in cocaine seizures in recent years. As the criminal landscape in South America has seen noticeable changes, there has been a shift in how cocaine enters Europe. Belgium has become the primary gateway for cocaine trafficking to Europe. With increased cocaine imports, organized criminal gangs have more money to be laundered. This thesis analyzes Belgium's trade data to investigate whether increased cocaine trafficking impacts a country's international trade flow.

We propose a method of detecting money laundering by analyzing trade flows of goods related to money laundering. This is done by introducing the synthetic difference-in-differences method in a case study. We analyze trade flows from 2000 to 2019 between Belgium, tax havens, and cocaine-trafficking countries. The thesis finds that as Belgium experiences an increase in cocaine seizures, there is a significant increase in the import of diamonds, arts, and antiquities from cocaine-trafficking countries. However, there is no conclusive evidence of increased money laundering activities between Belgium and tax havens.

The method cannot conclude the causes of increased imports. However, it can be a tool to narrow down different countries and products to identify trade flows that raise suspicion regarding money laundering activities. Further work should analyze the trade flows identified by the proposed method to detect money laundering.

Keywords - Trade-Based Money Laundering, Money Laundering Detection, Synthetic Difference-in-Differences, Drug Trafficking, Tax Havens

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Section 1 – Introduction

The battle against money laundering has occupied policymakers and law enforcement for decades. The United Nations Office on Drugs and Crime (UNODC) estimates that in 2009, 2,7 percent of global gross domestic product stemmed from money laundering connected to drug trafficking and other organized crime (UNODC, 2011). Even though anti-money laundering efforts have increased, there are still lacking empirical and theoretical studies on the topic. As globalization and innovative technologies have resulted in increased economic growth, organized criminal gangs have developed increasingly sophisticated methods for money laundering. According to the Financial Action Task Force (2010), the international trade system has become one of the main methods of laundering criminal proceedings. With increased global trade, criminals use false documentation, phantom shipments, and misinvoicing to move illegally gained revenue abroad. Thus, this thesis proposes a method for detecting money laundering by analyzing international trade flows.

We conduct a case study on Belgian foreign trade to test this method. With Antwerp having the second largest port in Europe, OCGs have in recent years found Belgium as a preferred distribution hub for cocaine in Europe. Law enforcement agencies have seen a four-time increase in the amount of cocaine confiscated in Europe. The UNODC and Europol (2021) state that Belgium has become a significant gateway for cocaine to enter Europe. The cocaine trade is filled with money that needs to be laundered, and thus money laundering activities in Belgium are expected to increase. This thesis tries to detect signs of money being moved out of Belgium due to increased cocaine imports. The research question is, can money laundering be detected by analyzing international trade flows?

To answer this question, we analyze Belgian trade data from 2000 to 2019. First, we analyze trade flows between Belgium and countries involved in cocaine production and trafficking to investigate if there is any evidence of cocaine payments from Belgium. In addition, as offshore companies and tax havens are used to hide illegal financial activity, we investigate if there are any suspicious changes in the trade flow between Belgium and tax havens. When analyzing these financial flows, we focus on the trade of products that Teichmann (2017) identifies as very secure money laundering methods. These products are gold, jewelry, diamonds, and art and antiquities. As imports of cocaine start to rise in Belgium, we hypothesize that an increase in the imports of said goods could indicate money laundering activities.

We apply the synthetic difference-in-differences method proposed by Arkhangelsky et al. (2021) to test the hypotheses. This new statistical method combines the traditional difference-in-differences and synthetic control methods to estimate the causal effect. Using this method, we compare Belgian imports to other European countries to isolate the impact of increased cocaine imports. However, as the European countries are a part of the European Union's free market, these results can be biased. Thus, we add a group of large shipping countries in Asia as a robustness check to evaluate the results.

The results show no significant changes in the import of gold and jewelry from tax havens or cocaine-trafficking countries in the treatment period. However, we find a significantly positive increase in the imports of diamonds, arts, and antiquities from cocaine-trafficking countries, indicating an increase in money laundering activities. In addition, we find a significant decrease in imports of diamonds from tax havens, implying that Belgian criminals have moved away from this method of laundering. These findings suggest that there is possible to detect signs of money laundering through trade flow analysis. However, due to the secretive nature of criminal activities, this method cannot provide direct evidence linking the results to money laundering originating from the cocaine trade. The technique can work to narrow down trade flows and identify certain countries and products that raise suspicion and need further investigation.

Section 2 – Background

2.1 Definitions

2.1.1 Money Laundering

Money laundering (ML) makes money gained illegally seem as if it comes from a legal source (Schneider & Windischbauer, 2010). The ML process can be split into three stages:

1. Placement - The initial stage of ML is where the illegally retrieved revenue comes into a legal bank/economic system (Schneider & Windischbauer, 2010). Most criminals use cash-based businesses to inflate receipts or buy expensive items that are difficult to valuate.
2. Layering - The second stage is the attempt to hide the source of the illicit revenues through multiple financial transactions. The funds are often transferred to offshore companies by over- and under-invoicing fictitious goods or services to make it difficult for regulators to see the actual origin of the revenue (Schneider & Windischbauer, 2010).
3. Integration - The final stage is integrating the laundered funds into the legitimate economy. Investing in the financial markets and properties, creating fake payrolls, or paying out loans are common ways of integration (Schneider & Windischbauer, 2010).

With the large amounts of money gained illegally, criminals have sophisticated methods for ML and are expanding their practices at an incredible pace. There is an ongoing development of techniques to avoid being detected by law enforcement.

2.1.2 Tax Havens

Tax Havens (TH) have no agreed-upon definition, leading to multiple definitions and factors of what defines tax-havens. The first definition of TH defined a country as a TH if three of four of the following criteria were met (*OECD*, 2008):

1. No or nominal tax on applicable income – The first criterion is insufficient as jurisdictions have the right to set their tax scheme (OECD, 2008).
2. Lack of effective exchange of information - The OECD encourages information exchange on tax matters to accept the information on-demand. The requested information between countries on a specific tax inquiry is usually a result of bilateral exchange agreements (OECD, 2008).
3. Lack of transparency - Transparency ensures the open and consistent application of tax laws for taxpayers and that the tax authorities get the information needed to determine the taxpayers' proper tax liability (OECD, 2008)
4. No substantial activities - This criterion targets jurisdictions that tolerate companies establishing themselves without any meaningful connections with the location of incorporation. The lack of a meaningful relationship may suggest that the jurisdiction seeks to attract investments driven by lower or no tax costs (OECD, 2008).

2.2 Cocaine Trafficking

According to the United Nations Office on Drug and Crime (UNODC) and Europol, the supply chain of cocaine to Europe have increased its efficiency and thus accessibility of cocaine to consumers (UNODC & Europol, 2021). Data suggest that the use of cocaine has increased in Europe. The European Monitoring Center for Drugs and Drug Addiction (EMCDDA) and Europol state that cocaine is the most consumed illicit stimulant drug in Europe and the second most consumed illegal drug behind cannabis (EMCDDA & Europol, 2019). The growing European cocaine market was estimated to have a minimum retail value of 10,6 billion USD in 2017 (EMCDDA & Europol, 2019). With increased cocaine consumption, one can expect that organized criminal gangs (OCGs) have more money to launder. In this section, we elaborate on the state of global cocaine production, how cocaine is smuggled into Europe and how the criminal landscape in Europe affects ML activities.

2.2.1 Cocaine Production

Cocaine is made through a chemical process involving coca bush leaves. Cultivation of coca bush hit a record in 2018, with estimated cultivation of 246 200 hectares globally (UNODC, 2019). Global cultivation has increased in recent years. The main reasons are the suspension of chemical aerial spraying of coca bushes in Columbia and reductions in alternative income sources for farmers (UNODC & Europol, 2021). In addition, the peace agreement signed in 2016 between the guerilla organization FARC and the Colombian government has created opportunities for OCGs to enter the market.

With increased coca bush cultivation and optimization of the manufacturing process, estimated cocaine production follows the same trend, see Figure 1. In 2017, UNODC estimates that global cocaine production reached an all-time high of 1976 tonnes (UNODC, 2019). The US Drug Enforcement Administration (DEA) estimates that approximately 68% of global cocaine stems from Colombia, with Peru and Bolivia accounting for about 19% and 4%, respectively (EMCDDA & Europol, 2019).

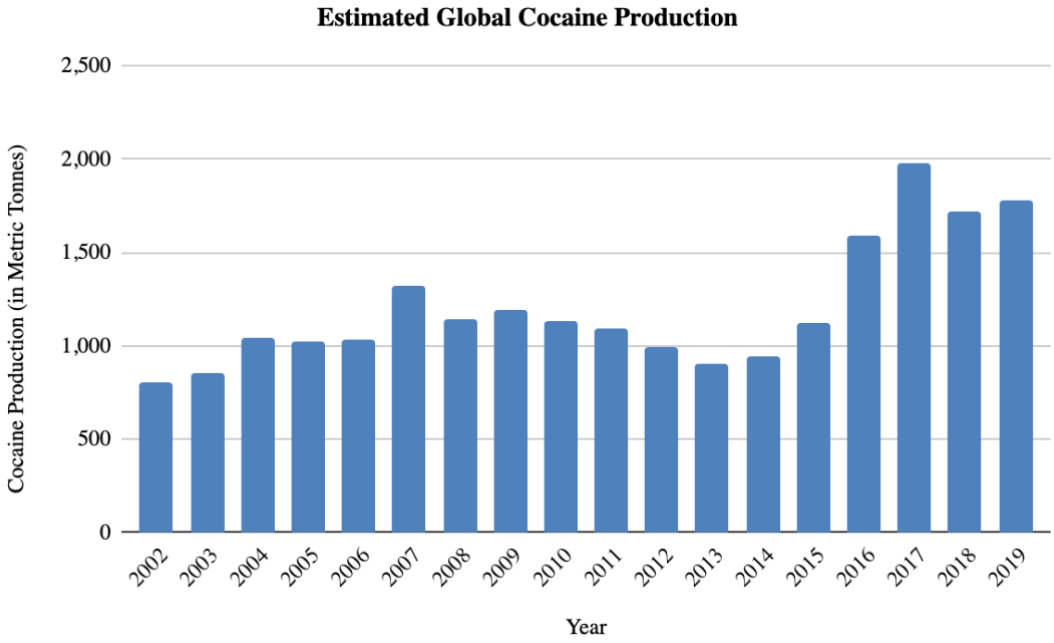

Figure 1: Estimated Global Cocaine Production (UNODC and Europol, 2021). Data from UNODC and Europol (2021) show that global cocaine production decreased from 2007 to 2013. From 2013 onwards, estimated production has increased. Our analysis tries to detect money laundering connected to this increase.

Law enforcement agencies have little information about cocaine production outside South America. There are, however, a few cases of cocaine production in Europe (EMCDDA & Europol, 2019), but the volume is minimal compared to South American production.

2.2.2 Cocaine Smuggling

There are numerous routes traffickers choose when smuggling cocaine from Latin America to Europe. Cocaine is hidden amongst goods and transported mainly by ship (EMCDDA & Europol, 2019). Furthermore, cocaine is often shipped directly from the producing country or via different transit routes. This section will elaborate on the most common transit routes for cocaine to enter Europe.

Central America and the Caribbean route

Central America is a big part of the international cocaine trade. With 120 tonnes of cocaine seized in 2017, Central America was the fourth largest region of seizures globally (UNODC & Europol, 2021). Panama is the biggest trafficking hub in Central America. Every year between 13 000 and 14 000 transits departs from the Panama Canal, making Panama an attractive location to transport illegal products worldwide (Panama Canal Authority, 2022). EMCDDA & Europol (2016) estimate that roughly 40% of cocaine destined for Western Europe departs from Panama. Spain, The Netherlands, and Belgium are the top three European destinations of goods departing from Panama (Panama, Canal Authority, 2022). Panama is also regarded as a TH (Chardonett & Langerock, 2017), and consequently, Panama is a suitable location for OCGs to conduct their smuggling operations.

Due to the geographical location and closeness to Florida and Latin America, the Caribbean has historically been used to import cocaine into the United States (INL, 2019). However, countries like The Dominican Republic, Trinidad and Tobago, and Jamaica have become important trafficking hubs for European cocaine imports (EMCDDA & Europol, 2019).

