Foreign Currency as a Barrier to International Trade: Evidence from Brazil

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Abstract

I study the role of foreign currency risk in affecting export behavior. The dominant role of the United States Dollar in the international payments system exposes many emerging market firms to exchange rate risk in international trade due to unexpected movements in prices paid in local currency. In 2008, Brazil and Argentina agreed to a "Local Currency Payments" (SML) system, which allowed exporters and importers to operate in their own local currencies. This system was responsible for nearly 10% of exports from Brazil to Argentina by 2012. I estimate the effect of eliminating foreign currency risk via the SML system by leveraging plausibly exogenous municipal variation in access to authorized financial institutions. Using a triple difference design, I find that municipalities with high access to the SML system exported 22% more to Argentina relative to other South American export destinations compared to municipalities with low access. Applying estimates of the trade elasticity from the literature, this effect is equivalent to reducing trade barriers by approximately 10%. I complement this finding with a firm-level analysis using confidential customs data. Export transactions through the SML system were on average 44% larger than otherwise similar transactions. In a stylized model of export behavior, I discuss these results as stemming from export frictions such as risk aversion or currency fees.

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1 Introduction

Emerging market firms frequently use foreign currency to buy and sell goods abroad, exposing them to exchange rate risk due to movements in prices paid in local currency. This exchange rate risk can be large both because the overwhelming majority of export transactions in emerging markets rely on the United States Dollar (USD) and because emerging markets' exchange rates are known to experience high volatility. Although there is a substantial body of evidence detailing how unexpected movements in exchange rates affect export behavior, we know comparatively less about the effects of foreign currency risk itself.

A potential reason for the omission of the effects of exchange rate risk is the observed stability of invoicing decisions. Empirically, there is almost no variation, let alone exogenous variation, with which to estimate the causal effect of exchange rate risk. Recent evidence has found this to be true both for individual firms and for entire countries (Gopinath, 2016; Amiti et al., 2018). Theoretically, international macroeconomic models mainly focus on the effects of exchange rate pass-through, or the relationship between prices and exchange rates. These models typically do not assume any first-order effects from the choice of invoicing currency. There is therefore no clear answer as to whether the usage of foreign currency limits emerging market firms in trading abroad due to exchange rate risk.

This paper estimates that the effect of exchange rate risk on export volumes is large. I leverage the introduction of a policy change in Brazil, the "Local Currency Payments" (SML) system.[1] This payments system reduced reliance on foreign currency by Brazilian exporters and Argentine importers and accounted for nearly 10% of the total value of exports from Brazil to Argentina by 2012. Using financial and customs data in Brazil, this paper estimates the effect of reducing exchange rate risk is similar to lowering variable trade costs by between approximately 10%. I do so using two different research designs. First, I leverage municipal variation in access to SML-authorized financial institutions. Second, I complement this evidence with disaggregated confidential customs data. In the last part of this paper, I argue in a stylized model that the reduction of exchange rate risk worked by shifting out demand for Brazilian exports by risk-averse Argentine importers.

Exporters and importers whose international trade is invoiced foreign currency face exchange rate uncertainty relative to firms from advanced economies, such as the United States, that can operate in their own currencies. In most cases, emerging market firms invoice the price in a vehicle currency, typically the United States Dollar (USD), and agree to the size of the export shipment as well as the invoice price. Importantly, the exchange of payments,

[1] The acronym SML comes from the Portuguese "Sistema de Pagamentos em Moeda Local".

especially the foreign exchange transaction, may take place long after shipment. To the extent that the value of the invoice currency changes, the price paid or received in the importers or exporters currencies may also change. This gives rise to risk from exchange rate movements based on the currency of invoicing.

The introduction of the SML system between Brazil and Argentina in 2008 reduced reliance on foreign currency for Brazilian exporters and increased the share of Brazilian exporters invoicing in their home currency. By opting into the system, Brazilian exporters would receive revenues directly in their currency, the the Brazilian Real (BRL), while Argentine importers paid directly in their currency, the Argentine Peso (ARS). As part of the requirements to use the SML system, exporters in Brazil were required to invoice the export in their local currency, the Brazilian Real (BRL). The central banks of the two countries manage the exchange of currencies between the two firms. The introduction of the SML system led to a large increase in the share of exports from Brazil to Argentina that were invoiced in BRL, which went from essentially 0% prior to the introduction of the program to slightly less than 10% by 2012.[2]

I leverage multiple empirical strategies to provide complementary evidence on the effects of foreign currency risk. First, using variation in municipalities' historical access to SML-eligible financial institutions, I estimate the causal impact of SML using a triple differences design. I define access by calculating the share of corporate loans within a municipality that come from SML eligible financial institutions. This approach then amounts to comparing changes in relative exports to Argentina between high- and low-access SML municipalities. Under a parallel trends assumption, that I can provide suggestive evidence for, I provide municipal-level evidence of the effect of the elimination of exchange rate risk.

I find that municipalities with high shares of corporate loans by SML authorized banks saw exports rise by approximately 20% relative to municipalities with low SML corporate loan shares. The lack of any obvious pretrends provides suggestive evidence that in the absence of the SML system, the the growth of export volumes to Argentina would have developed similarly. Using estimates of the elasticity of substitution from Broda and Weinstein (2006), this rise in export volume is equivalent to reducing trade costs by approximately 10%.

In a second approach, I provide firm-level evidence of the effects of foreign-currency risk. Because exporters that used the SML system were required to invoice in BRL, I study the

[2]In this paper, I focus on Brazilian exports to Argentina, rather than Argentine exports to Brazil. Takeup of the SML system by Argentine exports was close to zero. In the conclusion, I offer some reasons for this lack of takeup, specifically that Argentine monetary policy is much more volatile than Brazilian monetary policy, leading Argentine exporters to prefer to received USD. The variation I exploit in my empirical analysis is orthogonal to such effects, which allows me to estimate the effects on export behavior.

change in BRL invoicing behavior. I use confidential shipment level data available from the Brazilian customs administration that records detailed information about international trade including the invoicing currency. First, I investigate the types of firms that took up the SML system. Unlike other papers that lack temporal variation in the currency of invoicing, I am able to leverage a large change in invoicing behavior following the introduction of the SML system in Brazil. Prior to the introduction of the SML system, the usage of the BRL in exports to Argentina was effectively zero. By 2012, the share of exports invoiced in BRL had gradually risen to nearly 10%. Such a large increase has not been observed in other studies of invoicing behavior. The rise in BRL usage creates time-variation in invoicing shares that permit an analysis of the effect of invoicing currency on trade. Argentina is one of the largest trading partners of Brazil, so the overall share of firms using BRL is noticeable, albeit small.[3]

Perhaps surprisingly, the time variation in the currency of invoicing is not specific to any individual sector or firm characteristic. Commodity exports, such as raw minerals, saw the same rise in BRL invoicing as differentiated goods. Such a result contrasts with ideas that, since commodities are traded on international exchanges and priced in USD, exporters prefer to invoice in USD as well. While smaller firms more exposed to Argentina were most likely to switch to invoicing in BRL, larger firms exporting to over ten countries also switched.

I then exploit variation both across time and across destinations in the invoicing decision by Brazilian exporters to estimate the effect of foreign currency risk. I do so by leveraging the highly disaggregated customs data and using a restrictive fixed effect design that aims to control for any endogenous selection effect, both at the individual firm-sector level and over time by sector and destination. Specifically, I include firm-sector fixed effects to control for time-invariant determinants of selection as well as sector-time and destination-time fixed effects to control for aggregate demand and cost shocks. Under the assumption that the endogenous selection effect is time-invariant at the firm-sector level, this specification identifies the causal effect of the elimination of foreign currency risk on trade.

I find that that eliminating foreign currency usage via the SML system has a large positive effect on firms' exports. For an individual firm-sector, switching to BRL-invoiced shipments to Argentina raises the size of the shipment by approximately 0.44 log points relative to exports to other locations. This effect is not driven by changes in sectoral composition or overall destination-specific export growth. Additionally, I find essentially no effect on relative

[3]Much like other emerging market countries, I document that Brazil heavily relies on the United States Dollar (USD) for most of its external trade: over 90% of exports are invoiced in USD. This fraction is relatively stable both across countries and in the years before the introduction of the SML system.

prices, suggesting that transaction costs or hedging as a function of the shipment size is unlikely to be the mechanism at work. This increase in trading volume is reflected in overall firm exports. BRL-invoicing firms increase the share of sales to Argentina by around 22 percentage points. There does not seem to be any cannibalism of exports to other export destinations. Aggregating across all destinations, I show that while firms that switch to BRL invoicing had a higher share of sales towards Argentina, this did not come at the expense of exports to other destinations.

I also perform a series of heterogeneity analyses to understand which firms benefited most from the SML system. While firms of a wide variety of sectors and sizes used the SML system, the benefits accrued almost exclusively for firms in non-commodity sectors with a high share of exports to Argentina. This result suggests that models of imperfect competition and price setting, ubiquitous in international macroeconomics, are likely to be able to capture the main effects of the SML system.

I investigate potential concerns in each approach in a series of robustness checks. For the municipality evidence, the presence of SML eligible financial institutions may be endogenous to local firms' export behavior to Argentina. Specifically, firms may have petitioned their financial institutions to become authorized to use the SML system due to the anticipation of higher sales to Argentina. In a robustness check, I drop municipalities that account for a large share of a financial institutions' loan portfolio, and find similar results. Additionally given the timing of the SML system, it may simply be the case that SML authorized institutions may have been more resilient to changes in global economic conditions, either due to the collapse in trade or the global financial crisis. While the regression design mostly accounts for this issue by comparing exports to Argentina relative to South America across municipalities, it still may be the case that heterogeneity across the control group masks differential effects of global economic conditions across export destinations. In placebo tests to other South American countries, there is no significant effect of the SML system on export behavior, suggesting that the SML shares I calculate are not simply capturing resiliency to global economic conditions.

For the customs-level evidence, which relies on fixed effects to control for selection effects, it may be the case that the determinant of policy takeup varies at the firm-time level. In robustness checks, I show that results are relatively unchanged when including firm-time dummies, which aim to control for time varying, unobserved determinants of selection into the SML system at the firm level. I also instrument the decision to invoice in BRL with the an instrument that captures whether a firm exporting to Argentina is in a municipality with a high or low SML banking share. I find that the estimates are attenuated only slightly,

suggesting that the selection effect, although small, biases estimates upwards. However, the 2SLS point estimates are imprecise at the firm level, so these robustness results should be interpreted with caution.

In the last part of this paper, I argue that the effect of the SML system was to shift out both importer demand and export supply. Workhorse models of currency choice, such as Gopinath et al. (2010) or Casas et al. (2016) emphasize that exchange rate movements affect demand only through relative price movements. While firms choose their invoicing currency based on maximizing expected profits in a sticky price environment, final demand is only determined by the exchange rate adjusted local price. I instead present a stylized model of exports, and discuss potential mechanisms by which the SML system works. In particular, I emphasize the role of risk aversion or the depth of financial markets. While the SML system likely only reduced uncertainty for exporters (given the way the SML system worked), both importers and exporters could benefit from avoiding foreign currency, which may come with additional costs. I also discuss how to microfound such frictions.

Literature Review

This paper contributes to three strands of literature. First, this paper contributes to the literature in international macro on the effects of invoicing currency. Most work in this area focuses on exchange rate pass through, or the response of border prices and export volumes to unexpected movements in the exchange rate, given the influential argument by Friedman (1953) that exchange flexibility can be a source of needed relative price adjustment in response to negative economic shocks. In their survey of the literature, Burstein and Gopinath (2014) emphasize that the relationship between bilateral exchange rates and prices exhibits incomplete pass-through over time, with substantial heterogeneity across countries. Part of this incomplete pass-through is due to the dominant role of the USD in international trade (e.g. Gopinath (2016) or Cravino (2017)), and part is due to the role of strategic complementarities in pricing (e.g. Amiti et al. (2014)). My paper builds on this work by arguing that not only does the role of the USD affect relative price adjustment, but that it also limits trade directly.

Theoretically, international macroeconomic models studying invoicing currency have also emphasized the role of relative price adjustment by monopolistically competitive firms as influencing invoicing decisions. Early work in this area, such as Obstfeld and Rogoff (1995) or Betts and Devereux (2000) have studied how invoicing currency affects optimal monetary policy, but takes the invoicing decision as given. Recent advances, such as Engel (2006), Gopinath et al. (2010), and Mukhin (2018) have argued that currency choice is endogenous

and determined by minimizing variation around optimal prices. These papers assume currency choice does not have any first-order effect on profits, and that trade volumes only move in response to relative price movements. My paper tests this assumption and studies how invoicing currency, specifically risk around the realized price, can have first-order effects on export volumes without relative price movements. More recently, papers have begun to investigate the effects of firm invoicing on other firm-level outcomes. For example, Barbiero (2020) studies how currency mismatch between foreign currency import payments and export revenues may result in valuation effects that can affect investment. I build on this literature by leveraging time variation in invoicing currency to investigate first-order effects on international trade.

Second, this paper contributes to the vast literature in international trade on trade costs. While many papers have investigated the importance and sources of trade costs (see Head and Mayer (2014) for a survey), this paper specifically relates to how the usage of foreign currency may affect trading volumes. In their study of Canadian export determinants, Goldberg and Tille (2016) find that high exchange rate volatility of the Canadian dollar relative to the exporter's currency reduces the usage of that exporter's currency. Lyonnet et al. (2016) study how hedging via financial derivatives affects invoicing decisions and sales.

Other papers in international macroeconomics and international trade focus on how movements in the exchange rate may have permanent effects on trading volumes. The "beachhead effect," studied in Baldwin (1988) and Baldwin and Krugman (1989) argues that large devaluations may have persistent effects on trade if firm entry or exit decisions are affected. Later work by Devereux et al. (2019) extends this argument to forming new trade relationships. My paper relates to this strand of the literature due to its emphasis on the role of foreign exchange risk in affecting trade volumes. However, my paper emphasizes persistent effects on demand rather than market structure.

This paper also relates to the literature on trade effects of currency unions. (Rose, 2014). While the currency union literature has in some cases found large trade effects as a result of ascension to the currency union, these estimates also capture the effects of a number of other structural changes. This paper, by contrast, focuses on the role of currency only.

2 Setting and Institutional Background

> "With elimination of a third currency in direct transactions among companies, exporters will set their prices in the currency of their own countries. Thus, they will be better able to calculate their margins precisely, since they will no longer

be exposed to exchange rate risk" - Henrique Meirelles, Governor of the BCB (October 2008)

To understand how the usage of foreign currency affects export behavior, I study a policy change in Brazil that made it easier for Brazilian exporters to use the Brazilian currency, the real (BRL), to invoice trade. Latin America has a long history of managing foreign currency usage in regional trade dating back to at least the 1960s. The introduction of a new mechanism by which trade could be operated exclusively in their own currencies, the SML system, eliminated the usage of foreign currency without resorting to extreme measures such as a currency union.[4] In this section, I describe the evolution of foreign currency usage in Brazilian export trade.

2.1 A Brief History of Latin American Currency Treaties

In the 1960s, trade among Latin American countries at the time was predominantly denominated in USD owing to the lack of convertibility of many countries' currencies. So, central banks would clear international trade on a frequent and bilateral basis, meaning all banks needed constant access to dollar liquidity to make payments on behalf of importers and exporters. Latin America's long history of balance of payments difficulties and capital controls (specifically with respect to free convertibility of currency) made executing payments for international trade purposes difficult. Mathis (1969)

An early attempt among Latin American countries to rectify this problem was made through the Latin America Free Trade Agreement (LAFTA).[5] In 1965, a multilateral mechanism was created, known as the Reciprocal Payments and Credit Agreement (CPCR).[6] The CPCR accomplished two goals: it created lines of credit among Central Banks and established a multilateral settlement system among its signatories. The agreement allowed any such trade transaction, such as letters of credit or open accounts, to be settled within its mechanism. Under the 1965 system, international balances would be calculated by the Central Bank of Peru and settled bimonthly via the Federal Reserve Bank of New York. Trade was required to be in USD due to its convertibility. Firms and banks within countries would record import and export transactions with their respective central banks, who would only need to access

[4]Note that I do not discuss the Unified System for Regional Compensation (SUCRE), as neither Brazil nor Argentina are a part of it. For more information, see Caldentey et al. (2013).

[5]LAFTA was created by the 1960 Treaty of Montevideo, and had as its major focus a reduction of tariffs and the creation of a free trade area within Latin America. LAFTA replaced the The Economic Commission for Latin America (ECLA), which was created in 1948.

[6]This and the following paragraphs rely heavily on information from Flax-Davidson (1985) and Caldentey et al. (2013)

dollar liquidity a handful of times per year in order to settle cross-country balances.

LAFTA had a goal of creating an efficient trade zone with low tariffs by 1980. Failing to finalize agreements on free trade, LAFTA reorganized in 1980 into the Latin American Integration Association (ALADI) after the signing of the 1980 Montevideo Treaty. In August 1982, the Reciprocal Payments and Credit Agreement was formally extended by ALADI and operated similarly. Now, domestic financial institutions would contract directly with their central bank, paying or receiving either local currency or USD, depending on the local regulations. Net amounts among central banks would be settled at the end of four month periods.

The CPCR improves international trade by reducing reliance on foreign currency, minimizing risk, and reducing transaction costs. The lines of credit and multilateral settlement scheme limit the number of foreign currency transactions that are made by both public and private agents. It minimizes risk by having the central banks take on credit risk (ensuring that payment will be made regardless of whether the importing firm actually does) and ensuring convertibility in that the Central Bank is always willing and able to exchange local currency for the vehicle currency, typically the USD, that might not be available in private markets. Finally, it reduces transaction costs by eliminating reliance on correspondent banks that are possibly overseas. The usage of the CPCR was highest during the 1980s, although since the 1990s it has become largely unimportant. In fact, in April 2019, Brazil formally withdrew from the CPCR. [7]

Alongside ALADI, Mercosur was created in 1991 by Brazil and Argentina by the Treaty of Asunción and the Protocol of Ouro Preto in 1994. Mercosur is in some sense a specialization of ALADI with the goal of creating a common market.[8] Unlike ALADI, which focused on reducing trade barriers and promoting regional harmony, Mercosur focused additionally on, for example, building free movement of people, capital, and currency. Since, however, it has operated more as a customs union.

The development of Mercosur included discussions about a common currency for trade. Arguably the first discussions regarding establishing a mechanism for invoicing and settling bilateral trade between Brazil and Argentina without the use of foreign currency involved the Gaucho. In 1987, the presidents of Argentina and Brazil met in Viedma, Argentina and signed Protocol 20. This Protocol established the Gaucho. The Gaucho was not a common currency per se, but rather a common monetary unit created in response to large trade imbalances

[7] Link

[8] Another subregional South American cluster is the Andean Community of Nations, which involves Bolivia, Colombia, Ecuador, and Peru.

between Brazil and Argentina. Holders of Gauchos were to be penalized, encouraging usage of the currency in international Trade. However, this idea was quickly abandoned as other macroeconomic issues arose. Gardini (2011)

Over the 1990s, changes in the currency policy by Brazil and Argentina limited discussion of common currencies through Mercosur or LAIA.[9] Both economies grew and became increasingly integrated via trade. However, in 1998 the President of Argentina, Carlos Menem, suggested that Mercosur should consider a common currency. or a series of currency boards pegging Latin American currencies to the USD. Of course, a currency union is much more extreme then simply reducing exchange rate variability in regional trade. However, the idea of a Mercosur currency union was little more than an academic exercise over the following years.[10]

2.2 The SML System

In 1992, the BCB released the Consolidation of Foreign Exchange Standards (CNC)[11]. One of the implications of this regulation was that export trade by Brazil, even for exports not through the ALADI treaty, were required to be in foreign currency and accompanied by a foreign exchange contract.Central Bank of Brazil (1992) This foreign currency was typically in USD. Foreign exchange contracts were written and directly linked to the export operation recorded by the trade registry.

In March of 2005, the Central Bank of Brazil greatly reduced exchange rate controls. The BCB began allowing exports to be settled in BRL so long as they are recorded as such in the trade register. Central Bank of Brazil (2005a,b) Still, as in most countries, over 95% of total Brazilian trade even in the years following 2005 was invoiced in USD. More broadly, this law removed control from the BCB to monitor and control any issues related to foreign exchange receipts by exporters.[12]

To reduce reliance on foreign currency in trade, Brazil and Argentina negotiated a new mechanism by which trade between the two countries could be operated exclusively in their

[9]The Real Plan of 1994 introduced the BRL. For more information, see Ayres et al. (2019). In Argentina, the Convertibility Plan of 1991 pegged the ARS to the USD.

[10]See, for example, Edwards (2006)

[11]In Portuguese: Consolidação das Normas Cambiais

[12]The March 2005 reforms did not eliminate the requirement for foreign exchange coverage (in Portuguese: Cobertura cambial). Foreign exchange coverage refers to converting foreign currency receipts to BRL. In 2006, the *requirement* for foreign exchange coverage was eliminated, mainly due to the increased costs to Brazilian firms who wished to use foreign currency receipts to purchase imports. Presidência da República (2006) Instead, the Brazilian IRS (Reçeita Federal) began tracking foreign currency coverage and for tax purposes. Central Bank of Brazil and Reçeita Federal (2006)

own currencies. The Local Payments System (SML) was created in 2008 in order to facilitate trade between Argentina and Brazil. This facility was a payments mechanism and was managed by the two countries' central banks. One part of the payments system allows for Brazilian exporters to operate in their local currency, the Brazilian real (BRL), and Argentine importers to operate in Argentine pesos (ARS). Trade contracts are therefore settled without the usage of a third vehicle currency such as the United States dollar. As a requirement for using this system, Brazilian exporters must invoice their exports in reals. In this sense, for a Brazilian exporter, the price is set in real prior to the execution of any foreign exchange conversion. For the Argentine importer, the price is paid in pesos, with the peso price determined by the realization of the SML exchange rate.

To understand how the SML system works, consider Figure (2). An Argentine importer, who has agreed with a Brazilian exporter to use the SML system, registers the transaction and executes the payment in pesos at her local financial institution. That financial institution then registers and delivers the payment in pesos to the Argentine Central Bank, which clears the transaction with the Brazilian Central Bank. This clearing takes place daily in dollars. Because most foreign exchange reserves are held in dollars anyway, there is no direct exchange risk as a result of the SML system. The Brazilian Central Bank then transmits the funds (in reals) to the financial institution two days later, which releases the funds to the exporter.

The SML system is non-compulsory. Brazilian exporters are allowed to invoice and settle trade in dollars or reals even without using the SML system. What the SML system provides, however, is the ability to contract with the Argentine importer so that both parties may avoid the direct usage of the dollar. The main benefit of the SML system is therefore the ability to invoice and settle exclusively in local currency by both parties. This eliminates, for the exporter, uncertainty or the need to rely on expensive derivative contracts to hedge exchange rate risk. For the importer, as the SML system is a payments system, they still benefit from no longer needing to directly use the dollar, but face uncertainty due to movements in the SML exchange rate.[13]

There were two main goals of this policy (Meirelles, 2008). First, the SML was designed to reduce obstacles to trade for small and medium sized firms. In emerging markets with foreign currency capital controls, such as Brazil, the usage of foreign currency can involve

[13]The central bank also takes on some of this exchange rate risk, albeit at a significantly lower marginal cost. The Brazilian and Argentine central banks net out the difference in SML system transactions each business day. The central banks already hold a large amount of dollar reserves. Therefore, while a large change in the value of BRL relative to the dollar would of course affect the balance sheet, this effect would have occurred regardless of the imposition of the SML system.

substantial amounts of paperwork and documentation such as foreign exchange contracts. Second, the SML system was to deepen the real-peso exchange rate market. Turnover in this market was very small. According to the BIS triennial survey of 2010, approximately 5 million dollars per day of spot exchange rate trades involved the Brazilian real in Argentina out of a total of nearly 1.5 billion. This amount has barely moved since. As this paper is focused on the trade effects of the SML system, I do not investigate its role in any foreign exchange markets directly.

Usage of the SML system steadily rose following its introduction (Reiss, 2015). Figure (3) plots take-up of the SML system as a share of total exports to Argentina.[14] Following the introduction of the policy, the share of exports through the SML system rose to nearly 8% by 2012, and has remained elevated at close to 6% after dipping slightly in 2017. These amounts are not small. In 2007, Argentina was the second largest export destination after the United States, just ahead of China. By 2015, Argentina was still a top five export destination, having been overtaken by China and on par with the Netherlands.

3 Data Sources

3.1 Brazilian Transaction-Level Export Data

I use confidential, administrative transaction-level export data from Brazilian customs administration Secretariat of Foreign Trade (SECEX) to construct a quarterly database of export transactions.[15][16] Each transaction is identified by the 14-digit establishment identifier code, known as the *CNPJ*, the eight-digit NCM Code, which includes the standard Harmonized System (HS) code for the first six digits plus two additional digits, and the destination country. While I refer to an individual *CNPJ* as a "firm," it is more akin to an establishment. For each transaction, I observe the value of the trade in USD, the currency of invoicing, and when available either the net weight in kilograms or the statistical quantity. Along with the value V of the shipment, I also construct a measure of prices. I construct prices as unit values, taking the ratio of total value to a measure of quantity. More information on this construction is available in the appendix.

[14]Data for these figures comes from publicly available data on export trade, reported by the Brazilian Comércio Exterior, and SML data, reported by the Central Bank. The trade data is in USD, so I convert to BRL using the monthly average exchange rate available from FRED (mnemonic "DEXBZUS")

[15]I stress that I did not have direct access to this administrative data. Instead, code was written and sent to SECEX. SECEX ran the code, and only the results were returned.

[16]This data has been used in, for example, Chatterjee et al. (2013) to study the effect of exchange rates on quality upgrading.

As the main contribution of this study is to examine how currency choice affects trade, I first present aggregate statistics on currency choice across destinations and across sectors. Table 1 presents country-level statistics of currency choice across locations. As in most emerging markets, the USD is overwhelmingly used as an invoicing currency across destinations by Brazilian firms, with over 90% of exports invoiced in USD. The share of exports in BRL by value is also consistently smaller than the share by count, implying that smaller firms are more likely to use BRL as an invoicing currency.[17] The notable exception to this pattern is Argentina for the post-SML period, where value in BRL was larger than the count by BRL.

In the benchmark specifications, I focus on exports to South American countries throughout this paper. This assumes that the natural counterfactual to Argentine exports includes only those exports to other South American countries. I do so for three reasons. As discussed in Section 2, these countries had the option to use the CPCR.[18] I also focus on South America because exports to advanced economies with deeper financial markets may also involve borrowing in the destination currency, perhaps indirectly through trade credit. Finally, during this time period most advanced economies suffered from the Great Recession in a way that Latin American countries did not.

Table 2 reports summary statistics for the full sample, the South American sample, and Argentina.[19] Two facts stand out. First, South America accounts for nearly half of all export transactions. This is unsurprising from a gravity model perspective. Second, Argentina accounts for around 20% of export transactions to South America. In addition, exports to Argentina are on average much larger than other exports to South America, by almost a full log point.

3.2 Municipality Data

I supplement the customs data using financial data at the municipality level. I use the balance sheets of individual financial institutions operating in Brazil, available from the Central Bank of Brazil. For example, the amount of assets and loans by Banco do Brasil in the municipality of São Paulo is observable. These balance sheets are broken down into various categories for assets and liabilities. I focus only on total credit operations.[20]

[17] A similar result is found in other studies. See for example Amiti et al. (2018).

[18] Although by this point, they rarely used the mechanism.

[19] The South American sample includes the countries in Table 1: Argentina, Bolivia, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Uruguay, and Venezuela.

[20] In Portuguese, this category is "empréstimos e títulos descontados" (161). I choose this category as it includes working capital type loans, which most closely approximate the type of export financing I am inter-

4 Causal Evidence from Municipality Data

The first set of evidence I present leverages municipality variation in access to the SML system.[21] I leverage geographic variation in the market share of SML authorized financial institutions to construct a plausibly exogenous measure of takeup in the SML system. I show that municipalities with high SML market shares have 25% higher relative exports to Argentina compared with low SML market share municipalities.