The Atlantic route

Using the Atlantic Route, shipments of cocaine heading for Europe transit to West or North African destinations. The shipments depart from the southern part of Latin America in countries like Brazil, Uruguay, Argentina, and Chile across the Atlantic to the African coast (UNODC, 2011). Common transit areas in West Africa are Nigeria, Benin, and islands like Cape Verde and the Canary Islands. However, even though there are occasionally some significant cocaine seizures in the area, the seizure statistics for this area remain relatively small (EMCDDA & Europol, 2019).

Northern African countries have also seen increased cocaine trafficking activities in recent years. This region acts like a vital crossroad linking Europe, West Africa, the Mediterranean, and the Middle East. The central cocaine trafficking hub is Morocco, with Algeria and Libya as smaller trafficking hubs (EMCDDA & Europol, 2019). OCGs in Morocco have years of experience as significant cannabis exporters to Europe. Evidence shows that OCGs use the cannabis smuggling routes to Europe to smuggle cocaine (EMCDDA & Europol, 2019).

The Atlantic trafficking route has increased its operations of smuggling cocaine to Europe in recent years. However, based on the volume of cocaine seized in this region, the amount of smuggled cocaine via the Atlantic route is still relatively low compared to direct shipment or Central America and Caribbean routes.

2.2.3 Import of Cocaine to Europe

Due to the secretive nature of cocaine trafficking, there are difficulties in quantifying the exact amount of cocaine that enters Europe. EMCDDA & Europol (2021) states that interpreting seizure data is essential for quantifying the amounts entering Europe. In addition, production estimates, purity levels, and wastewater analysis are important side indicators in understanding the cocaine market (EMCDDA & Europol, 2021). This thesis uses drug seizure data and production estimates to analyze ML flows between countries.

According to collected data from the Europol partnership, Europe has, since 2013, seen a roughly 240% increase in cocaine seizures (EMCDDA & Europol, 2021). Of the 210 tonnes seized in 2019, Belgium, Spain, and the Netherlands accounted for 70% of total seizures. Figure 2 shows the growth of European cocaine seizures in the last decades.

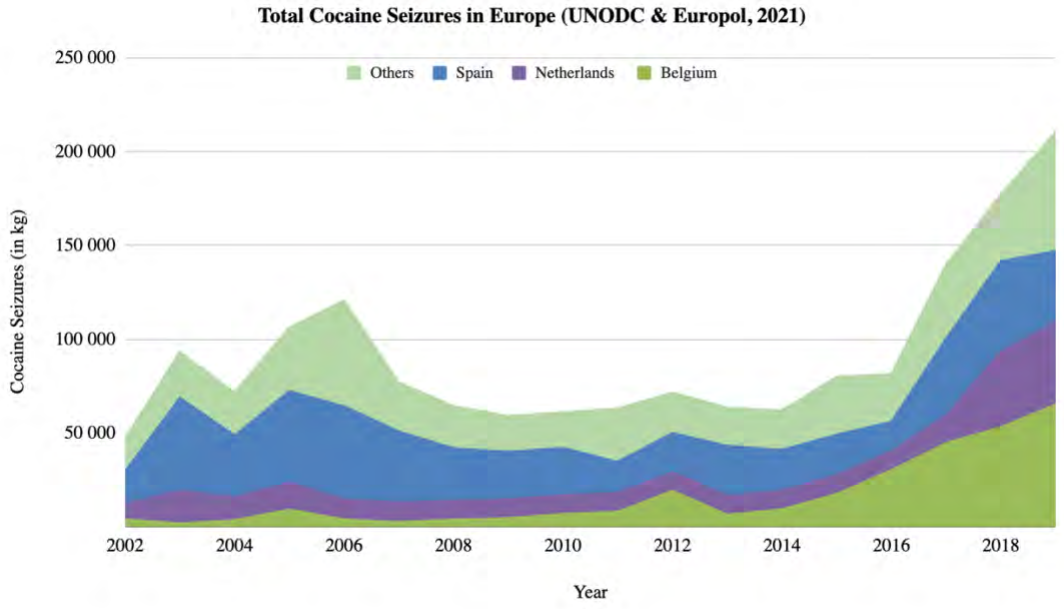

Figure 2: Total Cocaine Seizures in Europe (UNODC & Europol, 2021). Data from UNODC & Europol shows the total cocaine seized in Europe, filtered by the most prominent countries. From 2013 to 2019, Belgium has seen ten times increase in the volume of cocaine seized (UNODC & Europol, 2021).

Spain has been one of the main entry points of cocaine, reaching Europe for a long time. However, based on data from EMCDDA and Europol (2021), Belgium has increased its importance as a large importer of cocaine to Europe in recent years. This trend coincides with the increase in estimated global cocaine production, starting in 2013. In addition to the total volumes of cocaine seized, Belgium has increased its share of total seizures in Europe. With such growth in cocaine production and seizures, we expect that Belgium has increased its total imports of cocaine in the studied period. With this increase, we expect that there is more money to be laundered, making Belgium an attractive candidate for our case study. Figure 3 shows the development of Belgium's share of seizures compared to other European countries.

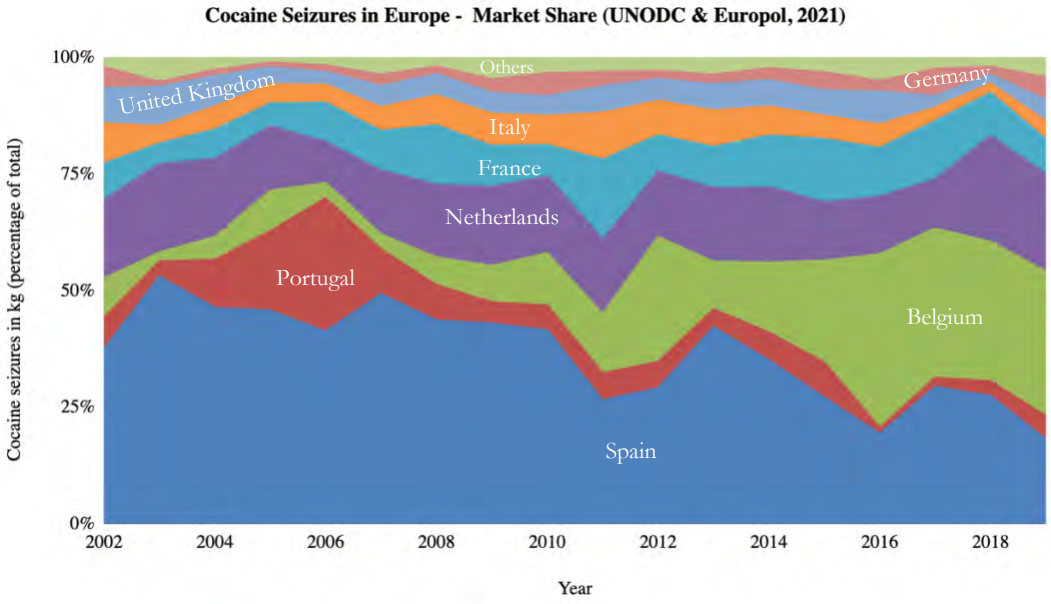

Figure 3: Cocaine Seizures in Europe – Market Share (UNODC and Europol, 2021). The graph from UNODC & Europol (2021) shows the development of total cocaine seizures in Europe distributed by countries. Belgium has seen an increase starting in 2013, becoming a significant gateway for cocaine to enter Europe.

The largest share of imported cocaine arrives by boat at the two biggest ports in Europe, Belgium's Antwerp and The Netherlands' Rotterdam. In Spain, the ports of Algeciras and Valencia are the most used (EMCDDA & Europol, 2019). Other notable ports of cocaine imports in the EU are Le Havre (France), Hamburg (Germany), and Gioia Tauro (Italy). A rising trend is the use of smaller ports with fewer security measures in Malta, France, The Netherlands, Spain, and The United Kingdom (EMCDDA & Europol, 2019). Furthermore, cocaine can enter Europe through air traffic. The use of regular luggage, freight, or private jets targets all major European airports (EMCDDA & Europol, 2019). However, these numbers are low compared to transportation by ship.

When the cocaine has arrived in the primary distribution hubs mentioned above, the product is distributed to other regions of Europe mainly by road or trains (UNODC & Europol, 2019). Cocaine transportation uses trains and commercial and non-commercial lorries for this purpose. In addition, the distribution of smaller quantities using personal vehicles as well as postal and parcel services is widespread (UNODC & Europol, 2019).

2.2.4 Organized Criminal Activity in Europe

An essential aspect of detecting ML activities from the European cocaine trade is understanding the criminal landscape. In the last decades, a fragmentation of the criminal landscape in Colombia has given opportunities for new OCGs to enter the cocaine market (UNODC & Europol, 2021). The demobilization of Autodefensas Unidas de Colombia (AUC) in 2006 and the Colombian government's peace agreement with FARC in 2016 have led to the formation of smaller OCGs (UNODC & Europol, 2021).

Due to its close links to Colombian cartels, the Italian 'Ndrangheta mafia has had a privileged position in the European cocaine trade for decades (UNODC & Europol, 2021). Even though the Italian mafia is still a prominent actor in the cocaine market today, the demobilization of Colombian cartels has opened possibilities for other European OCGs to buy cocaine directly from smaller suppliers in South America (UNODC & Europol, 2021).

In addition to the Italian mafia, collaborating OCGs in Belgium and the Netherlands, as well as Russian and Albanian-speaking groups, are highly active in the European cocaine market (UNODC & Europol, 2021). The complex structure of the criminal landscape in Europe can impact our analysis as there are multiple ways that the criminal proceedings can flow when laundered. Cocaine shipments arriving at Antwerp will not necessarily be paid directly from Belgium. Money launderers in Italy can pay the South American suppliers directly instead of paying intermediaries in Belgium. Structures like this can create large webs of transactions involving multiple countries and jurisdictions, making ML detection difficult.

2.3 Methods for Money Laundering

In the following, we elaborate on different methods criminals can use to launder illegal revenue from the cocaine trade in Belgium. Firstly, we look into Trade-Based Money Laundering (TBML) before presenting the products we use for analysis. The work of Teichmann (2017) identifies twelve standard methods of laundering illegal revenue used by professional money launderers. We have identified four internationally traded product categories of these twelve methods that we analyze to detect ML. The product categories are gold, jewelry, diamonds, and arts and antiquities.

The remaining methods are real estate transactions, consulting firms, mergers and acquisitions, banks of Dubai, deposit boxes, cash to cash, and currency exchange offices (Teichmann, 2017). These methods won't be analyzed in our thesis. However, they are likely a part of ML activities in Belgium and thus impact our analysis.

2.3.1 Trade-Based Money Laundering

According to Financial Action Task Force (FATF), TBML uses the international trade system to launder money and is one of the main methods of laundering criminal proceedings (FATF, 2010). The goal of TMBL is to move value out of a country or jurisdiction. False documentation, phantom shipments, and over-or under-invoicing are techniques used by money launderers (FATF, 2010).

When looking into international trade, it is essential to understand how money moves in imports and exports. When importing goods from other countries, the funds can be transferred out of the country as the supplier gets paid. OCGs in Belgium need to move money out of the country when they receive shipments of cocaine. Zdanowicz (2009) states that an effective TBML method is overvaluing import invoices. Another way of paying for the cocaine shipments could be to buy goods in Belgium and export these to the country where the payment is due for further resale. In this case, under-invoicing of exports is a preferred method (Zdanowicz, 2009). For instance, using a combination of bank transfers and cash, money launderers can buy goods in Belgium to be exported abroad. When shipping, the criminals can charge a lower value than the original for the item. When the arts arrive at the destination, the pieces can be sold for the total amount or higher.

This thesis focuses on imported goods to Belgium as an event study can detect an increase in over-valued or increased import numbers. As Belgium has increased cocaine seizures, we expect increased ML activities. Thus, the occurrence of both under-valued exports and over-valued imports should increase. An increase in overvalued goods will increase the total trade value, thus suitable for an event study. However, under-valuing does not necessarily significantly impact the total trade flow value and is, therefore, difficult to detect. Thus, finding increases in the trade value of imported goods can be a sign of ML activities.

2.3.2 Money Laundering Through Gold

The first trade flow we analyze is imports of gold to Belgium. Teichmannn (2017) states that gold trading is a suitable method for the placement and layering stage of the ML process. Gold can be purchased by cash or bank transfers and melted down to be sold to another party. This process makes it hard for law enforcement to trace the actual origin of the possessed goods, which is essential for money launderers (Teichmann, 2017).