4.1 Methodology

As discussed in Section 2, in order to use the SML system a firm must do so through a financial institution that is authorized by the country's Central Bank. In the case of Brazil, the Brazilian Central Bank (BCB) must list on its website that such a financial institution is eligible to use the SML system. Spatial differences across Brazilian municipalities in the presence of SML authorized financial institutions creates plausibly exogenous variation that can be used to tease out selection effects by individual firms and to estimate the causal effects of the SML system on municipal export behavior.

I begin by constructing the relative corporate market share of SML eligible banks within a municipality. As there have been additions to the list of SML authorized financial institutions since the introduction of the SML system in 2008, I focus only on the set of financial institutions that were authorized to participate in the SML system by the end of 2008.[22] This effectively controls for entry into the SML system by financial institutions who may have responded to local demand for the SML system due to expected growth in exports to Argentina.

Table (3) lists the largest 10 banks in Brazil by assets as of December 2005, along with their overall loan share and whether or not they are authorized to use the SML system.[23] Two facts stand out. First, the largest financial were most likely to be authorized to use the SML system. This is broadly true, as across all financial institutions, while only 12% of total financial institutions were authorized to use the SML system, these financial institutions accounted for 74% of total assets. Second, however, is that by the loan measure used in this paper, SML authorized banks were not overwhelmingly the largest. In fact, by loans, SML

ested in. However, results are qualitatively similar when including "financiamentos" (162). Results including financiamentos are available upon request.

[21] For this section, I use publicly available, aggregated export data available from the SECEX website.

[22] The list on the BCB's website is only available for the current list of authorized financial institutions. I obtain the historical list of entry into the eligible institution list via the Sistema Eletrônico do Serviço de Informação ao Cidadão.

[23] In this table, a financial institution is defined as a unique 8-digit CNPJ.

authorized institutions account for only 55% of the total.

I construct the share of total corporate loans within a municipality by SML institutions. I construct these market shares for December 2005, nearly three years prior to the launch of the SML system and before any announcement had been made. Formally, let L_{bt} denotes total loans by bank b at time t. The market share of loans by SML eligible banks in municipality m is given by

$$SML\_Share_m = \frac{\sum\limits_{b \in \Omega_m^{SML}} L_{b,2005m12}}{\sum\limits_{b \in \Omega_m} L_{b,2005m12}}$$

where b indexes banks, Ω_m is the set of all banks in municipality m, and Ω_m^{SML} is the set of all SML eligible banks in municipality m.

To view the spatial variation in SML shares, Figure (4) maps the distribution of SML market shares across Brazil. What stands out is the substantial heterogeneity both across and within states. The lighter colors represent higher market shares of SML assets. These municipalities are more likely to be located in the center and southern region of Brazil. The darker colors represent lower market shares of SML assets. These municipalities are occur more often in the South East near the major cities where there is a larger number of unique banks operating and the service sector is more prevalent.

Figure (5) plots a histogram of the SML-authorized market shares across municipalities along with a vertical line at the median value. As can be seen, the distribution is slightly top heavy with a large number of municipalities having 100% of assets at SML-authorized financial institutions. However, there is a large mass of municipalities at the bottom of the distribution as well, with between 0% and 25% of assets as SML authorized institutions.

Armed with a measure of SML intensity by municipality, I now turn to estimate the causal effect of the SML system on municipality export behavior. The municipality data is aggregated to the two-digit HS sector and destination at the annual frequency. I hypothesize that municipalities with larger SML asset shares had relatively larger export shipments in the years following the launch of the SML system. To estimate this relative effect, I use the following differences-in-differences-in-differences (triple difference) regression design.

$$y_{msjt} = \alpha + \beta_t \left(ARG_j \times \widetilde{SML\_Share}_m \right) + \mathbf{X}_{msjt}\Gamma + \varepsilon_{msjt} \tag{1}$$

where y_{msjt} denotes the log export value for HS2 sector s in municipality m to destination j in year t. ε_{msjt} is the regression residual. The definition of treatment at the municipality

level that I use, $\widetilde{SML\_Share}_m$, is a dummy variable equal to 1 if the SML share is above the median level across municipalities. As explained in detail below, β_t represents the triple difference estimate of the SML system. I normalize these coefficients to be relative to β_{2007}, which is the year prior to the launch of the SML system. $\mathbf{X}_{msjt}$ denotes controls that vary possibly at the municipality-sector-destination-time level. In the benchmark specification, I include municipality-time, destination-sector-time, and state-destination fixed effects. I also include the main interaction of $ARG_j \times \widetilde{SML\_Share}_m$.

The coefficients of interest are the time series β_t. The triple difference specification lends an interpretation to these β_t's that incorporates two relative effects. First, the β_t's leverage the effect of exports to Argentina relative to exports to other South American destinations within a municipality. Second, they leverage the effect of being in a high SML market share municipality relative to a low SML market share municipality. Taken together, the β_t's represent the effect of being above the median SML share on exports to Argentina relative to exports to other destination, compared with the same relative effect in municipalities below the median in year t.

In order for the coefficients β_t to have a causal interpretation, it must be the case that the evolution of log exports across municipalities to Argentina relative to other South American export destinations would have been the same in the absence of the existence of the SML system. This is the parallel trends assumption common in many difference in difference specifications. There are three main threats to identification.

First, the reason municipalities have a large share of SML authorized banks may be because of demand by local firms. Local exporters may have petitioned or lobbied their local banks to become authorized for the SML system. Such lobbying behavior may be correlated with unobserved determinants of export behavior, such as productivity, that may also adjust at the same time as the the introduction of the SML system.[24] This concern is difficult to directly account for in the absence of an observable predictor of SML authorization that is orthogonal to unobserved determinants of exports to Argentina. Instead, I rely on the fact that obtaining SML authorization was a national decision, rather than a municipality specific decision. I show in robustness checks that conditioning only on municipalities for which no SML authorized bank has more than 2% market share does not qualitatively change the results. To the extent that these municipalities had little effect on the national decision to participate in the SML system, then the selection decision of banks would be accounted

[24] A related identification concern that is observable is if municipalities with high SML authorized market shares have higher relative growth in exports to Argentina, thus pushing their local firms to demand SML authorization. Such a concern is observable in the estimated pretrends.

for.

A second threat to identification concerns whether the presence of SML-authorized institutions is correlated with other determinants of export behavior that may have occurred at the same time as the introduction of the SML system. In particular, the global trade collapse of 2008 or the global financial crisis may have disproportionately affected municipalities that had fewer SML-authorized institutions if such institutions were more or less resilient to global conditions. The triple difference specification partially alleviates this concern by comparing exports to Argentina relative to other export destinations conditional on destination-time controls. Still, the identification assumption may be violated if there is some other export destination that also experienced a relative increase in export volumes. In placebo tests, I show that there is no relative effect of the SML system towards other export destinations in South America.

Finally, SML-authorized banks may have simply chosen to increase market share in municipalities for which relative exports to Argentina were growing in order to increase future income. Using market shares in December 2005 helps to alleviate this concern. Market shares in December 2005 are likely to be exogenous to selection into municipalities by individual banks for two reasons. First, the long time lag between the observed market shares and the announcement and launch of the SML system makes it unlikely that financial institutions chose where to locate in anticipation of its usage. Second, import/export financing accounts for a relatively small portion of bank profits, of which Argentina is a moderate fraction. Banks were therefore unlikely to make location decisions based solely on the SML system.

4.2 Results

Figure (6) plots the coefficients β_t from estimating Equation (1).[25] First, note the lack of any significant pretrend prior to the launch of the SML system between 2003-2007. The coefficients are insignificantly different than zero, suggesting that there is no relative difference across municipalities in terms of SML intensity with respect to relative exports to Argentina. This provides confidence that the parallel assumption, that relative growth in exports to Argentina would have been similar across municipalities in the absence of the SML system, holds in the data.

Following the introduction of the SML system in 2008, there is a significant rise in log export values to around 0.25 log points by the end 2012. The effect stays elevated through 2015. Recall that identification leverages only the time-variation before and after the launch of the

[25]Standard errors are two-way clustered by municipality-HS2 and date and are plotted at the 95% level.

SML system and cross-sectional variation in access to the SML system. Endogenous selection by individual firms or municipalities into using the SML system is assumed to be orthogonal to the timing of the introduction of the SML system or the cross-sectional distribution of financial institutions. The lack of significant pre trends suggests that firms in high-SML municipalities did not anticipate the opening of the SML system.

To arrive at the overall effect of the SML system, and hence the causal effect of eliminating exchange rate risk, I estimate the following triple differences specification

$$\ln y_{msjt} = \alpha + \beta \left(POST_t \times \widetilde{SML\_Share}_m \times ARG_j \right) + \mathbf{X}_{msjt}\Gamma + \varepsilon_{msjt} \tag{2}$$

This equation is similar to Equation (1), except the effect is assumed to be static rather than dynamic; I replace the β_t's with only one β and include a $POST_t$ dummy that is equal to one in all $t \geq 2008$. Controls, $\mathbf{X}_{msjt}$, are as in Equation (1).

The first column of Table (4) presents results for this estimation. The coefficient estimate of 0.222 (SE: 0.090) implies that following the introduction of the SML system, exports to Argentina relative to other South American export destinations rose by approximately 22.2% municipalities with a high SML market share relative to municipalities with a low SML market share.

To place these results into context, consider a standard import demand curve with constant elasticity of substitution demand function. Broda and Weinstein (2006) estimate the median import demand elasticities at the three-digit Standard International Trade Classification level to be around 2. Applying this value to the estimated change in import demand of 0.2 log points suggests that the SML system lowered trade costs by around 10%. Simonovska and Waugh (2014) estimate the median trade elasticity to be around 4, suggesting that the SML system was equivalent to lowering trade costs by 5%.

There are at two concerns with this specifications that I aim to alleviate here.[26] The first concern with these results is that differential exposure by financial institutions to the global trade collapse or the global financial crisis may have disproportionately affected export resiliency. The triple difference specification above in some sense controls for this effect by

[26] In the appendix, I discuss two other robustness checks. First, I show that results are robust to balancing the sample after aggregating up to the municipality-time level, and I show that results are robust when conditioning on municipality-sectors with some pre-period observations. Second, I explore using the continuous measure SML_Share_m as opposed to the binary measure. The SML system was more costly to large banks than it was to small banks due to returns to scale in spot exchange rate markets. After assuming that the two largest banks in Brazil were not SML banks, I show that under this assumptions, results are similar when using the continuous measure.

taking exports relative to other South American export destinations. Regardless, I conduct placebo tests where I examine how exports to *other* destinations changed following the launch of the SML system. Specifically, I estimate the following regression

$$\ln y_{msjt} = \alpha + \beta \left(POST_t \times \widetilde{SML\_Share}_m \times Dest_j \right) + \mathbf{X}_{msjt}\Gamma + \varepsilon_{msjt} \tag{3}$$

This equation is similar to Equation (2). I run the regression multiple times, replacing $Dest_j$ with replace specific destinations to compare the inspect of the SML system on relative exports to different destinations. For example, setting $Dest_j = ARG_j$ means that $Dest_j$ is a dummy equal to 1 if the destination is Argentina. Setting $Dest_j = COL_j$ means that $Dest_j$ is a dummy equal to 1 if the destination if Colombia. When Argentina is not the destination, I drop exports to Argentina. The controls, $\mathbf{X}_{msjt}$, are as in Equation (1).

In columns (2)-(5), of Table (4), I drop all exports to Argentina and test the effect of the SML system on relative exports to other South American destinations: Colombia, Chile, Paraguay, and Uruguay. In all other columns, the coefficient on the triple interaction is insignificant and close to zero, suggesting there is little effect of the SML system on exports to other destinations.

A second concern with these results is that individual financial institutions may also have opted into the SML system due to persuasion efforts by their clients. Individual firms who wish to select into the SML system may have lobbied their financial institutions to do so. This would create correlation between the endogenous selection problem of firms and the endogenous selection problem of banks.

To account for this concern, I rely on the fact that the decision to opt into the SML system was a national one from the perspective of banks. I assume that the pressure exerted by a municipality for a bank to join the SML system is proportional to its portfolio share. For example, a municipality that accounts for 10% of a bank's loan portfolio is likely to be influence a bank's national decision compared with a municipality that accounts for only 1% of a bank's loan portfolio.

I drop municipalities for which the share of total loans by the financial institution is equal to or above 2%. These municipalities are mainly large municipalities such as Sao Paulo. Figure (7) shows the results. While the initial effect is attenuated, the significant rise in exports remains in the years following the introduction of the SML system.

5 Micro Evidence of the SML System

I complement the municipal analysis in Section 4 with a detailed look at the evolution of export behavior by individual firms using confidential customs data. The analysis proceeds in two parts. First, I show how BRL-invoicing behavior proxies for SML takeup, and use this measure to understand the heterogeneity across firm takeup of the SML system. Second, I estimate the effect of the SML system on export volumes and prices using detailed fixed effect regression designs.

5.1 Time-Varying Invoicing Decision

I construct a time-varying measure of participation in the SML system at the transaction level. I define SML take-up by Brazilian exporters to Argentina as whether or not the export is invoiced in BRL. Recall that SML statistics are recorded by the Central Bank, while I only observe customs data that includes only the currency of invoicing. However, a requirement of using the SML system is that the export transaction must be invoiced in BRL, so BRL usage can be thought of as an upper bound on SML takeup. In Figure 8, I compare the value share of exports to Argentina invoiced in BRL from the customs data to the value share of SML usage reported by the Central Bank. Both track each other similarly, giving confidence that BRL invoicing represents SML usage.[27]

I define BRL-invoicing at the transaction level as a dummy variable equal to one if if the percentage of exports invoiced in BRL within a given period is at least 50%. Formally, policy take-up, denoted by ι_{isjt} for firm i in sector s exporting to destination j at over time period t, is given by

$$\iota_{isjt} = \mathbf{1}\left(\frac{V_{ijst}^{BRL}}{V_{ijst}} > 0.50\right)$$

where V_{isjt}^{BRL} denotes the total dollar value of the transaction that is invoiced in BRL and V_{ijst} is the total dollar value of exports in any currency.[28] Figure 9 plots the distribution

[27] That both do not line up exactly is likely the result of two factors. First, the BCB reports SML usage in BRL, while export data is denominated in USD. The exchange rate adjustment I use may be imprecise. Second, it is possible that some firms invoice in BRL when exporting to Argentina while not using the SML system. Additionally, as one of the goals of the SML system was to reduce reliance on the USD in export transactions, it may be that some firms that initially used the SML system switched to simply invoicing in BRL. Unfortunately, without detailed data on SML usage, I cannot examine this possibility.

[28] Recall that the data is constructed by aggregating monthly data by 8-digit sector to quarterly data by 4-digit sector. I therefore choose a threshold greater than 0 to ensure it ensure that no small month or 8-digit sector drives results.

of value shares over the entire sample, with a vertical line at 10%. As can be seen, the vast majority of 4-digit commodity codes at the firm-destination-quarter level are either 0% or 100%.[29]

Figure 10 plots the quarterly average value of the measure of policy takeup, ι_{isjt}, for Argentina ($j = ARG$) over the sample period, with 2-standard deviations error bands. While ι_{isARGt} is effectively zero before the implementation of the SML system, there is a steady increase to approximately 8% by 2012. This rise is even larger when looking at the share of *firms*, as opposed to firm-sectors, that switch to BRL invoicing. Figure 11 shows that the ι share across firms rises to nearly 10%.[30]

It may seem strange that not all eligible firms take up the SML system. There are at least three reasons why they may not. First, firms that rely on imported intermediate goods from other locations may benefit from the natural hedge that dollar export revenues provide.[31] Similarly, firms with borrowing denominated or indexed to USD borrowing rates may also prefer the natural hedge from foreign currency export revenues. Second, given that the SML system requires opting in from *both* the importer and the exporter, some Argentine importers may not have wished to use the SML system. The Argentine exchange rate has historically been very volatile, and holding deposits and operating in USD is common in Argentina. Finally, the system was announced with little fanfare, so a number of firms may have taken time to learn more about the system. Caldentey et al. (2013) argue that even by 2014, many firms may have been unaware of the system's existence.

I next decompose ι_{isARGt} along three dimensions: sector, size, and number of destinations. As mentioned in Section 3, small exporters typically invoice in their home currency. Additionally, it is traditionally assumed that because most commodities are priced in dollars on commodity exchanges, then it is only natural for commodity exports to be invoiced in USD. It may be tempting to assume, then, that only small exporters in non-commodity sectors used the SML system.

I find that all manner of exporters, including large and multi-destination exporters, switched took up the SML system. Figure 12 decomposes the ι_{isARGt} along three different dimensions.

[29] I experimented with setting the cutoff to be 0% and 10%, and the results are unchanged. t

[30] For comparison, Figure C.9 plots the evolution of ι_{isjt} for Colombia. The share of transactions invoiced in BRL is orders of magnitude smaller, and there is no break following the introduction of the SML system. Figure C.10 plots the increase in ι_{isjt} relative to other Latin American countries, showing that the rise is unique to Argentina.

[31] Unfortunately, invoicing data on imports is not available from SECEX, but rather by the Receita Federal. Because Argentine exporters and Brazilian importers barely used the SML system, it is reasonable to conclude that the currency of invoicing for imports, and hence exchange rate exposure through marginal costs, did not change significantly.

The top-left panel decomposes ι_{isARGt} by size as measured by total 2007 exports. While the entering and small firms took up the SML system at higher ates, even firms in the top half of the size distribution switched to BRL invoicing through the SML system.

The top-right panel decomposes the rise in ι_{isARGt} by the number of export destinations. Again, while firms that only exported to Argentina saw the highest takeup, a non-trivial share of exporters with at least ten different export destinations also had high SML takeup.

Finally, the last panel shows the change in invoicing split between commodity and non-commodity exports.[32] Both sectors experienced similar increases in BRL-invoicing. This coarse classification, however, masks considerable heterogeneity. For example, within the HS Section "Live Animals", dairy produce (HS04) experienced a sharp rise in BRL invoicing whereas meat did not (HS02).[33]

These simple decompositions suggest that the invoicing change was not due to sector-specific or time-specific events. To understand better the sources of variation across policy takeup, I perform a variance decomposition of the change in invoicing currency on varying sets of fixed effects. The R^2 of this regression provides insight into where most of the variation in currency choice is coming from. Formally, I run the following regression

$$\Delta\iota_{iARGst} = \alpha + \varepsilon_{iARGst}$$

The left-hand side variable, $\Delta\iota_{isARGt}$, is equal to one in the first quarter where BRL-invoicing occurs for firm i exporting in sector s to Argentina, assuming that the firm had invoiced at least once in non-BRL previously. $\Delta\iota_{isARGt}$ is therefore the moment a firm switches from USD invoicing to BRL invoicing.[34] α represents different sets of fixed effects to determine whether or not the change in invoicing behavior changes along a specific dimension. This is a similar exercise as in Amiti et al. (2018), although given the time-variation in my data I look at the *change* rather than the level of invoice currency.

The method of calculation of $\Delta\iota_{isARGt}$ only looks at changes from one non-zero export period to the next. One benefit of this specification is that it avoids issues related to imputing invoicing decisions for missing data for firms that may not export every quarter. One downside is that it does not capture effects along the extensive margin. This is because firms that

[32] Commodity exports are defined as in Boz et al. (2018). See the appendix for more details.

[33] In the appendix, I show the rise in ι_{isARGt} across all two-digit HS sectors. The heterogeneity across HS2 sectors does not appear to have any obvious pattern.

[34] Note that in a small number of cases, the value of this variable is -1. This means that a firm switched from BRL invoicing to USD invoicing. However, in the sample of firms that export to Argentina, this happens only five times.

enter and immediately export in BRL are set to zero in this regression. In this sense, the R^2 should be interpreted only as an intensive margin effect. Still, it is informative to see where most variation in changes in invoicing comes from.

Table 5, shows that more than 50% of the variation in $\Delta\iota_{iARGst}$ occurs across firm-time cells. This suggests that firms typically adjust their currency of invoicing across all sectors at the same time, rather than one at a time. There is very little variation explained by sector or even sector-time fixed effects. This is because not only is there a wide set of industries that switch to the SML system, but within each industry firms stagger their adoption.

5.2 Methodology

I leverage time-variation in invoicing currency to estimate how changes in invoicing behavior affect the size of export volumes and their prices. The preceding analysis defined the treatment group to be those firm-sector-destinations that invoice in BRL within a given quarter. This BRL-invoicing is meant to capture takeup of the SML system. Firms of a variety of different sizes across different sectors switched to BRL invoicing for Argentina shipments following the introduction of the SML system at staggered times.

I utilize the rise in BRL-invoicing due to the introduction of the SML system to compare otherwise similar transactions that are invoiced in different currencies. This specification is akin to an event study specification whereby once a unit is treated, it remains treated for the remainder of the sample. The regression specification relates the log value of exports and the log price to the time-varying invoicing decision at the shipment level. Formally, the regression to be estimated is

$$y_{isjt} = \alpha + \beta\iota_{isjt} + \gamma\left(\iota_{isjt} \times ARG_{jt}\right) + \mathbf{X}_{ijst}\Gamma + \varepsilon_{isjt} \tag{4}$$

where y denotes either the log values of exports or the log price of firm i to Argentina in HS4 sector s during quarter t. $\mathbf{X}_{ijst}$ denotes controls that vary possibly at the firm-destination-sector-time level. I include firm-HS4, HS2-time, and destination-time fixed effects. These fixed effects control for time-invariant transaction-specific effects and aggregate changes in sector-specific or destination-specific conditions, such as demand or supply shocks. In this sense, I compare BRL-invoiced transactions to Argentina with a counterfactual transaction by the same firm in the same sector, holding constant aggregate economic conditions.

I estimate Equation (4) for two samples. First, I estimate this equation only for the sample of exports to Argentina (by dropping the interaction term and destination-time dummies). In this specification, I recover estimates of β that using time-variation within a given firm-

sector. In the second specification, I include exports to all South American destinations. This specification leverages both time-variation within a given firm-sector but also variation across destinations within a given firm-sector.

The main coefficients of interest are β and γ. Specifically, β represents the marginal effect of BRL invoicing across all export destinations, while γ represents the relative effect of BRL invoicing on exports to Argentina. Because $\iota_{isjt} = 0$ for essentially all exports to Argentina prior to the introduction of the SML system, and the rise in BRL-invoicing closely matches the share of exports through the SML system reported by the Central Bank, the coefficient γ can be interpreted as the effect of the SML system itself relative to non-SML transactions.

I am interested in interpreting γ (or, when using only exports to Argentina, β) as the effect of the SML system. For OLS estimates of γ to have a causal interpretation, it must be the case that the switch to BRL-invoicing is exogenous with respect to other determinants of trade values. In other words, the evolution of export volumes and prices should have been the same for SML and non-SML exports to Argentina in the absence of the SML system.

The main threat to identification involves endogenous selection into the SML system. These selection effects can bias the estimate of the SML system upwards or downwards. If firms are more likely to select into the SML system because sales are falling and they believe the SML system may improve their prospects, then the SML system will be biased downwards. If instead firms select into the SML system because they are growing, and expect the SML system to continue improving their export prospects, then the effect will be biased upwards.

In Section 4, I leveraged municipality variation in access to the SML system that is orthogonal to such selection effects and find similar results as in this section. The results of that analysis found that the introduction of the SML system significantly increased exports to Argentina in municipalities more likely to take up the SML system. The methodology in this section, on the other hand, is focused on understanding the extent to which individual firms increased their exports.

I emphasize that for endogenous selection to bias estimates of the SML system, it must be that the reason for taking up the SML system is either time-varying at the firm-sector level. Time-invariant determinants of selection are controlled for by firm-sector fixed effects. However, if firms choose to use the SML system because of, for example, foreign currency borrowing, such reasons would not be controlled for. In an alternative specification, I directly include firm-time controls. These controls account for time-varying characteristics at the

firm-level, such as import intensity or foreign currency borrowing. However, given that must variation in changes in invoicing comes from the firm-time dimension, including such controls is likely to result in lower powered estimates.

I do stress that other threats due to omitted variable bias can be directly controlled for. First, there is the effect of the Global Recession.[35] International trade peaked in 2008Q3, which is precisely the same quarter as the introduction of the SML system. (Eaton et al., 2016) It is unlikely this trade collapse is biasing my results. First, as a practical measure, the inclusion of sector-time fixed effects should control for aggregate changes in economic activity, including the demand and supply effects of the trade collapse. Second, the global collapse in trade during the Great Recession was temporary, and largely recovered by 2011. In Brazil, the value of exports reached its pre-Great Recession peak by the end of 2010. However, BRL-invoicing continued to rise beyond this recovery. Finally, the Global Recession had muted effects on countries in Latin America.

Second, there is the effect of foreign currency credit shocks for firms that may disproportionately rely on foreign currency. Firms may have taken up the SML system may have switched their financing decision. This change in financing decision may drive any subsequent results, and the direct effects of the SML system may be small. The Global Financial Crisis distorted credit markets which had large a large effect on exports, as described for example by Amiti and Weinstein (2011). If USD-invoicing firms were to borrow in USD, and BRL-invoicing firms were to borrow in BRL, then any disproportionate tightening of USD credit would affect trade values similarly.[36] While most Brazilian non-financial corporate firms do not directly borrow in USD for capital control reasons, offshore bond issuance or turmoil in the financial sector as a result of distress in global credit markets could be problematic for identification. Specifically, firms may have chosen to switch away from USD borrowing as a result of the Global Financial Crisis, invoice in BRL. In robustness checks leveraging cross-destination exports, I show that including firm-time fixed effects that control for firm-financing do not change the results.

[35]Note that domestic economic conditions are less likely to be concerned in the case of trade between Argentina and Brazil. This is because, for the most part, economic conditions did not worsen in Latin America until much later.

[36]In practice, firms do not directly borrow in USD in Brazil due to capital controls. Instead, firms borrow at the *cupom cambrial*, which is an interest rate pegged to offshore USD rates. Chamon and Garcia (2016) summarize these synthetic USD markets.

5.3 Results

I begin in the top panel of Table 6, which presents results including only firm-HS4 and HS2-time fixed effects. Column (1) of this top panel reports results from estimating Equation (4) using the log value of exports as the outcome for *only* the set of export transactions to Argentina. In column (1), the estimate of 0.273 (SE: 0.077) for the coefficient on ι_{ijst} implies that switching to a BRL invoiced shipments results in trade volumes being higher by approximately 27%.

Column (2) repeats this estimation using the log price as the outcome instead of log value. If the SML system worked only to eliminate transaction costs, then if there is some pass-through of costs into prices these transaction costs savings should be reflected in a lower relative price. I instead find that prices do not move much in response to changing invoice currency, with an insignificant point estimate of -0.007 (SE: 0.025). This result is consistent with models of optimal currency choice, such as Gopinath et al. (2010), who argue that in the presence of nominal rigidities, optimal price setting is not a function of currency choice.

Columns (3)-(4) show the results for estimating the full specification of Equation (4), including all South American export destinations and including destination-time fixed effects. First, note that the coefficient estimate for the direct effect of ι_{ijst}, β, is -0.035 (SE: 0.089). This is small and statistically insignificant, suggesting that there is not a noticeable change in export behavior when a specific firm-sector transaction has different invoicing behavior across locations, conditional on time-varying sector and destination effects. The coefficient estimate of 0.437 (SE: 0.118) for γ suggests that firms raise export volumes in response to the SML system by 44%.

One way to interpret the estimates of 27% and 44% is to again compare it to the change in relative price necessary to generate such a result. Broda and Weinstein (2006) find that the median value of the elasticity of substitution at the five-digit SITC level is 2.7. This implies that the introduction of the SML system at the HS4-firm level is similar to reducing prices by approximately 10%-16%, a slightly larger estimate as the result from the municipality data.