In some cases, money launderers can use financial derivatives to sell gold without physically moving the gold (Teichmann, 2017). An article from The Independent (2013) revealed that Colombia reported gold exports of 70 tonnes in 2012, despite producing only 15 tonnes the same year. Money launderers can export metals that look like gold or create phantom shipments of gold and, in that way, transfer money into the exporting country (Teichmann, 2017). In our case, we expect that cocaine money is leaving Belgium as payment for actual or fictitious gold. An increase in imported gold from cocaine-trafficking countries or THs to Belgium could be linked to ML activities.

2.3.3 Money Laundering Through Jewelry

In contrast to the fixed market price of gold, jewelry has an ambiguous value, making it suitable for placement and layering (Teichmann, 2020). It can be challenging for law enforcement to establish objective values and detect overvalued items. High-end fake jewelry can be hard to distinguish from its genuine counterparts, which criminals can exploit. Money launderers can import fake and genuine jewelry to pay for cocaine shipments. With large margins, criminals can move substantial amounts of money through jewelry. In addition, the jewelry business is characterized by high degrees of anonymity and a lack of regulations (Teichmann, 2020). We expect that an increase in the total trade value of imported jewelry could be a sign of ML activities.

2.3.4 Money Laundering Through Raw Diamonds

The diamond trade has been a paradise for money launderers since the 1990s (Teichmann & Falker, 2020). Several aspects make diamonds lucrative for ML. Firstly, the diamond market is cash-intensive, meaning purchases of diamonds through cash does not raise suspicion at vendors (Teichmann & Falker, 2020). Secondly, diamonds do not have a serial number, like jewelry or gold, thus making the origin hard to trace (Teichmann & Falker, 2020). Teichmannn & Falker (2020) interviewed professional money launderers who stated that cutting diamonds can increase their worth and hide their origins. In addition, they can claim that it is a much larger cut, further increasing the price. Furthermore, disguising diamonds as pearls or other precious stones are techniques used to move value abroad (Teichmann & Falker, 2020). Thus, diamonds allow both placement and layering of illicit funds. In addition, diamonds are small and value preserving, making them suitable for ML. The size of 50 million dollars in diamonds is far smaller than the same amount in cash, making shipments of diamonds harder to detect.

For centuries, Antwerp has been the center of the global diamond trade. In 2019, Antwerp World Diamond Center (AWDC) estimated that 84% of the world's rough diamonds and 50% of the polished diamonds pass through Antwerp (AWDC, 2019). This market accounts for 5% of Belgium's foreign trade, valued at 46 billion USD (AWDC, 2019). With the size and history of the Belgian diamond market, we expect that money launderers use the techniques mentioned above to launder criminal proceedings from the cocaine trade. Thus, an increase in the imports of diamonds to Belgium could be a sign of increased ML activities.

2.3.5 Money Laundering Through Arts and Antiquities

The lack of regulation and transparency, combined with volatile prices, makes the art market suitable for placement and layering in the ML process (Teichmann, 2017). Art is a broad term with subjective value, allowing many possibilities of layering illicit funds. Discrete private collectors allow cash payments for precious art, enabling the placement of money (Teichmann, 2017).In addition, the ambiguous value of artworks allows both under-and overpricing items to move money abroad without raising suspicion. Furthermore, the art market has successfully averted tighter regulations meant to prevent ML (Teichmann, 2017).

Like arts, the actual value of antiquities is challenging to measure, which is advantageous for ML activities (Teichmann, 2017). Teichmann (2019) states that criminals use lesser-known antiquities to inflate their subjective value and avoid public attention. The antiquities market is poorly regulated, and often anti-money laundering regulations do not apply when buying or selling antiquities (Teichmann, 2019). In addition, merchants are usually not required to register information and identify their counterparts, making the antiquities market appealing to individuals seeking anonymity (Teichmann, 2019). As there are many definitions of what defines art and antiquities, combined with similar characteristics, we combine them into one product category. This categorization allows detection of increases in different products like paintings, collectibles, engravings, statues, and antiquities. Findings of increased imports of these goods could indicate ML activities.

2.4 Anti-Money Laundering Efforts in Belgium

In 2015, FATF evaluated the Belgium government's ML and tax fraud efforts. The report clearly stated that the government's initiatives were falling short in combating the problems (FATF, 2015). This report, amongst others, has led to stricter regulations and oversight of the diamond industry in Belgium in recent years. Registration, licensing of import and export, record keeping and annual stock declarations, self-regulation, and increased anti-money laundering activities are examples of how the diamond industry has been regulated (Merket, 2021). One measure the Belgian government has carried out is to limit the payment with cash to a maximum of 10% of the transaction price, and no cash payment above 3000 euros is allowed (AWDC, 2022).

The Belgium authorities' increased efforts have led to several illegal conflict diamonds and ML revelations. One example is the Omega Diamond case, where a whistleblower revealed how the company had relabeled the origin of conflict diamonds (Merket, 2021). The scheme involved smuggling the diamonds from Angola and the Democratic Republic of Congo to Switzerland and the United Arab Emirates (UAE). The diamonds were repackaged and falsely valued in Switzerland and the UAE for further export to Antwerp to launder money (Merket, 2021).

Exposures of the methods mentioned above and government efforts could lead OCGs to adapt and change plans. As of 2014, there have been no new revelations of conflict diamonds in Belgium (Merket, 2021). Whether the increased efforts have worked or whether the OCGs are using new undetected methods is hard to verify. However, the discussion above shows that OCGs find ways to launder through the Belgian market even with increased anti-money laundering efforts.

Section 3 – Literature Review

3.1 Money Laundering Detection

This section elaborates on the current literature regarding detecting ML. An essential aspect of detecting ML is quantifying the amounts of money being laundered globally. Past research estimates that ML activities are the third largest industry globally (Baity, 2000). However, many researchers face difficulties validating the size of global ML activities due to inappropriate statistical techniques combined with insufficient available data quality (Gilmour, 2017). The current estimates have been criticized for being misleading. Unger (2013) links the difficulties of precisely estimating the true scope of global ML activities to the mysterious underlying nature of criminal activities. The challenges of correctly assessing numbers connected to illegal activity are a liability that affects our work. Our thesis is based on estimations regarding cocaine production and import amounts, which cannot be confirmed. We must consider that Belgium perhaps is not the biggest importer of cocaine in Europe.

Zdanowicz (2009) detected asymmetries in international trade pricing by analyzing the value of goods imported and exported between the United States and other countries. In his work, Zdanowicz analyzed the average price of items worldwide compared to the average prices for each country the US trades with. Zdanowicz (2009) found that cut emeralds imported to the US from Panama cost 22 times more than the average world price in the period analyzed. Analysis shows that illegally gained funds may be laundered from one country to another by under-valuing export invoices or over-valuing import invoices (Zdanowicz, 2009). Zdanowicz's (2009) work shows that it is possible to detect signs of ML activities by analyzing international trade flows.

There seems to be a gap in the current literature regarding detecting ML of illicit drug money. Chief of Organized Crime and Money-Laundering at UNODC, Pierre Lapaque, expresses that it is hard to separate drug money from other crime money. This is because there is a large flow of illegal funds originating from the drug business and one needs to detect the stream of illicit money before it enters the global financial market (Lapaque, 2011). This impacts our analysis because we cannot conclude that increased imports of goods linked to ML necessarily stems from increased cocaine imports.

Section 4 – Methodology

4.1 Data

4.1.1 International Trade Data

In this thesis, we have extracted international export and import numbers between countries from the World Integrated Trade Solutions database (WITS). WITS is maintained by the United Nations (UN) and provides open access to international merchandise, tariff, and non-tariff measures data (WITS, 2022). There are numerous different standards and classifications for items in global trade data. In this thesis, we have chosen the Standard International Trade Classification Revision 4 (SITC4) as this is the classification the UN uses for external trade statistics (Eurostat, 2022). We have identified several product codes which align with the methods of ML presented by Teichmann (2017). Due to inconsistencies in observations within specific products, multiple product codes are pooled together into four categories. In Table 1, we present the product categories we use for our analysis. The total dataset consists of 29.339 observations in the period between 2000 to 2019. Additional descriptive statistics can be found in the appendix.

Overview of Product Categories with SITC4 Classification Codes

Product Categories	**SITC Revision 4 (UN Trade Statistics, 2021b)**
Gold	9710 - Gold, non-monetary (excluding gold ores and concentrates)
Jewelry	8972 - Imitation Jewelry
	8973 - Jewelry of gold, silver, or platinum group metals (except watches and watch cases) and goldsmiths' and silversmiths' wares (including set gems)
	8974 - Articles of precious metal or clad with precious metal, n.e.s. (other than jewelry and goldsmiths' or silversmiths' wares)
Diamonds	6671 - Pearls (natural or cultured), not strung, mounted or set; ungraded pearls (natural or cultured) temporarily strung for transport
	6672 - Diamonds (other than sorted industrial diamonds), worked or not, but not mounted or set
	6673 - Precious and semiprecious stones (no diamonds) not strung, mounted, etc.; ungraded precious and semiprecious stones (no diamonds), strung for transport
Arts and Antiquities	8961 - Paintings, drawings, and pastels, executed by hand as works of art (not hand-painted, etc. manufactured items); collages and similar decorative plaques
	8962 - Original engravings, prints and lithographs
	8963 - Original sculptures and statuary, in any material
	8964 - Postage or revenue stamps, stamp-postmarks, first-day covers, etc. as collectors' items (if unused not current or new issue in country of destination)
	8965 - Collections and collectors' pieces of zoological, botanical, mineralogical, anatomical, historical, archaeological, numismatic, etc. interest
	8966 - Antiques of an age exceeding 100 years

Table 1: Overview of Product Categories with Respective SITC4 Codes. The table shows the product categories we use for further analysis with the coherent SITC4 product codes used to extract international trade data from WITS.

The first product category is gold and consists only of the 9710 SITC4 code. The jewelry group consists of SITC codes 8972, 8973, and 8974. Imitation jewelry (8972) is chosen as these can be used for ML by valuing fake jewelry as high-end jewelry. Jewelry of gold, silver, or platinum group metals (8972) is included as these can be high-end jewelry with ML potential. The last included product code is 8974 – Articles of precious metal, a group of miscellaneous decorations, and ornaments of expensive material, which can be suitable for ML.

The diamond category consists of SITC4 codes 6671, 6672, and 6673. This category consists of natural diamonds, pearls, and other precious stones. The reason for adding pearls and precious stones is that these products can be used for ML by being disguised as diamonds (Teichmann, 2020). The last product category is arts and antiquities. This group consists of SITC4 codes 8961 through 8966 and includes various products with ambiguous values suitable for ML (Teichmann, 2017). This includes, amongst others, paintings, prints, sculptures, collectibles, and antiquities.

4.1.2 Tax Havens

We use a group of defined TH countries to analyze their trade with Belgium to detect ML flows. As there are contradicting views on what defines a TH, we use a combination of different lists of THs proposed by World Data Info (WTO, 2022). These lists are produced by Oxfam (2020), FATF (2022), European Union (EU) (2017), IMF (2018), and OECD (2022). For our list of THs, we choose countries that are listed in two or more of these reports. This definition includes Ireland, Luxembourg, and the Netherlands. However, as these countries are a part of Europe's free trade market, they will be a part of our European control group. Thus, they are excluded from the list of THs. As a result, the list of THs consists of 19 countries. The complete list of THs can be found in the appendix.

4.1.3 Cocaine-trafficking Countries

The second trade flow we investigate is imports of goods to Belgium from cocaine-trafficking countries. These are defined as trafficking countries when mentioned by EMCDDA (2016) as countries involved in smuggling and trafficking routes from the Caribbean, Central- and South America. As these countries are the predominant source of cocaine in Europe, we expect to see increased import of ML-related goods from these countries to Belgium. The complete list can be found in the appendix.

4.1.4 European Control Countries

To detect signs of ML in Belgian imports from the countries mentioned above, we compare Belgian import trends to countries in the EU's open market. The EU open market is the world's largest trade agreement and provides free movement of goods across borders (EFTA, 2022). In addition to the 27 EU countries, Switzerland, Iceland, Norway, and Liechtenstein are included. Switzerland has access to the EU's open market through bilateral agreements, and the remaining countries have access through the EFTA agreement (EFTA, 2022). The United Kingdom was a part of the EU in the studied period. Thus, they are not excluded from the analysis. The complete list of European control countries can be found in the appendix.