Another way to interpret the estimates is to compare them to estimates of the trade effect of joining a currency union. Rose (2014) finds that the effect of joining a currency union is to increase exports by around 54%, similar to the estimate of 47% found in an earlier meta study by Rose and Stanley (2005). The ascension to a currency union incorporates much more than simply changing to a common currency. My estimate suggests, that a large share of the trade benefits from joining a currency union come from eliminating foreign currency

risk.

The reason for such large differences between the estimate on the Argentina sample vs. the South American sample can be seen in Panel B. In Panel B, I include firm-time and firm-destination fixed effects, although the changes in coefficients are mainly due to the inclusion of firm-time fixed effects. To the extent that the selection effect of opting into the SML system is due to unobserved firm characteristics that vary only over time, but not across sector, then the inclusion of firm-time fixed effects should control for this endogenous selection effect. I find that this specification significantly raises the effect when conditioning only on exports to Argentina, but the effect when including all of South America remains similar, albeit slightly attenuated. Results for prices are relatively unchanged.

Including these fixed effects also naturally allows an instrumental variables specification. I use as an instrument the time-varying presence of the importance of SML institutions within the municipality of the firm, as described in Section (4).

$$Z_{m(i)jt} = POST_t \times \widetilde{SML\_Share}_m \times ARG_j$$

Results are displayed in columns (5) and (6) of the bottom panel of Table (6). Column (5) shows results of the second state. The first stage is positive and significant. However, the value for the F-test is just below the standard threshold of ten, suggesting that there may be issues customary of weak instruments. Still, the results of the second stage, shown in column (6), shows a point estimate of 0.318 (SE: 1.542). The large standard errors are the result of a weak reduced form. Regressing the log value of exports on the instrument (and including all fixed effects) results in an estimate of 0.017 (SE: 0.081). While the second stage coefficient is insignificant, the point estimate suggests that the selection effect of the SML system is that growing *firm-sectors* are likely to opt into the program, consistent with intuition. This selection effect is likely to be small, with the caveat that the instrumental variable analysis has high uncertainty.

Finally, I also perform a series of heterogeneity analyses. Specifically, I interact the invoice dummy ι_{ijst} with a number of firm observable characteristics. First, I study the difference in volume effects between commodity and non-commodity exporters, potentially due to being in a less competitive differentiated goods sector. Second, I study whether having a larger share of exports to Argentina affects the benefits of the SML system by calculating the share of exports by firms to Argentina in the six quarters prior to the introduction of the SML system. Finally, I look at heterogeneity along firm size by comparing firms above and below the median total exports in the six quarters prior to the introduction of the SML

system.[37]

Results of the heterogeneity analysis are in Table (7).[38] In columns (1) and (2), I show that non-commodity exporters that predominantly export to Argentina are the main beneficiaries of the SML system, suggesting that models of imperfect competition (common in differentiated goods sectors) that focus on frictions that rely on only one destination are likely to capture the main benefits of the system. In the last column, I show that both small and large firms benefit from the the SML system.

The evidence within this section suggests that import demand is a function of currency choice. It points to exchange rate risk being an important determinant for import demand. Because prices do not change in response to the invoicing change, this suggests that neither marginal costs nor optimal markups have changed substantially. Still it is useful to examine a specification that includes firm-time fixed effects. These fixed effects not only control for changes in marginal costs at the firm level, but also control for other determinants of policy takeup such as import intensity and foreign currency borrowing.

5.4 The Effects of BRL Invoicing on Firm Size

The transaction-level analysis does not capture whether or not firms respond to the SML system by changing the distribution of their sales across countries or by growing overall. If total sales by firms are relatively unchanged but the volume of shipments to Argentina rise, it suggests either low returns to scale in production or high elasticities of substitution across export destinations.

I investigate how the SML system influenced firms' export behavior in terms of their reliance on Argentina as an export destination and in terms of their total size as measured by total exports. Collapsing across destinations, an empirical specification at the firm-sector-time level can estimate how overall sales and exposure to Argentina evolve following the introduction of the SML system. This specification takes a similar form as Equation (4)

$$y_{ist} = \alpha + \beta \iota_{ist} + \mathbf{X}_{ist}\Gamma + \varepsilon_{ist} \tag{5}$$

where the outcome variable is now either total log value of exports in sector s by firm i at time t to *any* destination, denoted $\ln V_{ist}$, or the share of total exports in sector s by

[37] For these last two analyses, I drop firms that do not export in the six quarters prior to the introduction of the SML system.

[38] Results including firm-time fixed effects are qualitatively similar. However, when including firm-time fixed effects the effect of being large is bigger and marginally significant. This is likely due to the fact that smaller firms do not have much variation across destination or sectors, so I elect not to report them.

firm i to Argentina, denoted Arg_Share_{ist}. ι_{ist} is a dummy variable equal to one if for any destination j, $\iota_{isjt} = 1$, and ι_{ist}^{ARG} is a dummy equal to one if exports specifically to Argentina are invoiced in BRL. $\mathbf{X}_{ist}$ denotes controls that possibly vary at the firm-sector-time level. I include firm-HS4 and HS2-time fixed effects.

The main coefficient of interest, β, estimates the relative effect any BRL invoicing by the firm has on the total value and Argentine share of exports. As in Equation (4), the identifying assumption is that firm-sectors that have any BRL-invoiced shipments would have grown at the same rate as those that did not have any switch. Under this assumption, the treatment effect identified by β is the causal effect on *total* sales from *at least some* BRL invoicing.

Under the assumption that the coefficient β is causal when estimating at the shipment level in Equation (4), the results of estimating at the firm level provide evidence simply about the possible reallocation of sales across export destinations. Causality as a result of BRL invoicing due to the SML system follows directly from those firms that switch to BRL invoicing in shipments to Argentina. However, it is not necessarily true that *all* BRL-invoicing can be considered plausibly randomly assigned. In fact, it is almost surely not. For example, Bolivia and Paraguay have non-trivial shares of exports invoiced in BRL almost exclusively by smaller firms. To ensure that the results are not driven by non-Argentina BRL-invoiced exports, I also decompose ι_{ist} into an indicator for only Argentina and another for other export destinations:

$$y_{ist} = \alpha + \beta_1 \iota_{ist}^{ARG} + \beta_2 \iota_{ist}^{OTH} + \mathbf{X}_{ist}\Gamma\varepsilon_{ist} \tag{6}$$

where ι_{ist}^{ARG} is an indicator equal to one if $\iota_{isjt} = 1$ for $j = ARG$, while ι_{ist}^{OTH} is an indicator equal to one if $\iota_{isjt} = 1$ for any $j \neq ARG$. The coefficient of interest in this equation is β_1. So long as the effect we find in Equation (5) is due to the SML system, then β_1 should have a similar magnitude as β. I include the same fixed effect controls as in Equation (5).

Columns (1) of Table (8) reports the results of estimating Equation (5) using the share of exports to Argentina as an outcome variable. The switch to BRL invoicing by firms results in a statistically significant increase of around 7 percentage points. This suggests that firms that switch to BRL invoicing do so when tilting their sales towards Argentina. Column (2) estimates Equation (6) and decomposes the effect into that coming from invoicing in BRL to Argentina and that of elsewhere. Splitting in this way shows that all of the effect on Argentina export shares comes from BRL invoicing to Argentina.

Column (3) changes the outcome variable to log total value of export shipments. The point estimate of 0.211 suggests that total exports rise by approximately 22% for firms switch to

BRL invoicing. This point estimate alone suggests that firms do some substitution across destinations, as it is less than the point estimate in Table (6). However, Column (4), which decomposes into the Argentine and non-Argentine invoicing dummies, finds again that the whole effect is due to the SML system, which leads to exports being larger by 54%.

6 Discussion

Workhorse models that feature a role for invoicing currency typically assume some sort of nominal rigidity on output prices. [39] These models are able to successfully capture many important features of currency choice and exchange rate pass through. For example, they are able to match the fact that import prices (in local currency) are not sensitive to bilateral exchange rate movements when invoiced in the dollar or that the terms of trade are not very sensitive to exchange rate movements Boz et al. (2018), or that firms with high market share have low exchange rate pass-through Amiti et al. (2014).

At the same time, these models struggle to explain why switching invoice and payment currency through the SML system would have such a large effect on export volumes. This is because, in those models, import demand is only a function of changes in the relative price. Importers observe the exchange-rate adjusted realized local price when making purchasing decisions. Due to price stickiness, fluctuations in the market exchange rate of the local currency vis-a-vis the invoice currency causes relative price changes, which then result in changes in quantity demanded. Switching invoicing currency changes only which exchange rate import prices are sensitive to.

Similarly, while the exporter's invoicing decision is certainly a function of exchange rate volatility (see Engel (2006) or Mukhin (2018)), the optimally chosen price is not a function of the invoicing currency. As in most models of price-setting, the optimally chosen price is set to be a markup over marginal cost. While movements in the exchange rate may temporarily change profits via marginal costs (if intermediate input prices change as in Boz et al. (2018)) or markups (due to strategic complementarities in pricing as in Atkeson and Burstein (2008)), the optimal price is typically unaffected.

That the introduction of the SML system results in higher export volumes without a decline in the relative price suggests some effect on both supply and demand. The heterogeneity

[39] The literature on *endogenous* invoicing decisions further assume that exporting firms choose the invoicing currency that maximizes expected profits. Under some assumptions, Mukhin (2018) shows that the choice of invoicing currency reduces to minimizing the variation of the import price around its flexible price benchmark. For example, strategic complementarities in pricing and input-output linkages across firms may cause firms to invoice in home, destination, or vehicle currencies Engel (2006); Gopinath et al. (2010).

analysis also shows that only firms in non-commodity sectors, typically firms with some form of price setting ability facing downward sloping demand curves, captured the benefits of the SML system. It is therefore unlikely that either import demand or export supply curves are perfectly elastic, and so the small effect on price and large effect on volume must shift both curves outwards.

Consider the following stylized model. There exists an exporter, who produces and sells some good to an importer. Assume that the importer's demand for the exporter's good, Q^D, takes the following CES form

$$Q^D = \left(S_\ell^M(1+\tau_M)P^\ell\right)^{-\rho}\mathbf{X} \tag{7}$$

Here, the price faced by the importer in invoice currency ℓ is given by $(1+\tau_M)P^\ell$, where P^ℓ is the price posted by the exporter in currency ℓ and τ_M is some friction faced by the importer. S_ℓ^M is the importer's currency price of currency ℓ, such that an increase in S_ℓ^M is a depreciation of the importer's currency. ρ is the elasticity of substitution. Finally, $\mathbf{X}$ is a constant that includes, for example, the relevant price index or total income.

The exporter uses only one input, labor l, with cost W in production according to the technology $Q = l^\alpha$ where $0 < \alpha < 1$. Costs for the exporter are therefore given by $C(Q) = WQ^{\frac{1}{\alpha}}$. The exporter has some market power and chooses the price P^ℓ in the (exogenously given) currency of invoicing ℓ. The exporter takes the importer's demand as given and sets prices by maximizing profits.

$$\begin{aligned} P^\ell &= \arg\max_P \frac{S_\ell^X P}{(1+\tau_X)}Q - C(Q) \\ \text{s.t. } Q &= \left(S_\ell^M(1+\tau_M)P\right)^{-\rho}\mathbf{X} \end{aligned}$$

where S_ℓ^X is the exporter's currency price of currency ℓ, such that an increase in S_ℓ^X is a depreciation of the exporter's currency. τ_X denotes some friction faced by the exporter, such that the amount received per unit is only $P^\ell/(1+\tau_X)$.

Solving for the optimal posted price P^ℓ, then plugging in for demand gives the equilibrium price in currency ℓ as[40]

$$P^\ell = \left[\frac{(1+\tau_X)/S_X^\ell}{(S_M(1+\tau_M))^{\rho\frac{1-\alpha}{\alpha}}}\frac{\rho}{\rho-1}\frac{W}{\alpha}\mathbf{X}^{\frac{1-\alpha}{\alpha}}\right]^{\frac{1}{1+\rho\frac{1-\alpha}{\alpha}}} \tag{8}$$

[40]See Appendix C.1 for a full derivation.

Equilibrium sales can be found by examining the demand curve.

To the extent that the SML system reduced *both* τ_X and τ_M, then we would expect to see P^ℓ stay stable.[41] The reduction of τ_M shifts out the importer's demand curve and the reduction of τ_X shifts out the exporter's supply curve, resulting in higher export volumes.[42] What might these frictions be as they relate to the currency of invoicing and the currency of payment?

Risk aversion: Risk-averse exporting firms may charge higher prices based on the variability of profits. In Appendix C.2, I show that under the formulation of risk aversion as in Mann (1989), that if firms do not have access to hedging markets, then higher levels of risk aversion result in higher prices. Intuitively, exporters must be compensated for bearing some risk in international trade as it pertains to realized revenues.[43] In the context of the SML system, risk aversion is likely to only affect the exporter, as the importer is still exposed to movements in the SML exchange rate. Recall that the SML system is a payments system. Payments through the SML system are therefore still subject to exchange rate risk vis-a-vis changes in the posted SML rate. Thus, in my context, risk aversion only should affect τ_X.[44,45]

Imperfect competition in exchange rate markets: There may also exist transaction costs in the foreign exchange market if financial intermediaries charge firm additional fees relative to global currency markets. The SML rate, compiled based on underlying dollar reference rates, is updated daily and so reflects market changes in exchange rates. It is important to emphasize that many are not able to make exchange rate transactions at this market rate, and so the SML system can potentially lower costs of foreign exchange transactions by permitting firms to use the market rate. In Appendix C.3, I outline a stylized model of the foreign exchange market, whereby market power allows financial intermediaries to apply an exchange rate that is a markup over the exchange rate faced in global markets, thereby af-

[41] In my data, I only observe unit values rather than posted prices. I assume that the total value of goods is inclusive of these frictions.

[42] Note that under this formulation, changes in τ_M affect quantity exported while changes in τ_X affects (real) revenues. To the extent that I observe (real) revenues, rather than quantity purchased, then both of these effects would be active.