4.1.5 Shipping Control Countries

As the increase in cocaine seizures is present in all of Europe, the European control countries can be biased toward the potential trade flow changes. Secondly, due to the complex criminal landscape in Europe, ML activities can be conducted in other countries in Europe. These potential ML structures can affect the trade flow of other European control countries. Thus, we include another group of control countries.

The shipping control group consists of several large shipping countries in Asia. These countries are not a part of the European open market and can act as a more independent control for analyzing Belgian imports. These countries are derived from the UN Conference on Trade and Developments (UNCTAD) Review of Maritime Transport 2020 (UNCTAD, 2021). The control group will consist of Asian countries featured on the top shipping fleet owners list. However, China is excluded due to its rapid growth of imports in the period. Between 2016 and 2019, China had a 500 billion USD increase in imports (Santander, 2022). This increase would nullify trends in Belgian trade flows. In addition, Russia is excluded due to missing observations in the WITS database. As a result, the shipping control countries consist of Japan, South Korea, Vietnam, Indonesia, Malaysia, Singapore, and Turkey.

4.1.7 Limitations

The data quality in the WITS database relies on countries reporting the correct amounts themselves. There are countries in the dataset with different quality of institutions. There could be under- or overreporting of trade data, which can impact the conclusions drawn in this thesis. In addition, there are missing values in the dataset, mainly from smaller countries. We interpolate the missing observations using the two nearest observations in these cases. In the case of countries with too many missing observations to interpolate, the country was excluded from the regression. To mark the exclusion amount, we present the percentage of total trade value used with the results. This percentage shows the sum of trade value used after the exclusion, divided by the total available trade value.

We only use the total trade value of imports from the WITS database, not the number of goods imported. This is due to many missing reports of quantity throughout the whole dataset. Many countries only report trade value, and that quantity is either not required or prioritized. This hinders the analysis by not being able to analyze relative changes in Belgium imports.

4.2 Research Method

To detect ML trends in the Belgian trade flow, we use the synthetic difference-in-difference estimator (SDID) to evaluate the effect of the increased cocaine imports. The SDID is an estimator for causal effect introduced by Arkhangelsky et al. (2021). The method combines properties from the traditional difference-in-differences and synthetic control methods. As the increase in cocaine does not exclusively affect Belgium, the method's robustness is essential. Arkhangelsky et al. (2021) argue that SDID has desirable robustness properties and performs well in settings where the conventional estimators previously have been used. In the following, we briefly explain the difference-in-differences and synthetic control and how the SDID combines and enhances the traditional estimators. At last, we present the research design and hypotheses used.

4.2.1 Difference-in-Differences

Difference-in-differences is a statistical technique used in various fields of social sciences to estimate causal effects. It studies the differential effects on a treatment group and compares it to a control group, like in a natural experiment (Bertrand et al., 2004). The average change over time of an outcome in the treatment group is compared to the average change over time for the control group (Bertrand et al., 2004). The method's success relies on how fitting the choice for the control group is (Abadie, 2005). Difference-in-differences require a parallel trend assumption, meaning that in the absence of treatment, the difference between the treatment group and control group is constant over time(Abadie, 2005). Violation of this trend assumption will lead to biased results of the causal effect.

4.2.2 Synthetic Control

Synthetic control is a statistical method used to estimate causal effects without making the parallel trend assumption. First, it constructs a weighted combination of groups to match their pre-exposure trends, to which the treatment group is compared. Then, like in the difference-in-differences method, the comparison is used to estimate what would have happened to the treatment group if it had not received the treatment (Swarup, 2022). So instead of using a single unit in the untreated group, it forges it's own based on a combination of multiple untreated groups, creating what is known as a synthetic control (Swarup, 2022).

Arkhangelsky et al. (2021) argue that Synthetic control and difference-in-differences target different applications. Difference-in-differences methods are used when there are many treated units, and one can argue for the parallel trend assumption. Synthetic control is used when researchers cannot make a parallel trend assumption and the number of treated units is low (Arkhangelsky et al., 2021).

4.2.3 Synthetic Difference-in-Differences

The Synthetic difference-in-difference method combines attractive features of both the previously presented methods. First, it re-weights and matches pre-exposure trends to weaken the reliance on parallel trends assumption, like the Synthetic control method (Arkhangelsky et al., 2021). In addition to weighting the untreated groups, SDID also weights the periods. The argument for including time weights follows the same logic as weighting the untreated group. Time weights emphasize units that, on average, are similar to the treated units, as well as periods that are, on average, similar to the treated periods (Arkhangelsky et al., 2021). As a result, SDID creates a parallel trend for the post-exposure period based on the most aligned un-treated units and periods of the pre-exposure period. Lastly, this trend is compared to the treated group and is used to calculate the estimated effect of the treatment.

4.2.4 Research Design

The event study is structured to test the trade flow from both THs and cocaine-trafficking countries. As we have identified that Belgium's import of cocaine started to rise in 2013, the period between 2013 and 2019 will be the treatment period for our event study. Thus, an increase in the import of goods related to ML in this period could be connected to the sudden rise in cocaine imports. The import data for each trade flow will be aggregated and sorted into the four product groups previously presented. This allows us to test each potential ML source and evaluate the trends for Belgium after 2013. The European and shipping groups are used as control groups to isolate the effect of increased cocaine imports to Belgium.

The SDID estimator gives point estimates and confidence intervals for each product group for the tested trade flows. Additionally, using two different control groups results in 16 different estimates. The point estimate will show an average yearly change after 2013. In the cases of the confidence interval not including the value of zero, the SDID can give a significant estimate of an increase or decrease in imported goods compared to the control groups. The analyzed trade flows will be structured into two hypotheses:

Hypothesis 1:
Belgium has significantly increased imports of goods associated with money laundering from tax havens.

Hypothesis 2:
Belgium has significantly increased imports of goods associated with money laundering from cocaine-trafficking countries.

The discussion for each hypothesis is conducted through all four product groups. Proving or disproving each hypothesis will answer the research question on detecting ML through trade flow analysis.

Section 5 – Results

5.1 Trade Flow Analysis – Imports from Tax Havens

In this section, we test the first hypothesis to see whether there is an increase in the import of goods linked to ML in Belgium. In table 2, the SDID results from testing imports from THs are displayed.

Imports to Belgium from Tax Havens – SDID Results

Product	Point Estimate (In 1000 USD)	Standard Error (in 1000 USD)	95% CI Low	95% CI High	Value of Imports (%)
European Control Countries					
Diamonds *	-1.031.810	31.223	-1.097.529	-966.090	99,9 %
Arts and Antiquities	-425	4.769	-9.225	8.375	97,0 %
Jewelry	1.586	546.376	-1.144.233	1.147.404	99,8 %
Gold	-122.506	3.038.369	-6.077.709	5.832.698	99,6 %
Shipping Control Countries					
Diamonds *	-725.245	60.599	-865.353	-607.998	100,0 %
Arts and Antiquities	-5.565	14.030	-32.655	21.525	99,8 %
Jewelry	15.330	102.646	-179.117	209.778	100,0 %
Gold	93.833	453.983	-855.687	1.043.352	95,2 %

(*) Significant at 95% CI level

Table 2: Imports to Belgium from Tax Havens - SDID Results. The first column shows the estimated effect on imported value from THs compared to the control group. Following, the Standard Error and the higher and lower 95% Confidence Interval (CI) are shown. The right column shows the total value of imports in the dataset after excluding countries with missing observations. Results are marked as significant when the 95% CI does not include the value of zero.

Results show that the import of diamonds has a significant decrease at the 5% level in the treatment period for both the European and shipping control countries. This contradicts our expectation for this trade flow. In the following, we apply further testing to see whether we can find any explanation for this decrease. The remaining products show no significant results, and thus, we won't explain these further. The results plots from non-significant findings can be found in the appendix.

5.1.1 Import Analysis of Diamonds

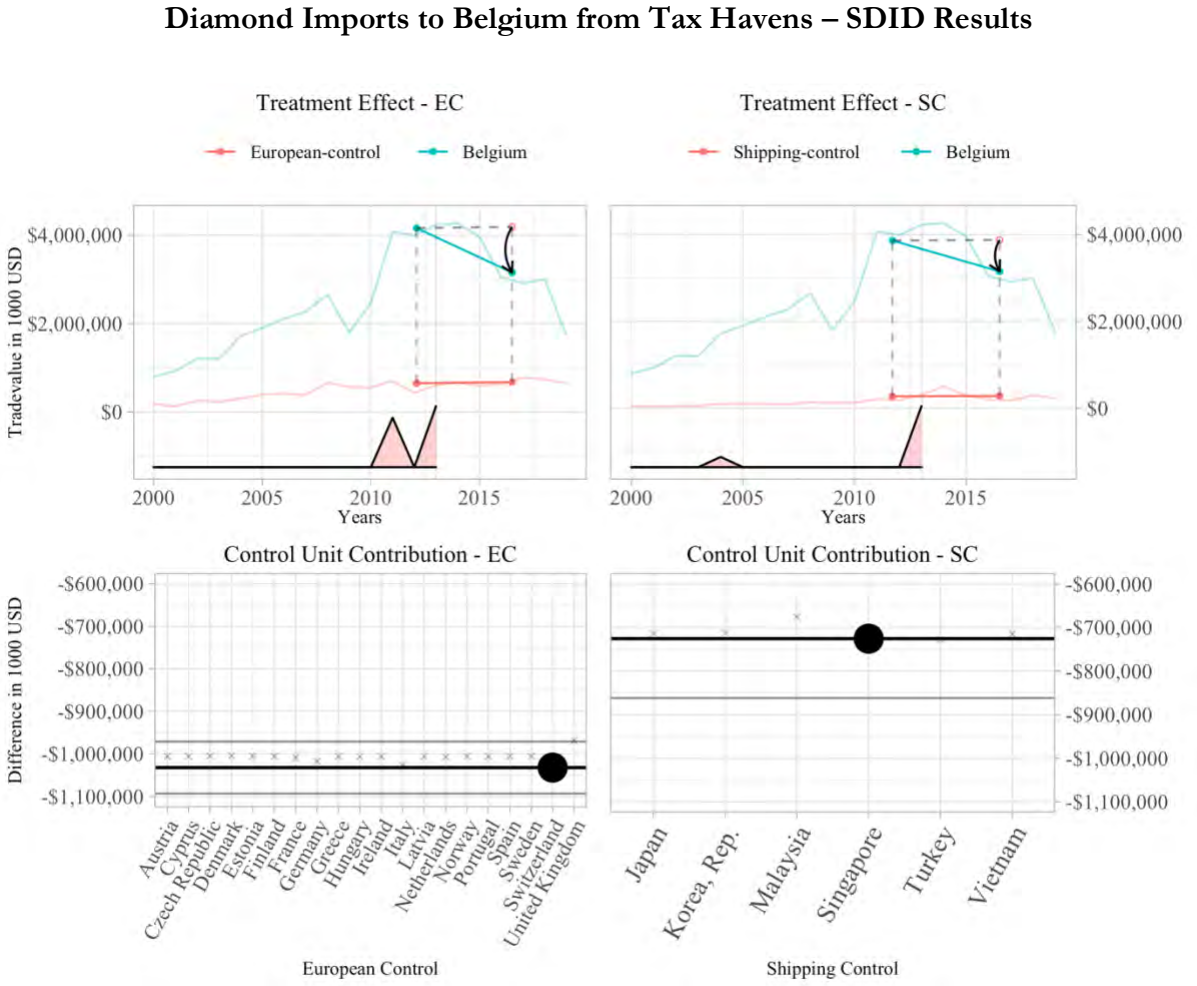

Figure 4: Diamond Imports to Belgium from Tax Havens - SDID Results. The trend in imported Diamonds from TH with the weighted average of the European Control (EC) countries is displayed in the first column. The black arrow indicates the point estimate. The period weightings are shown along the x-axis. The weightings used to average pre-treatment periods are displayed below, with the weightings expressed by the dot size and difference from the estimated effect. Observations that the SDID doesn't weigh are displayed as X. In the second column; the same information is displayed for the Shipping Control (SC) countries.

The SDID results presented in figure 1 show that Belgium has steadily imported diamonds from TH for roughly 4 billion USD from 2011 to 2015. Since 2015, the total trade value of diamonds has been halved, resulting in a negative 1 billion USD point estimate compared to the European control countries. The same trend can be seen compared to the shipping control countries, showing a 725 million USD decrease. Considering these estimates, we try to identify why Belgium has seen such a decrease in the trade of diamonds from TH in the period.

The data shows that the UAE export of diamonds to Belgium accounts for nearly half of Belgium's imports from THs. In addition, we find that the UAE exports have dropped in the same period. Thus, we remove UAE from the SDID analysis. The updated results are shown in Table 3.

Diamond Imports to Belgium from Tax Havens (UAE Excluded) – SDID Results

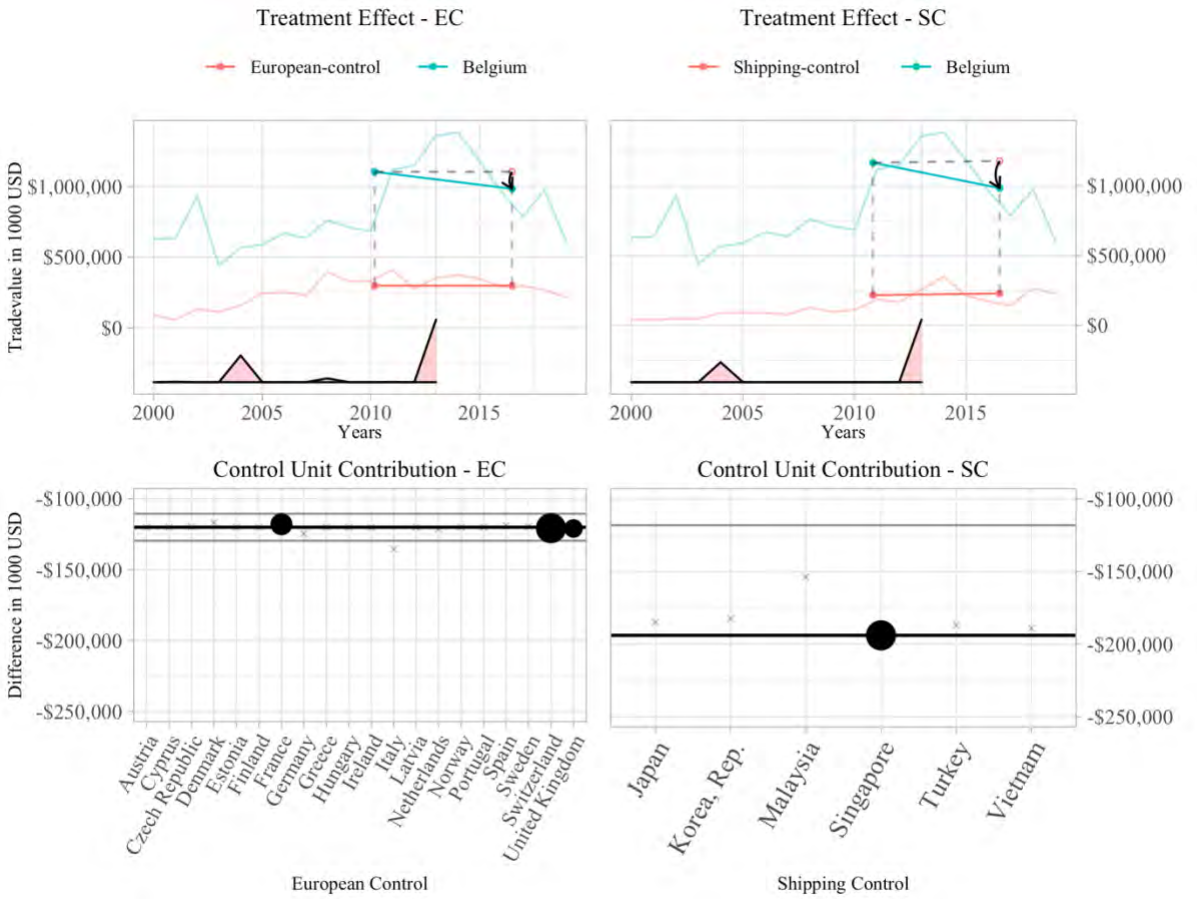

Figure 5: Diamond Imports from Tax Havens (UAE Excluded) – SDID Results. When removing the UAE, we find that UAE stands for roughly 75% of the trade flow of diamonds from tax havens. Furthermore, the UAE decline heavily impacts the results from Figure 4.

Control Group	Point Estimate (In 1000 USD)	Standard Error (in 1000 USD)	95% CI Low	95% CI High	Value of Imports (%)
European countries *	-120.122	4.531	-129.813	-110.430	99,9 %
Shipping countries *	-193.940	39.707	-273.577	-114.303	100,0 %

(*) Significant at 95% CI level

Table 3: Diamond Imports to Belgium from Tax Havens (UAE Excluded) - SDID Results. When excluding UAE, the estimates show a significant decrease at the 5% level for both control groups.

When excluding UAE, the SDID results show a significant decrease at the 5% level for both control groups. However, these estimates are relatively lower than the total value of imported diamonds from THs. The difference in estimates suggests that the UAE stands for most of the decrease seen in Figure 1.

5.2 Trade Flow Analysis – Imports from Cocaine-Trafficking Countries

In the following, we will test the second hypothesis to investigate if Belgium had an increase in the import of goods linked to ML from cocaine-trafficking countries. Table 4 shows significant increases in the import of diamonds and arts and antiquities for both control groups. Thus, we will elaborate further on these findings. As there are no conclusive results for jewelry and gold, we won't consider these results. The plots for the non-significant results can be found in the appendix.

Imports to Belgium from Cocaine-Trafficking Countries – SDID Results

Product	Point Estimate (In 1000 USD)	Standard Error (in 1000 USD)	95% CI Low	95% CI High	Value of Imports (%)
European Control Group					
Diamonds *	31.088	13.718	4.200	57.976	99,9 %
Arts and Antiquities *	2.160	711	881	3.440	98,8 %
Jewelry	-728	3.678	-7.328	5.872	99,7 %
Gold	4.059	1.154.339	-2.428.737	2.436.854	91,4 %
Shipping Controll Group					
Diamonds *	23.547	3.102	17.404	29.690	99,6 %
Arts and Antiquities *	1.504	158	1.199	1.809	99,8 %
Jewelry	-11.381	26.818	-65.998	43.235	97,5 %
Gold	176.923	137.474	-109.566	463.411	88,3 %

(*) Significant at 95% CI level

Table 4: Imports to Belgium from Cocaine-Trafficking Countries - SDID Results. Testing the second hypothesis shows significant increases in imports of diamonds and arts and antiquities from cocaine-trafficking countries. This trend is significant compared to both control groups.

5.2.1 Import Analysis of Diamonds

Import of Diamonds from Cocaine-Trafficking Countries – SDID Results

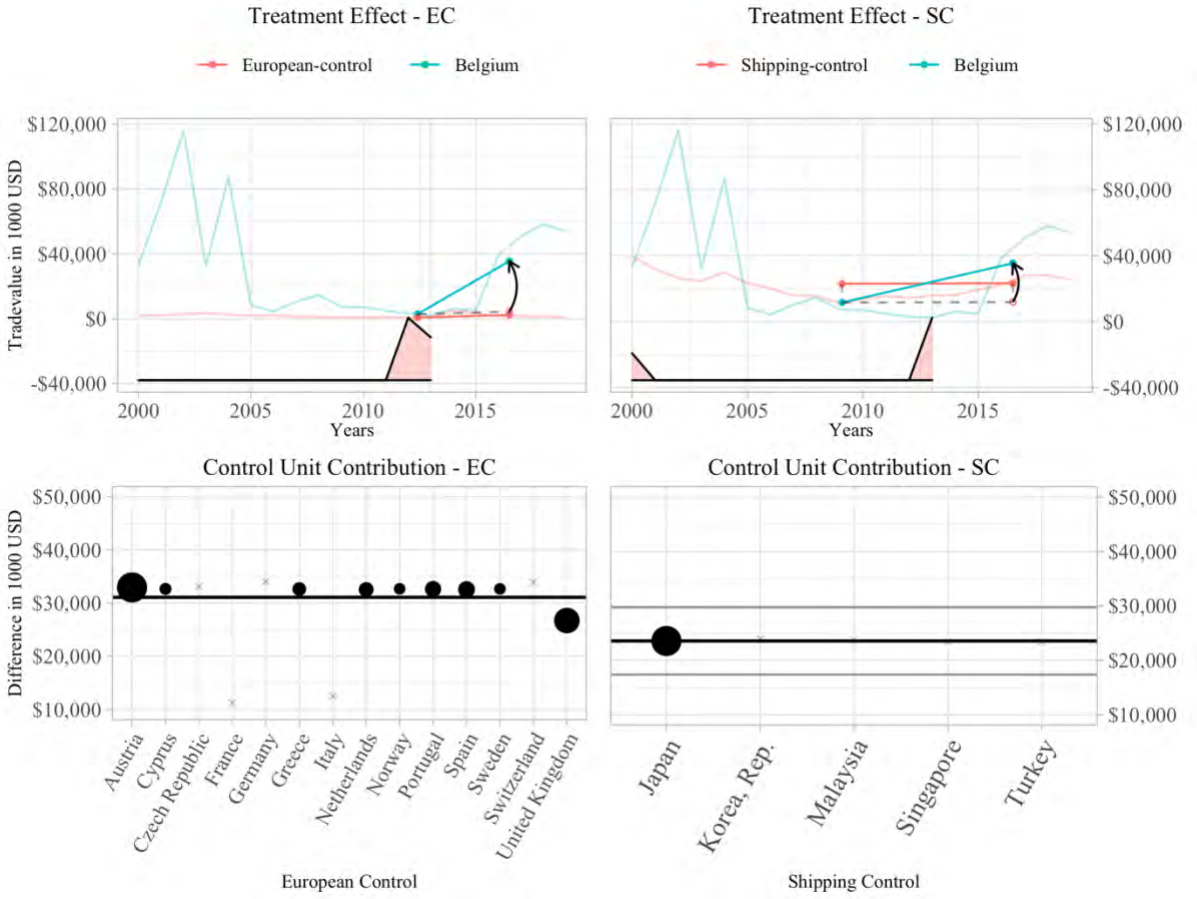

Figure 6: Import of Diamonds from Cocaine-Trafficking Countries - SDID Results. The SDID results show an out-of-norm increase in diamonds from cocaine-trafficking countries compared to European and shipping control countries.

Figure 5 shows that Belgium had some noticeable imports of diamonds from cocaine-trafficking countries in the early part of the studied period. These numbers dropped in 2005 and remained relatively steady and low until an increase starting in 2016. This gives a significantly positive point estimate compared to the European control countries at 31 million USD. However, this control group has a flat trend of import values close to zero for the whole period. The shipping control countries have more noticeable import values, and the SDID analysis shows a significant positive point estimate at 23,5 million USD.