[43] One famous result is the separation theorem as proposed by Ethier (1973), which argues that with hedging the spot exchange rate volatility does not affect optimal pricing. Other work by Feenstra and Kendall (1997), Friberg (1998), or Lyonnet et al. (2016), which also feature hedging, also find some form of the separation theorem.

[44] The SML rate and the bilateral market rate as reported by Interactive Data Corporation (ICE) are almost perfectly correlated.

[45] Still, there may be some benefits of reduced risk for importers. To the extent that movements in exchange rates are due to changes in the value of the dollar, then bilateral exchange rates could be more stable. To the extent that firms would benefit by hedging against dollar-specific movements, then the SML could offer some protection. However, it is difficult to think this explanation alone would explain the empirical results in this paper, as importers could have already benefitted from this channel by simply paying in Reals.

fecting τ_M, although in practice, this could also potentially affect τ_X. Such monopoly power by financial intermediaries may come from legal restrictions, local knowledge of foreign exchange markets, or direct access to central bank liquidity. The SML system, which would direct apply the SML rate, could alleviate this market power by allowing firms to directly trade at the global exchange rate.

Unhedged FX borrowing: Time delays between when importing firms purchase goods (either for domestic retail sales or as an intermediate input) and when sales are realized may affect the real value of loan repayment due to realized movements in foreign currency. More concretely, firms may borrow in foreign currency to buy foreign currency imports in the form of trade credit or trade finance. When firms then repay the foreign currency loan, realized movements in the exchange rate may directly affect profits.[46] In Appendix C.4, I outline a stylized model of foreign currency working capital loans showing how expected depreciations and borrowing rates can affect demand for imported intermediate inputs by producers, motivating τ_M as a friction related to intraperiod borrowing. The SML system works by removing the effect of such exchange rate movements, as the producer may now borrow the required amount in local currency. Note that this time difference is distinct from local currency changes in prices between when the invoiced price is posted and when the realized price is determined by exchange rate movements.

7 Conclusion

This paper studies the role of foreign currency risk as a barrier to trade. It exploits the introduction of the SML System, a trade agreement between Brazil and Argentina that allowed exporters and importers to invoice and transact in their home currencies, the Brazilian Real and the Argentina Peso. Using municipal variation in quasi-randomly assigned SML system access, I find that municipalities with a high share of SML authorized institutions saw relative exports to Argentina rise by 22% over the eight years following the introduction of the SML system relative to municipalities with a low share of SML authorized institutions. In a complementary analysis using confidential customs data that includes the currency of invoicing, I find that firms that switched to BRL invoicing, a requirement of using the SML system, resulted in exports rising by approximately 44%. A back of the envelope calculation suggests that these effects are similar to reducing trade barriers by between 10-17%. Finally, in a stylized model, I argue that the SML system worked by reducing exchange rate risk for exporters and by reducing transaction costs for both exporters and importers.

[46]This channel is similar to Barbiero (2020), who studies how the currency mismatch of importers and exporters may result in capital gains for manufacturing firms due to movements in the exchange rate.

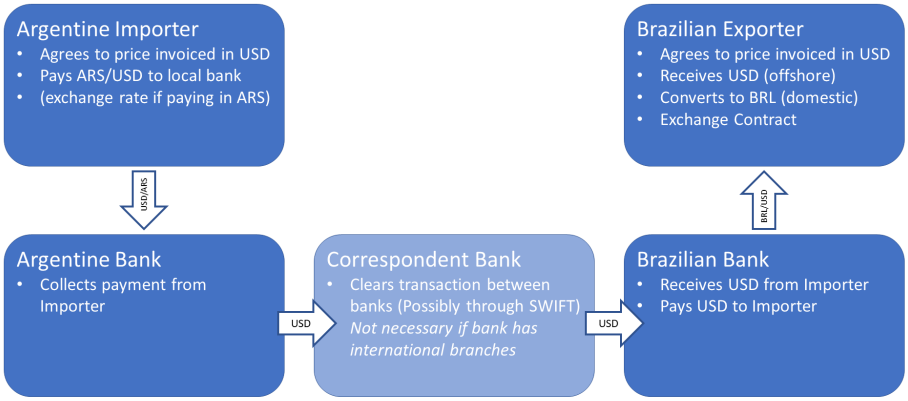
There are at least two important questions left for future research. First, although this paper argues that the SML system worked by increasing import demand due to importer risk, the role of risk by exporters may also be an important factor in understanding how foreign currency risk affects international trade. Research areas such as Lyonnet et al. (2016) or Goldberg and Tille (2008), which focus on how firms manage exchange rate risk via financial derivatives or bargaining, may help explain why emerging markets have relatively lower levels of international trade. Such an issue seems especially important in a world where the dollar plays such an important role in international trade.

Second, understanding how local currency payments systems operate more generally may give clues to why they may be effective. Brazil has since entered into agreements with Uruguay and Paraguay. In addition, a number of countries in Southeast Asia, such as Indonesia, Malaysia, and Thailand have also begun to implement local currency payment systems. Argentina did not take up the SML system at the same scale as Brazil. The reason is likely to be unique to Argentina, as statistics reported by the Central Bank of Brazil note a similar take-up by both Uruguayan and Brazilian exporters as a result of the SML system introduced in 2015. It is likely that the reliance on the dollar both due to historical instability of Argentine monetary policy and as a financing currency contribute to its lack of usage. The link between exchange rate volatility in goods trade and monetary policy, as studied for example in Drenik et al. (2019), is likely to be a fruitful area of research.

As a matter of policy, reducing exchange rate risk for exporters in emerging markets may be a path to economic growth. Economists have long understood the potential role of international trade in driving economic growth.[47] Understanding how to expand the SML system may provide a boost not only to trade, but also to long-run growth.

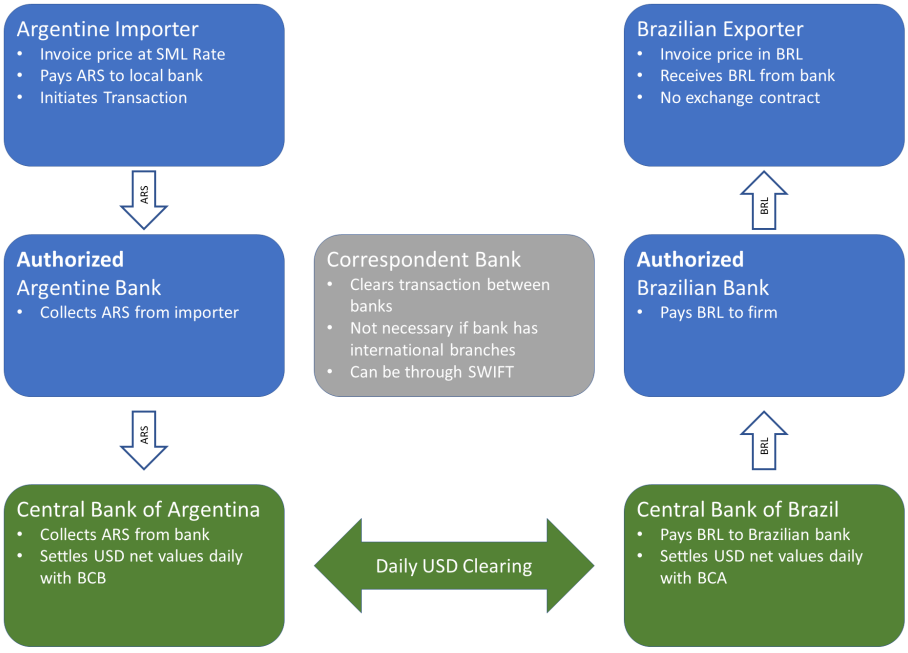
[47]See, for example, Frankel and Romer (1999), Pavcnik (2002), or Bloom et al. (2015)

Figure 1: Example Transaction



This figure shows the flow of payments from an Argentine importer to a Brazilian exporter prior to the introduction of the SML system.

Figure 2: Example Transaction through the SML system



This figure shows the flow of payments from an Argentine importer to a Brazilian exporter under the SML system.

Figure 3: Take-up of the SML System

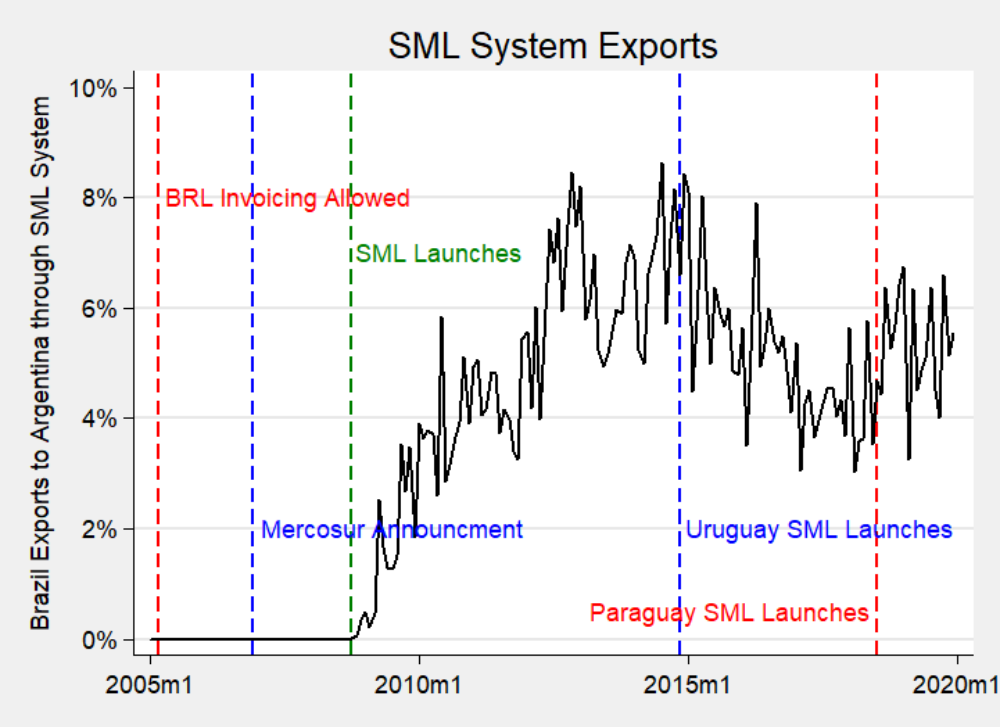
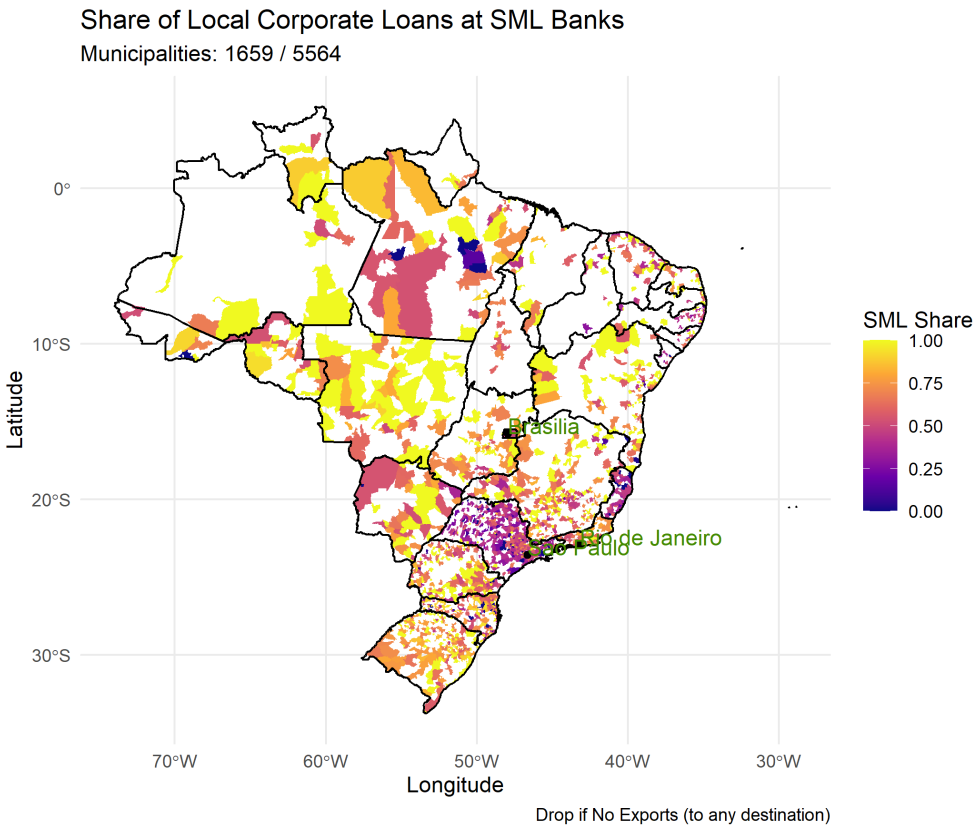