5.2.2 Import Analysis of Arts and Antiquities

Import of Arts and Antiquities from Cocaine-Trafficking Countries – SDID Results

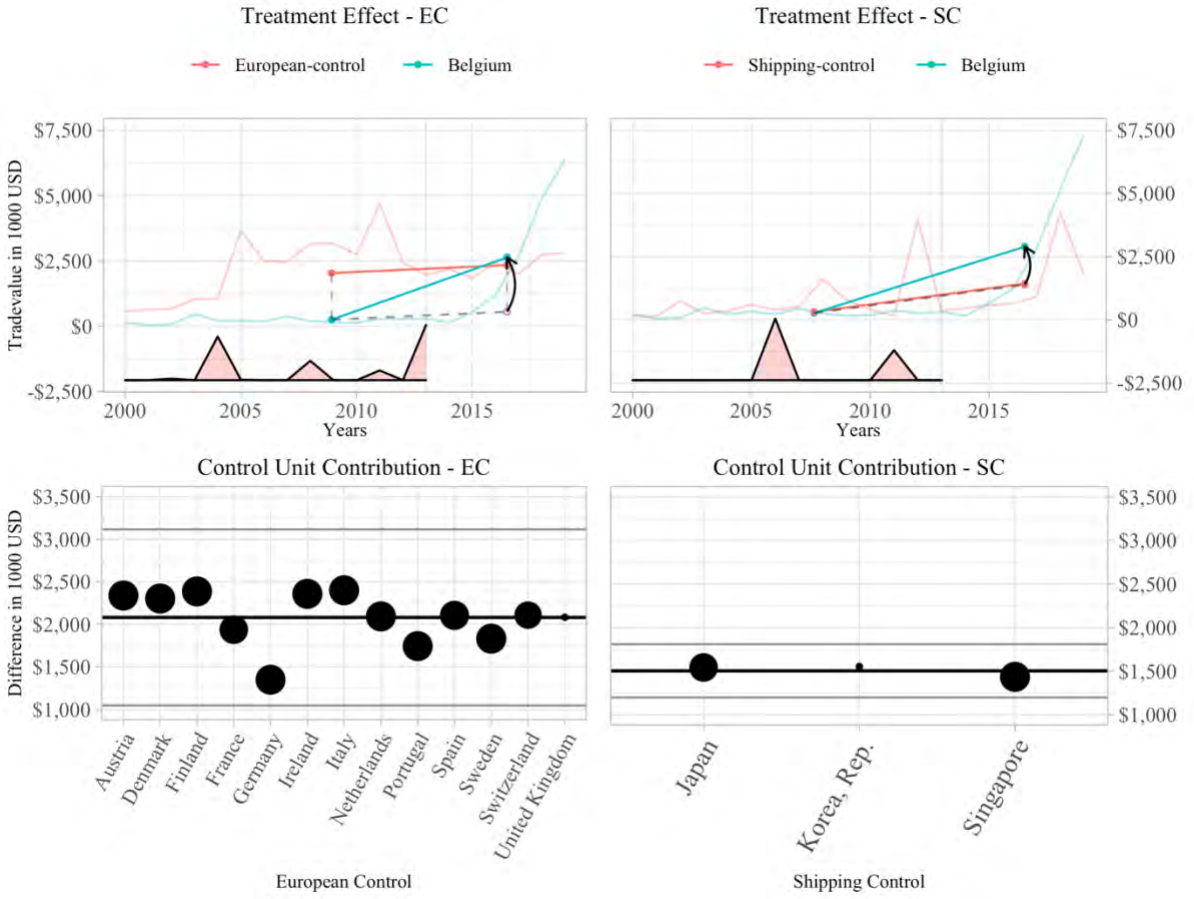

Figure 7: Import of Arts and Antiquities from Cocaine-Trafficking Countries - SDID Results. The SDID results show an out-of-norm increase in the import of arts and antiquities from cocaine-trafficking countries.

Figure 6 shows that Belgium's import of arts and antiquities from the cocaine-trafficking countries has been trending around zero until a close to exponential increase starting in 2014. This increase is significant when compared to the European and shipping control countries. The SDID results for the European control countries show a positive point estimate of 2,16 million USD. The European trend has been relatively stable since 2005 and shows no signs of change in imports of arts and antiquities in the period when cocaine imports to Europe increased.

The trend for shipping countries shows a slight increase in imports, with two spikes in 2012 and 2018. The point estimate is significantly positive at 1,5 million USD, marginally less than the European control countries. The trade of arts and antiquities is suitable for ML (Teichmann, 2017), making these findings suspicious regarding ML activities.

Section 6 – Discussion

This thesis focuses on the direct money flows from Belgium to THs and cocaine-trafficking countries. However, the web of all ML activities connected to the Belgium cocaine trade is likely to be more complicated. The Belgian share of the European cocaine market can be estimated to be worth roughly 3 billion USD (UNODC & Europol, 2021). Our findings cannot explain all the ML activities happening in Belgium. Thus, this section will discuss our results to determine whether ML can be identified by analyzing trade flows. In addition, we will elaborate on how our results can add valuable information to the larger picture of ML in Europe. Figure 14 represents the structure of this thesis and a simplified version of how ML could take place in Europe.

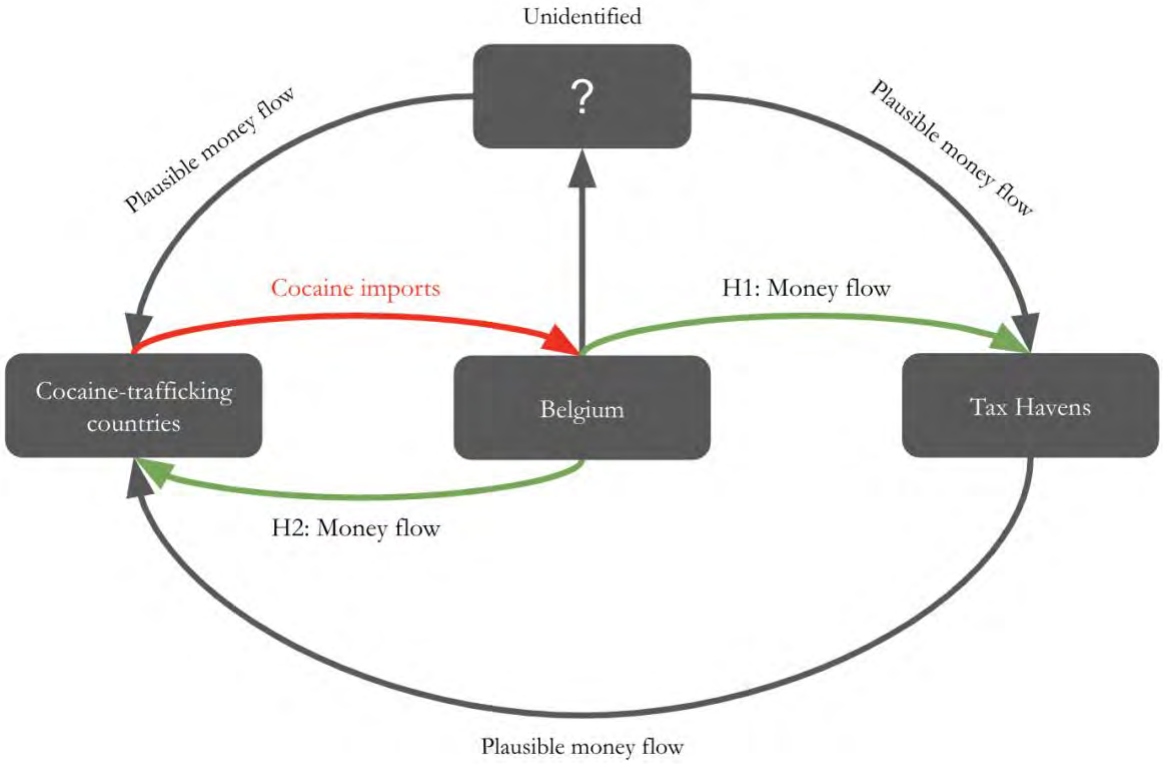

Figure 8: Plausible Money Laundering Flows. In this thesis, we have tested money flows from Belgium to tax havens and cocaine-trafficking countries. However, several unidentified money flows not explored by this thesis must exist to explain the bigger picture of ML in the European cocaine market. As criminals seek to stay undetected, there are chances that our findings are just a tiny part of the bigger picture.

6.1 Evaluation of hypotheses

Hypothesis 1:
Belgium has significantly increased imports of goods associated with money laundering from tax havens.

The results from section 5.1 show that the import of diamonds from TH countries significantly decreased, contradicting the first hypothesis. Due to the significant decrease in this trade flow, we excluded UAE to see how this would affect the results. The exclusion showed that the majority of the decline was connected to UAE. These findings can suggest that the use of diamonds for ML activities in the UAE has decreased in the treatment period. An explanation for this can be Belgium's efforts and revelations regarding conflict diamonds and ML, like the Omega Diamonds case (Merket, 2021). However, we cannot explicitly claim that this is the source of the decrease in traded diamonds. Considering these findings, we cannot reject the first null hypothesis for the import of diamonds.

The remaining product categories, gold, jewelry, and arts and antiquities, show no significant result. Thus we can not reject the null hypothesis for any products imported from THs.

Hypothesis 2:
Belgium has significantly increased imports of goods associated with money laundering from cocaine-trafficking countries.

As the results from the first hypothesis do not show signs of increased imports, we continue to test the second hypothesis. The gold and jewelry product groups do not provide conclusive evidence of increased imports from countries related to cocaine smuggling, meaning we can't reject the null hypothesis for these products. However, the remaining groups showed a significantly positive increase in imported value. The increase is significant for testing against European countries and the shipping control group. Thus, we can reject the null hypothesis for importing diamonds and arts and antiquities.

The first significant increase is the imports of diamonds from cocaine-trafficking countries.
We cannot point to specific factors facilitating this increase, as there could be numerous explanations for the observed rise in imports of diamonds. However, given the size of the Belgium diamond industry and previous revelations, an increase in the trade of diamonds can be an indicator of increased ML activities.

The second significant increase is imports of arts and antiquities. Figure 15 shows that imports from cocaine-trafficking countries have been relatively flat for most of the period we study. An exciting aspect of these findings is that as the cocaine seizures in Belgium start to rise, imports of arts and antiquities seem to follow the same trend. A plausible explanation for this can be that as OCGs have more money to launder, arts and antiquities have become an increasingly important method for ML. These results can support the claim that we can identify signs of ML by analyzing international trade flows.

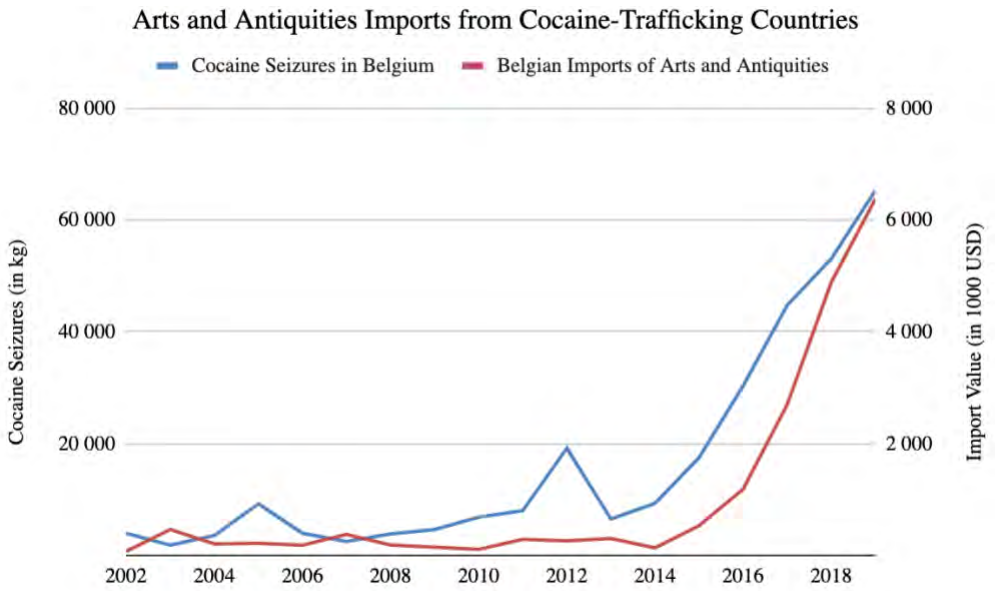

Figure 9: Cocaine Seizures vs Imports of Arts and Antiquities (UNODC & Europol, 2021)(WITS, 2022). The figure shows a plausible money laundering case in the trade of arts and antiquities between Belgium and cocaine-trafficking countries.

The results from section 5.2 support the claim that we can identify ML by analyzing international trade flows. However, there are some considerations to take into account when answering the research question. Firstly, the research method can't determine if the observed increase stems from ML or other market factors. It can only identify product groups that have had an out-of-norm rise compared to the trend of control groups used. However, this method can locate suspicious movements within international trade flows regarding ML activities.

Considering the economic size of Belgian cocaine imports, our findings cannot explain all the ML occurring in Belgium. Therefore, one must look at alternative ways that ML could happen outside of our area of research. Figure 8 shows an unidentified trade flow that must exist to explain how illegal revenue from the cocaine trade is laundered. Considering the complexity of the criminal landscape in Europe, OCGs located in countries like the Netherlands, Albania, and Italy can use Belgium as their import location. The payment for the product can therefore be coming directly from these countries. Other ways can be that the money moves out of Belgium via other countries to be rerouted back to the cocaine-producing countries. Sophisticated ML methods like these can be hard to detect by analyzing international trade flows.

As our thesis has identified two plausible cases of increased ML activities, further research could expand the analysis to more products. In the case study of Belgium, we have focused on products stemming from Teichmann's (2017) work. However, in theory, all kinds of products and services can be used for ML activities. The work of Zdanowicz (2009) supports this claim by identifying plausible ML cases in the international trade of many different products. Expanding the combinations of trade flows and products allows further research to narrow down global trade data to identify specific trade flows and products with an increased risk of involving ML activities.

Section 7 – Conclusion

This thesis has explored if money laundering can be detected by analyzing trade flows. We have conducted a case study in Belgium to answer this question, given the recent increase in cocaine imports. Two hypotheses were tested by using the synthetic difference-in-differences method. We tested Belgian imports of products associated with money laundering, as proposed by Teichmann (2017), from cocaine-trafficking countries and tax havens.

The results showed that Belgium had had an out-of-norm increase in imports of diamonds, arts, and antiquities from cocaine-trafficking countries in the period of increased cocaine imports. These findings give indications that organized criminal gangs might use the method of over-invoicing imports of diamonds, arts, and antiquities to pay or launder proceedings from the cocaine trade in Belgium. Given the sizable increase and the products associated with money laundering, we conclude that it is possible to detect money laundering trends by analyzing trade flows. Additionally, we find a significant decrease in the import of diamonds from tax havens, suggesting that criminals might have moved away from this method of money laundering.

The combined use of the synthetic difference-in-differences estimator and trade data can identify unusual changes in trade flow but cannot prove the cause. This implies that the method used only functions as a comprehensive tool to provide insight into suspicious trading activities within different countries and products regarding money laundering. Thus, further research should be conducted on the cause of these increases. Additionally, the method could be expanded to include more products and applied to different countries to narrow down potential cases of money laundering activities.

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Appendices

Appendix A Descriptive Statistics of International Trade Data

ReporterName		**Year**		**ProductCode**		**TradeValue in 1000 USD**	
Length	: 29339	Min.	:2000	Min.	:6671	Min.	:0
Class	:character	1st Qu.	:2005	1st Qu.	:8962	1st Qu.	:2
Mode	:character	Median	:2011	Median	:8972	Median	:17
		Mean	:2010	Mean	:8553	Mean	:15150
PartnerName		3rd Qu.	:2015	3rd Qu.	:8973	3rd Qu.	:207
Length	: 29339	Max.	:2019	Max.	:9710	Max.	:16383902
Class	:character						
Mode	:character						

Table 5: Descriptive Statistics of International Trade Data

ReporterName Observations per Country

Austria	Belgium	Bulgaria	Croatia	Cyprus
1060	2433	173	238	332
Czech Republic	Denmark	Estonia	Finland	France
596	796	245	499	1785
Germany	Greece	Hungary	Iceland	Indonesia
1913	388	335	275	271
Ireland	Italy	Japan	South Korea	Latvia
749	1546	1199	1027	193
Lithuania	Luxembourg	Malaysia	Malta	Netherlands
190	257	615	252	1147
Norway	Poland	Portugal	Romania	Singapore
591	515	595	15	966
Slovakia	Slovenia	Spain	Sweden	Switzerland
298	278	1577	903	2194
Turkey	United Kingdom	Vietnam		
683	1926	284		

Table 6: Number of Observations per Country – Control Groups

PartnerName Observations per Country

Albania	Antigua and Barbuda	Bahamas
424	80	286
Bahrain	Barbados	Bermuda
627	152	203
Bolivia	Brazil	British Virgin Islands
548	3267	293
Cayman Islands	Colombia	Dominican Republic
210	1665	767
Ecuador	Guam	Hong Kong
772	160	5719
Jamaica	Mauritius	Mexico
192	1247	2671
Palau	Panama	Paraguay
14	531	221
Peru	Singapore	Trinidad and Tobago
1855	3402	189
United Arab Emirates	Vanuatu	Venezuela
3038	113	693

Table 7: Number of Observations per Country – TH and Cocaine-Trafficking Countries

Appendix B List of Tax Havens

Tax Havens	OXFAM	FATF	EU	IMF	OECD
Albania	✓	✓			
Antigua and Barbuda	✓				✓
Bahamas	✓				✓
Bahrain	✓				✓
Barbados		✓			✓
Bermuda	✓			✓	
British Virgin Islands	✓			✓	
Cayman Islands	✓			✓	
Guam	✓		✓		
Hong Kong	✓			✓	
Malta	✓				✓
Mauritius	✓	✓			
Palau	✓		✓		
Panama		✓	✓		
Singapore	✓			✓	
Trinidad and Tobago	✓		✓		
United Arab Emirates	✓				✓
Vanuatu	✓		✓		✓
Virgin Islands	✓		✓		
	(Oxfam, 2020)	(FATF, 2022)	(EU, 2017)	(IMF, 2018)	OECD(2022)

Table 8: List of Tax Havens (WorldData, 2022). The table shows our defined tax havens in the left column. We define a country as a tax haven if they appear in two or more lists. This definition should include the Netherlands, Ireland, and Luxembourg. However, they are excluded due to being a part of Europe's open market.

Appendix C List of Cocaine-Trafficking Countries

Cocaine-Trafficking Countries	
Bolivia	Mexico
Brazil	Panama
Colombia	Paraguay
Dominican Republic	Peru
Ecuador	Trinidad and Tobago
Jamaica	Venezuela

Table 9: List of Cocaine-Trafficking Countries (EMCDDA & Europol, 2019)

Appendix D List of Control Groups

European Control Countries	
Austria	Liechtenstein
Bulgaria	Lithuania
Croatia	Luxembourg
Cyprus	Malta
Czech Republic	Netherlands
Denmark	Norway
Estonia	Poland
Finland	Portugal
France	Romania
Germany	Slovakia
Greece	Slovenia
Hungary	Spain
Iceland	Sweden
Ireland	Switzerland
Italy	United Kingdom
Latvia	

Table 10: List of European Control Countries

Shipping Control Countries	
Japan	Singapore
Malaysia	South Korea
Phillipines	Turkey

Table 11: List of Shipping Control Countries

Appendix E Additional SDID Results

This section presents the treatment effect and control unit distribution plots with no significant results from sections 5.1 and 5.2.

Import of Arts and Antiquities from Tax Havens – SDID Results

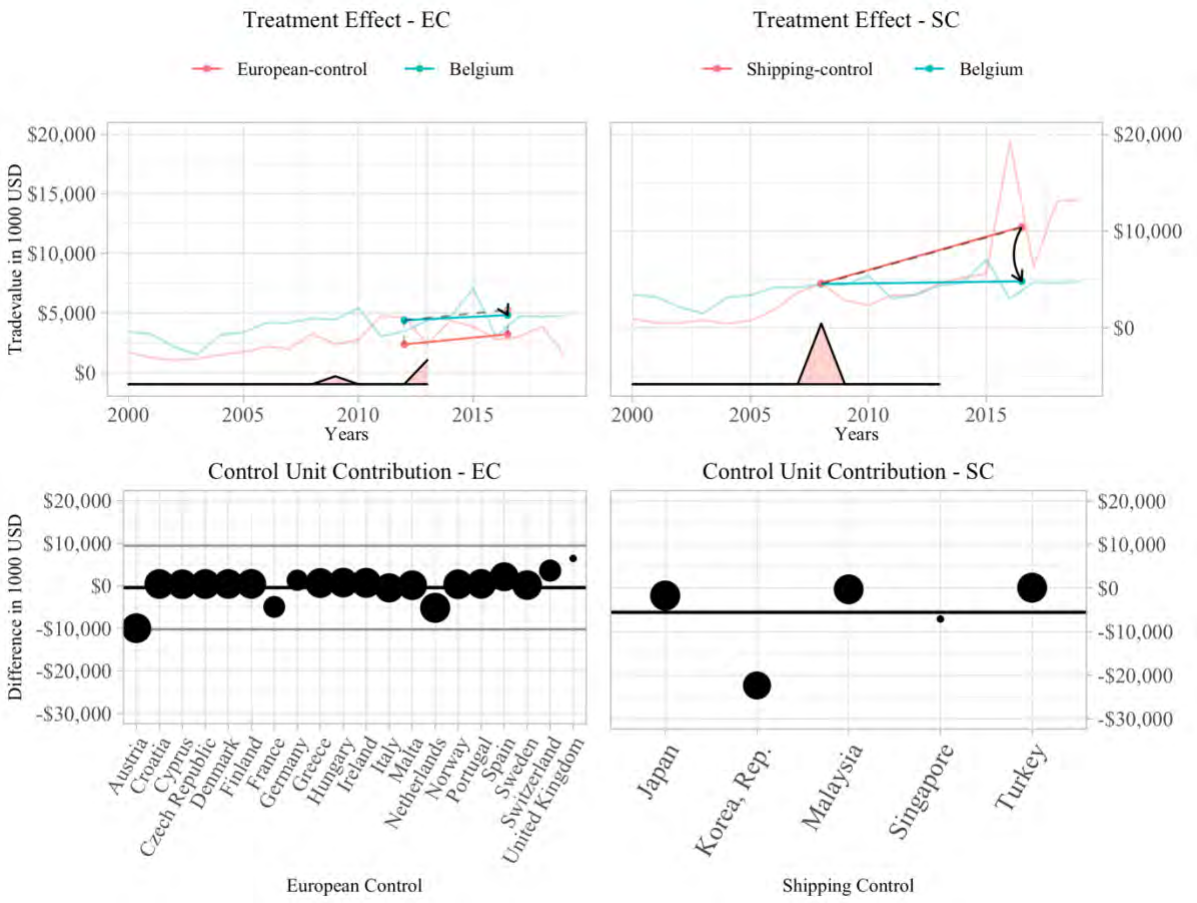

Figure 10: Import of Arts and Antiquities from Tax Havens – SDID Results. The left columns show a non-significant point estimate of - 425 000 USD with a standard error of 4,8 million USD. The right columns show a non-significant point estimate of – 5,6 million USD with a standard error of 14 million USD.

Import of Jewelry from Tax Havens – SDID Results

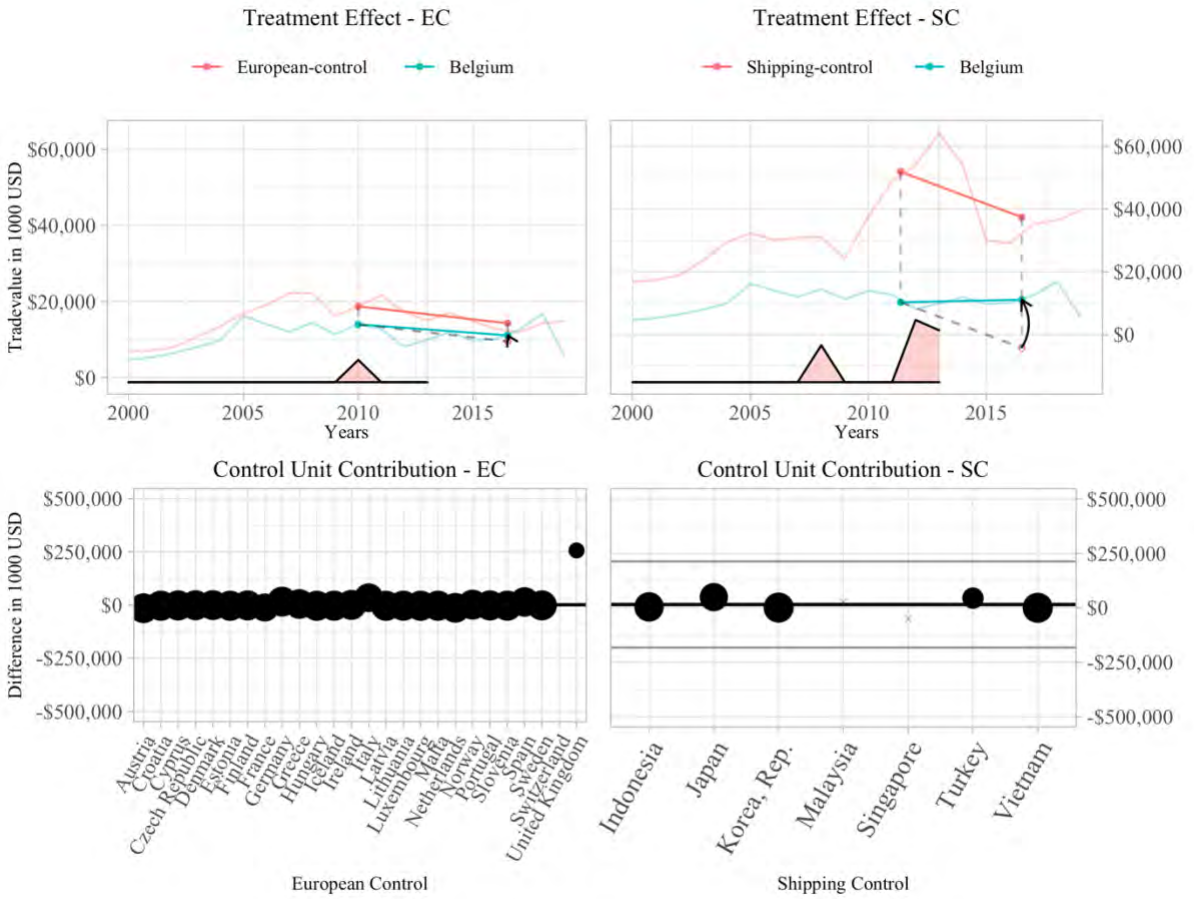

Figure 11: Import of Jewelry from Tax Havens – SDID Results. The left column shows a non-significant point estimate of 1,6 million USD with a standard error of 550 million USD. The right column shows a non-significant point estimate of 15,3 million USD with a standard error of 103 million USD.