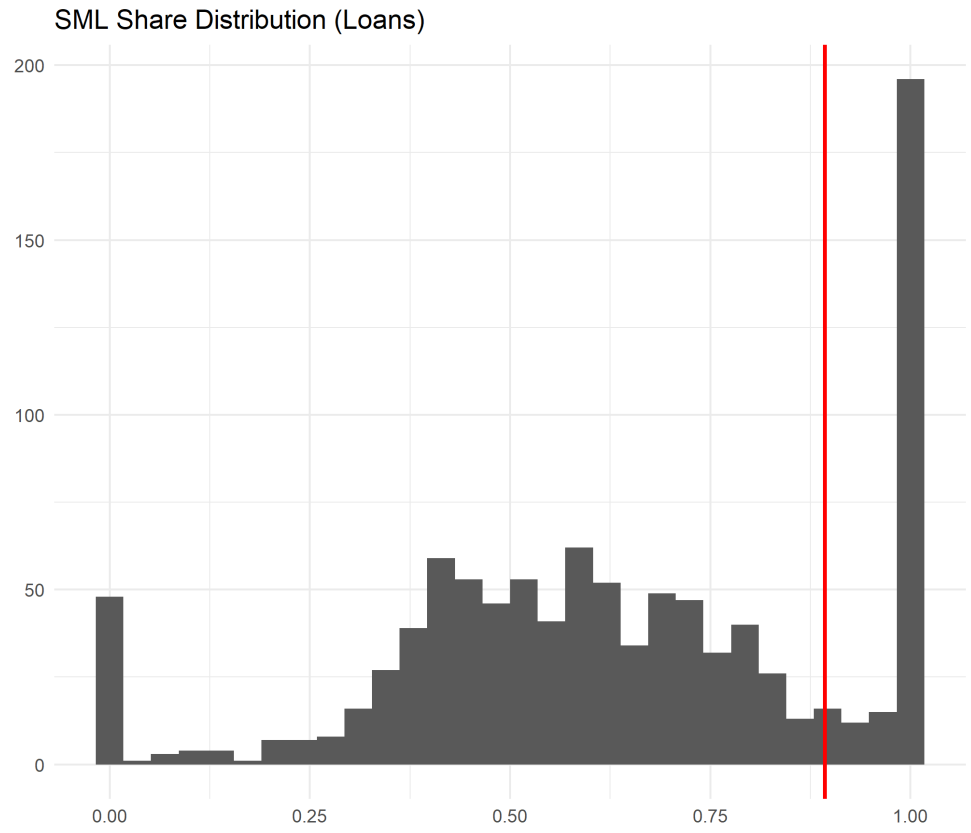
Figure plots SML usage as a share of total exports to Argentina. **Source**: Brazilian Central Bank, World Bank, SECEX

Figure 4: Map of SML Shares



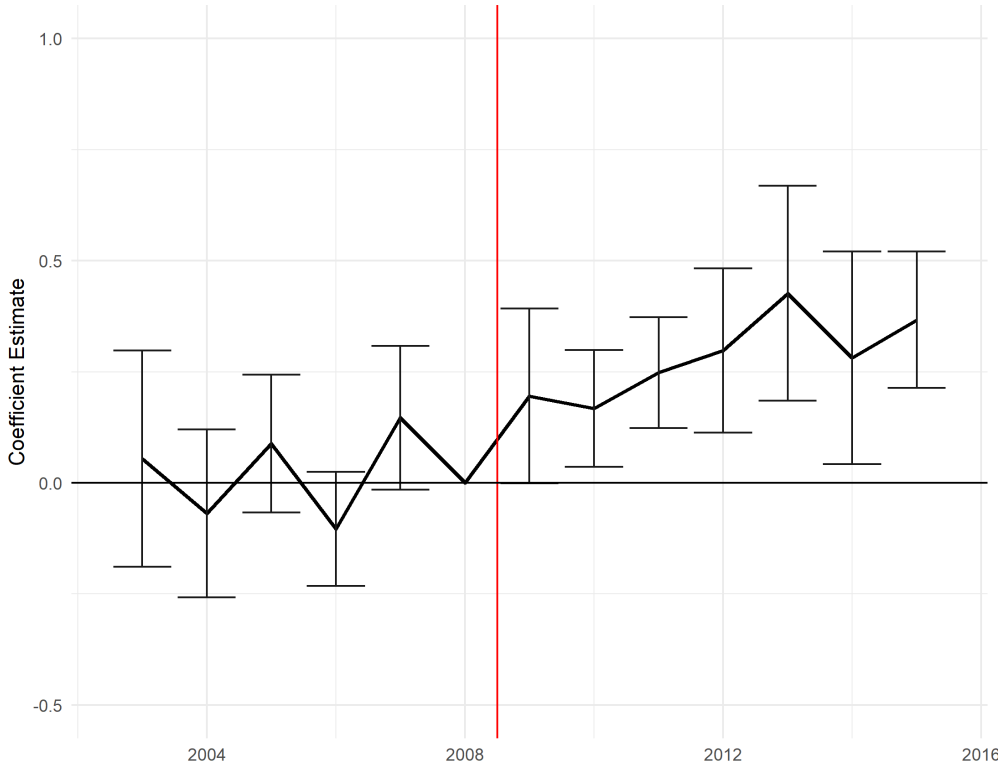
Each polygon within the figure denotes a municipality in Brazil. The color of the municipality signifies the market share of loans at SML authorized institutions. Municipalities with either no financial data or no export data are in white. **Source**: Brazilian Central Bank, SECEX

Figure 5: Distribution of SML Shares



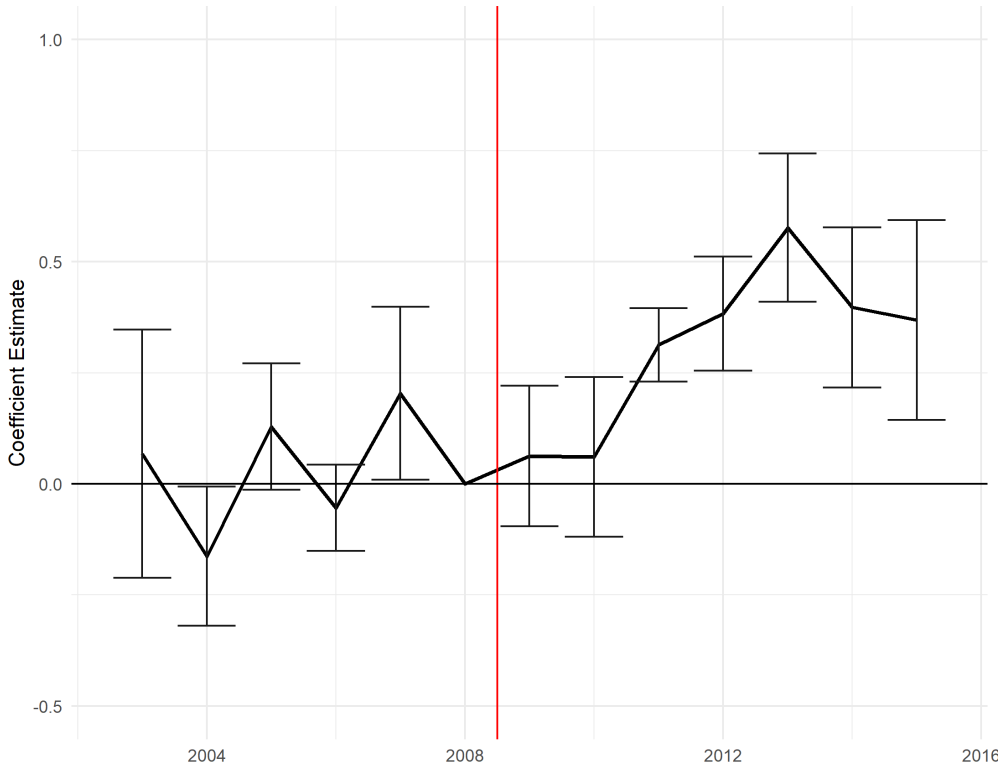
This figure plots the distribution of SML_Share_m, with a vertical line drawn at the median value. **Source**: Brazilian Central Bank

Figure 6: Relative Effect of SML Financial Institutions



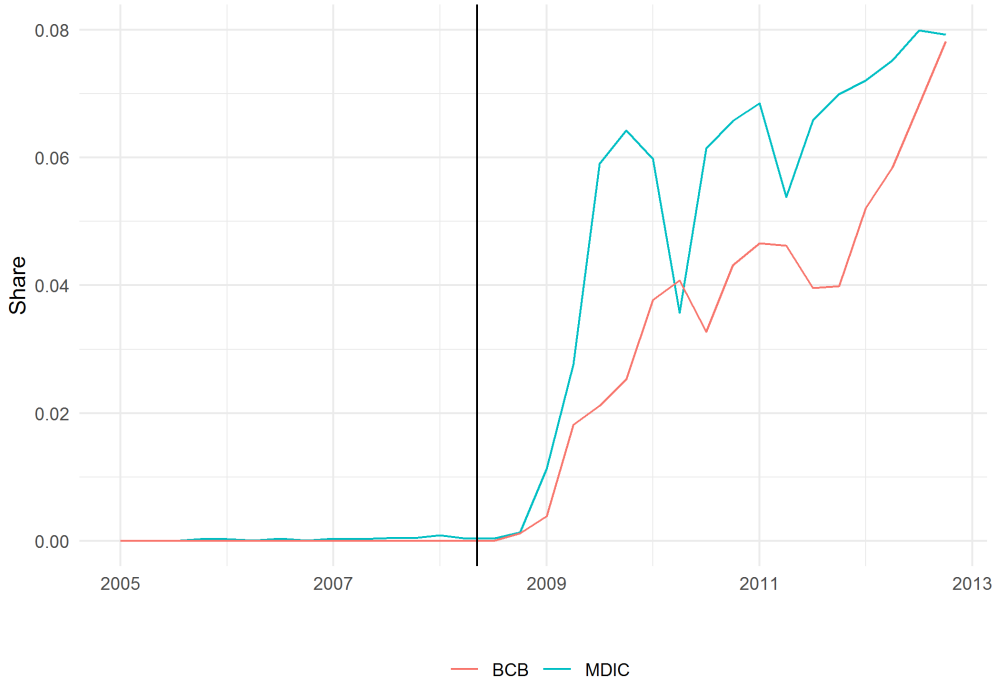
This figure presents results from estimating Equation (1): $y_{msjt} = \alpha + \beta_t \times \left(\widetilde{SML\_Share}_m \times ARG_j\right) + \mathbf{X}_{msjt}\Gamma + \varepsilon_{mst}$, where the outcome y_{msjt} is log exports in sector s from municipality m in year t to destination j, $\widetilde{SML\_Share}_m$ is a dummy variable equal to 1 if a municipality has above the median market share of SML corporate loans, and ARG_j is a dummy equal to 1 if the destination is Argentina. I include municipality-time, destination-sector-time, and state-destination fixed effects as well as main interactions. Standard errors are two-way clustered by municipality-sector and time. **Source**: Brazilian Central Bank, SECEX

Figure 7: Dropping Municipalities with Greater Than 2% Market Share



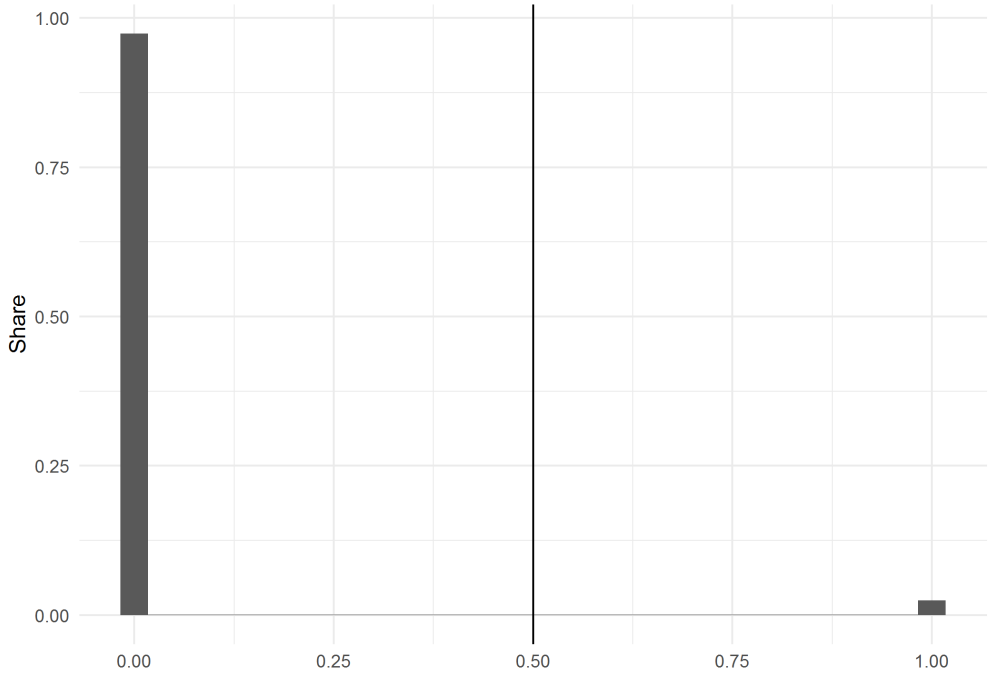
This figure presents results from estimating Equation (1): $y_{msjt} = \alpha + \beta_t \times \left(\widetilde{SML\_Share}_m \times ARG_j\right) + \mathbf{X}_{msjt}\Gamma + \varepsilon_{mst}$, where the outcome y_{msjt} is log exports in sector s from municipality m in year t to destination j, $\widetilde{SML\_Share}_m$ is a dummy variable equal to 1 if a municipality has above the median market share of SML corporate loans, and ARG_j is a dummy equal to 1 if the destination is Argentina. I include municipality-time, destination-sector-time, and state-destination fixed effects as well as main interactions. Municipalities with at least 2% market share of any SML institution are dropped. Standard errors are two-way clustered by municipality-sector and time. **Source**: Brazilian Central Bank, SECEX

Figure 8: BRL Invoicing and SML Usage



This figure compares the share of exports invoiced in BRL from the customs data with the share of total exports reported as SML exports via the Central Bank of Brazil. **Source**: Brazilian Central Bank, SECEX

Figure 9: Distribution of BRL Shares of Transactions



Histogram of BRL-invoicing for exports, V_{ijst}^{BRL}/V_{ijst}. V_{ijst} is the dollar value of total exports to destination j by firm i in 4-digit sector s in quarter t. V_{ijst}^{BRL} is the dollar value of BRL-invoiced exports. (Values strictly greater than 0 or strictly less than 1 are available in Figure (C.5))