Import of Gold from Tax Havens – SDID Results

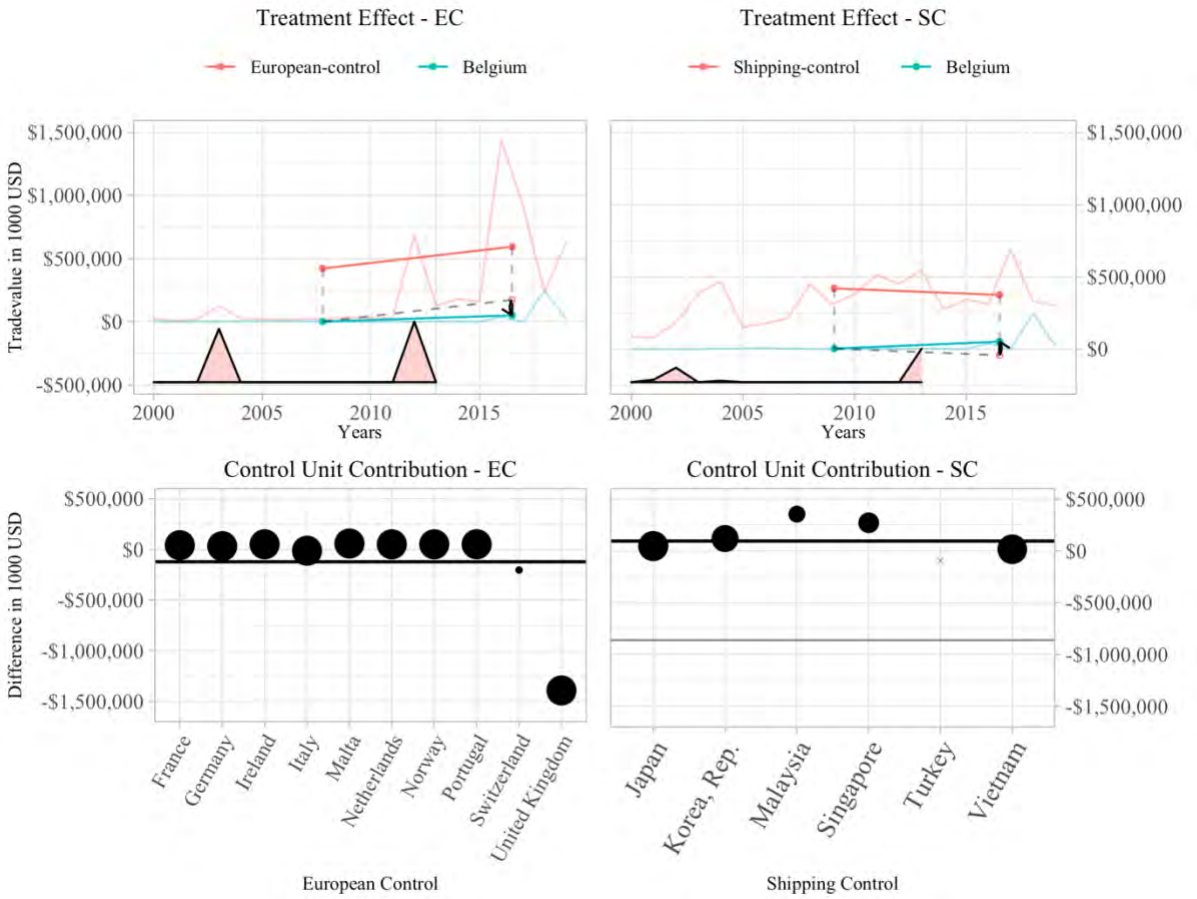

Figure 12: Import of Gold from Tax Havens – SDID Results. The left column shows a non-significant point estimate of – 122,5 million USD with a standard error of 3 billion. The right column shows a non-significant point estimate of 93,8 million USD with a standard error of 454 million USD.

Import of Jewelry from Cocaine-Trafficking Countries – SDID Results

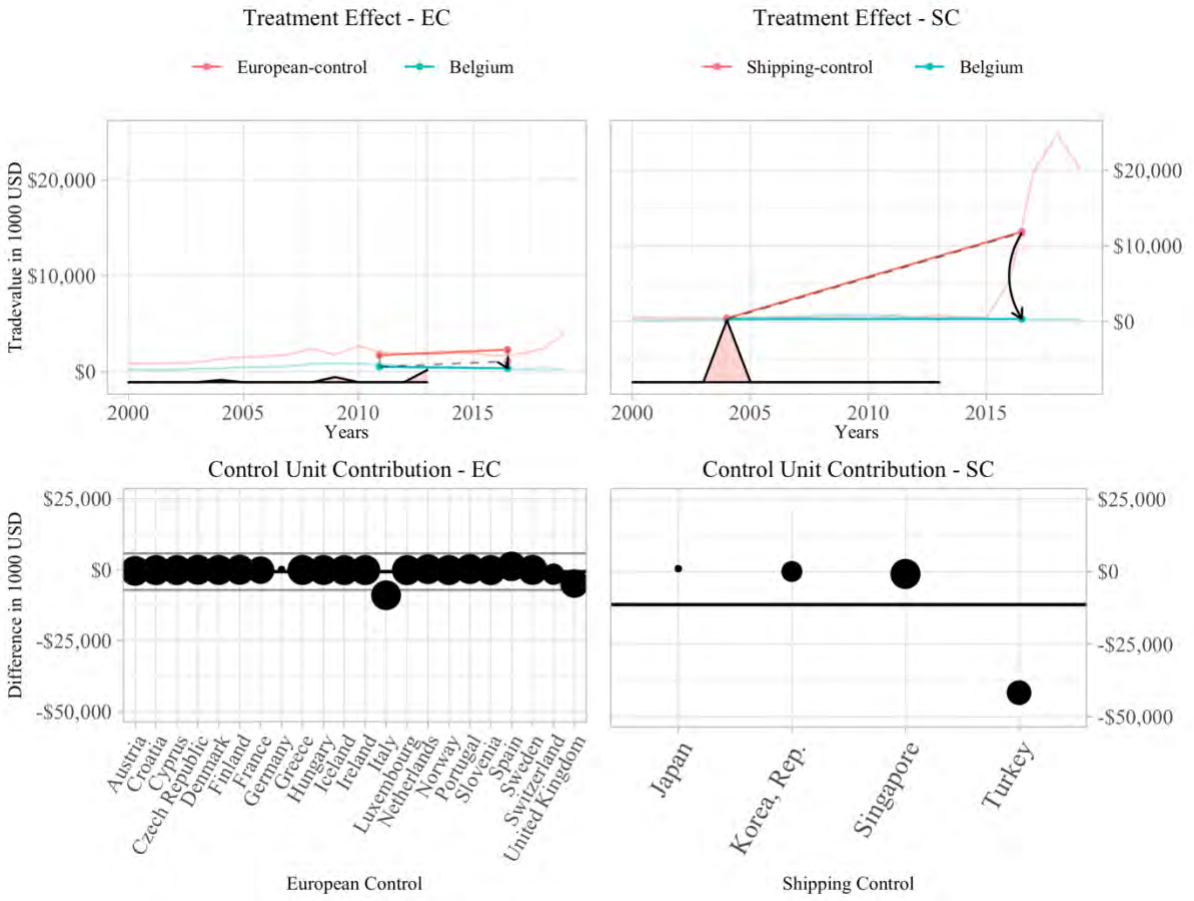

Figure 13: Import of Jewelry from Cocaine-Trafficking Countries – SDID Results. The left column shows a non-significant point estimate of – 728 000 USD with a standard error of 3,7 million USD. The right column shows a non-significant point estimate of – 11,4 million USD with a standard error of 26,8 million USD.

Import of Gold from Cocaine-Trafficking Countries – SDID Results

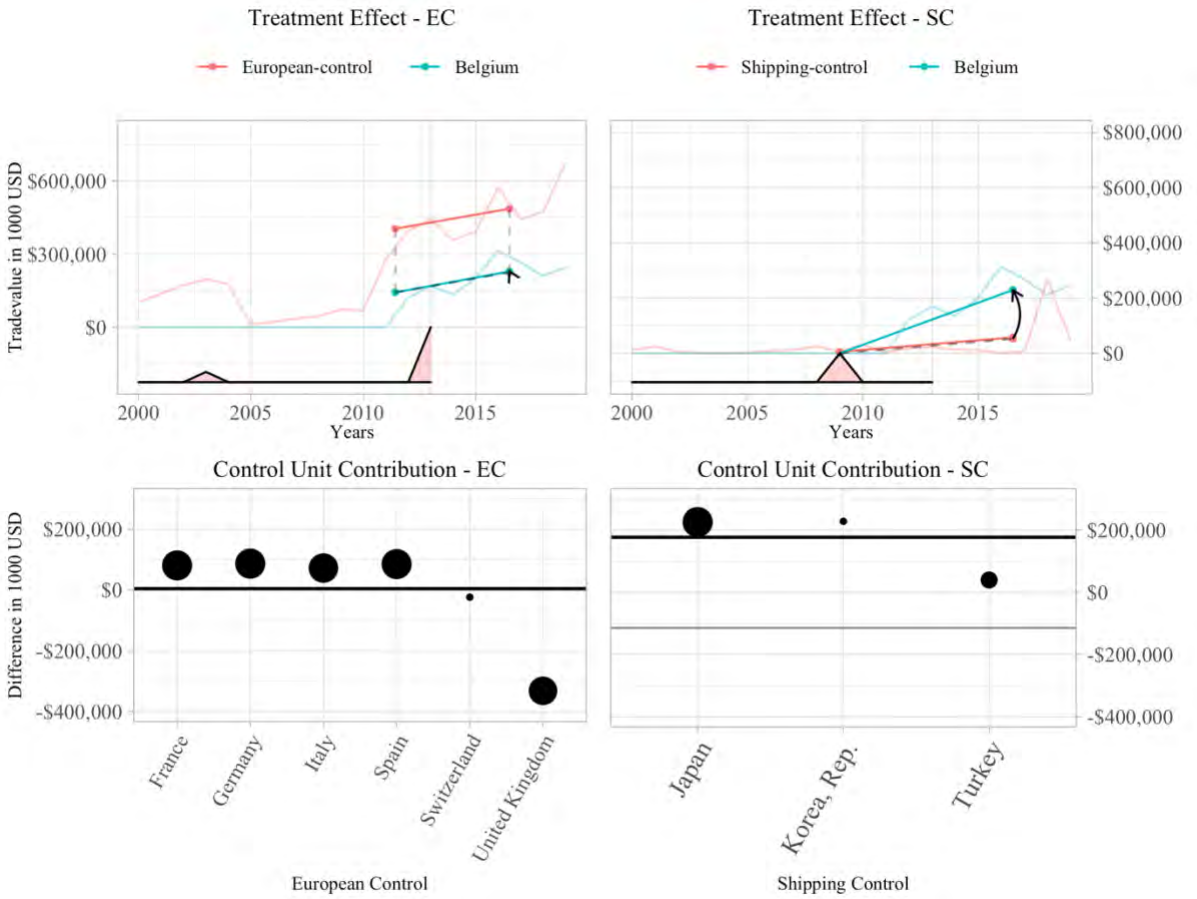

Figure 14: Import of Gold from Cocaine-Trafficking Countries – SDID Results. The left column shows a non-significant point estimate of 4 million USD with a standard error of 1,15 billion USD. The right column shows a non-significant point estimate of 177 million USD with a standard error of 137 million USD.