Figure 10: BRL-Invoiced Exports to Argentina

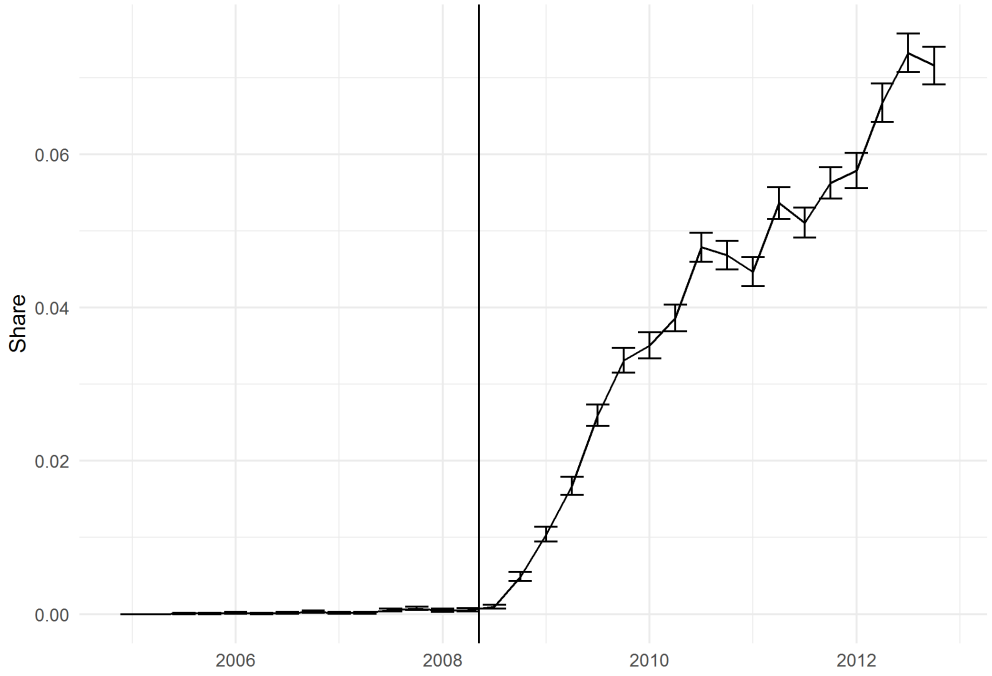


Figure shows the mean and standard deviation bands of the value of ι_{iARGst}. ι_{iARGst} is a dummy variable equal to one if at least 50% of the value of exports to Argentina by firm i in 4-digit sector s in quarter t are invoiced in BRL. **Source**: SECEX

Figure 11: Argentina ι Shares by Firm

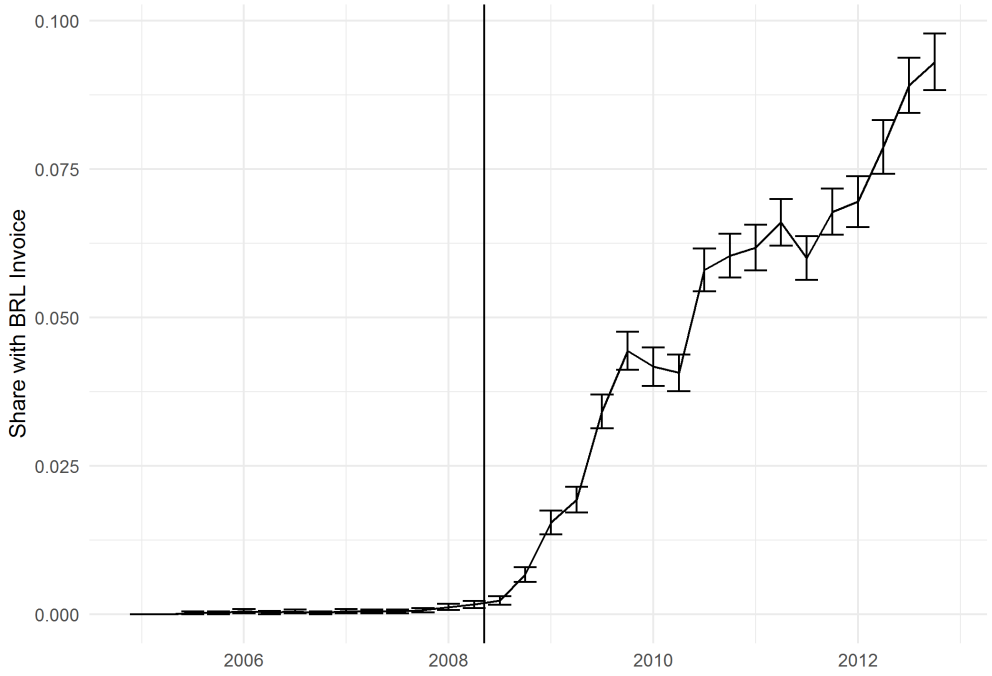
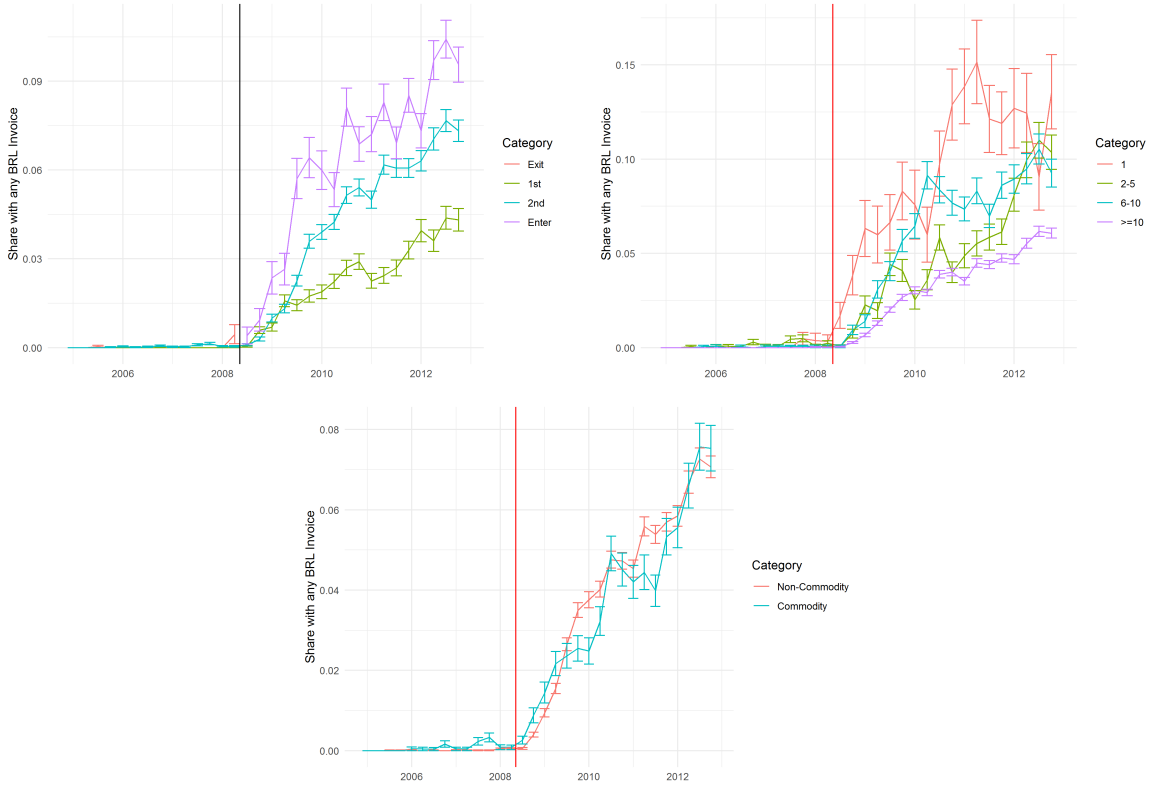


Figure shows the mean and standard deviation bands of the value of ι_{iARGt}. ι_{iARGt} is a dummy variable equal to one if for at least one sector exported by for i to Argentina in quarter t has at least 50% of the value of exports invoiced in BRL. **Source**: SECEX

Figure 12: Decomposition of BRL-Invoiced Exports to Argentina



Figures show the mean and standard deviation bands of the value of ι_{iARGst}. ι_{iARGst} is a dummy variable equal to one if at least 50% of the value of exports to Argentina by firm i in 4-digit sector s in quarter t are invoiced in BRL. In the first panel, the categories are determined by size as measure by total exports between 2007Q1 and 2008Q2 (below and above the median), where "exit" and "enter" denote not having or having exports after 2008Q2, respectively. In the second panel, the categories are determined by the total number of export destination by the firm including Argentina. In the last panel, the categories are whether the industry is a commodity as measured by Boz et al. (2018). **Source**: SECEX

Table 1: Currency Distribution Across Destinations

	2005Q1-2012Q4				2005Q1-2008Q2				2008Q3-2012Q4			
	Count		Value		Count		Value		Count		Value	
	USD	BRL	USD	BRL	USD	BRL	USD	BRL	USD	BRL	USD	BRL
Argentina	88.0	2.1	94.8	4.4	91.1	0.0	99.4	0.0	85.6	3.8	92.3	6.9
Bolivia	92.7	6.8	97.1	2.6	98.3	1.1	98.7	1.1	89.1	10.4	96.4	3.4
Chile	99.0	0.0	99.3	0.0	99.3	0.0	99.6	0.0	99.0	0.0	99.2	0.5
Colombia	99.3	0.0	98.7	0.0	99.6		99.5		99.1	0.0	98.2	0.0
Ecuador	99.7	0.0	99.4	0.0	99.8		99.8		99.5	0.0	99.4	0.0
Guyana	98.6	1.0	99.4	0.3	99.6		99.6		98.2	1.6	99.3	0.4
Paraguay	73.7	26.1	90.0	9.4	77.0	22.8	90.7	9.2	71.0	28.1	89.8	9.5
Peru	98.2	0.0	99.1	0.2	98.4		99.6		98.9	0.1	98.9	0.2
Uruguay	89.1	10.5	97.3	2.3	87.3	12.3	97.5	2.0	90.3	9.1	97.2	2.4
Venezuela	99.3	0.1	98.9	0.0	99.6		99.7		98.9	0.2	98.5	0.2

Each column presents the total share of exports, either by count (shipment) or by value, in USD and BRL. More details of the sample construction are found in the appendix. Shares are out of totals, which include shipments without the currency recorded. **Source**: SECEX

Table 2: Empirical Sample - Firm-Destination-HS6-Quarter

	Full Sample		**South America**		**Argentina**	
Variable	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Observations	4,673,465		2,011,410		392,324	
$\ln Val_{ijst}$	8.450	3.028	8.063	2.773	8.755	2.977
$\ln p_{ijst}$	2.545	2.201	2.686	2.039	2.737	2.103
BRL_Share_{ijst}	0.025	0.155	0.057	0.230	0.022	0.143

This table presents summary statistics for the customs data. **Source**: SECEX

Table 3: Top Ten Banks by Assets (December 2005) and SML Authorization

Bank Name	Assets (Share %)	Loans	SML (2008)
Banco ItauBank S.A.	31.9	2.2	X
Banco do Brasil S.A.	25.2	15.9	X
Banco Bradesco S.A.	6.9	14.9	X
Caixa Economica Federal	5.6	5.8	
Itau Unibanco S.A.	4.6	8.2	X
Unibanco-Uniao Bancos Bras SA	2.6	6.7	X
Banco Real	2.4	7.1	
Banco Nossa Caixa	1.8	2.4	
Banco Santander Brasil	1.7	2.7	
Kirton Bank	1.7	4.0	
Banco Safra	1.5	4.2	

This table presents a summary of the largest financial institutions in Brazil by the share of assets. The first column shows the share of assets, the second columns show the share of loans, and the final column shows whether or not the financial institution was a member of the SML system by the end of 2008. **Source**: Brazilian Central Bank

Table 4: Placebo Tests

	Dependent variable:				
	Log Value				
	(1)	(2)	(3)	(4)	(5)
Dest x SML	-0.362^{***}	-0.033	0.045	-0.166	-0.091
	(0.090)	(0.151)	(0.169)	(0.163)	(0.164)
Post x Dest x SML	0.222^{**}	-0.023	0.011	0.025	0.0004
	(0.090)	(0.163)	(0.039)	(0.133)	(0.126)
Country	Arg	Col	Chl	Par	Ury
Muni-Time FE	Y	Y	Y	Y	Y
HS2-Cou-Time FE	Y	Y	Y	Y	Y
State-Cou FE	Y	Y	Y	Y	Y
Observations	406,847	343,898	343,898	343,898	343,898
R^2	0.344	0.343	0.343	0.343	0.343
Adjusted R^2	0.297	0.292	0.292	0.292	0.292
Residual Std. Error	2.664	2.625	2.625	2.625	2.625

This table presents results from estimating the regression $\ln y_{msjt} = \alpha + \beta\left(POST_t \times \widetilde{SML\_Share}_m \times Dest_j\right) + \mathbf{X}_{msjt}\Gamma + \varepsilon_{msjt}$. Controls include municipality-time fixed effects, state-destination fixed effects, HS2-destination-time fixed effects, and main interactions. Each column of this table replaces the term $Dest_j$ with a dummy variable equal to one if the destination j is equal to the country denoted in the Country row. With the exception of Column (1), all exports to Argentina are dropped. Standard errors are two-way clustered by municipality-sector and time. **Source**: SECEX

Table 5: Variance Decomposition

R^2	0.022	0.002	0.023	0.512	0.031	0.048
Firm	X		X			X
Time		X	X			
Firm-Time				X		
HS4-Time					X	X

This table presents regression results from estimating $\Delta\iota_{isARGt} = \alpha + \varepsilon_{ijARGt}$. ι_{isARGt} is a dummy equal to one if at least 10% by value of a shipment by firm i in sector s to Argentina at time t in in BRL. $\Delta\iota_{isARGt}$ denotes the medium-run change in invoicing behavior, as I take the difference between periods where positive values are observed. α denotes the different levels of fixed effects. **Source**: SECEX.

Table 6: Shipment-Level Effects of BRL Invoicing

Panel A: Benchmark Specification

	$\ln V_{ijst}$	$\ln P_{ijst}$	$\ln V_{ijst}$	$\ln P_{ijst}$
	(1)	(2)	(3)	(4)
ι_{ijst}	0.273***	-0.007	-0.035	0.007
	(0.077)	(0.025)	(0.089)	(0.029)
$\iota_{ijst} \times ARG$			0.437***	-0.034
			(0.118)	(0.035)
Firm-HS4 FE	Y	Y	Y	Y
HS2-Time FE	Y	Y	Y	Y
Dest-Time FE			Y	Y
Sample	Arg	Arg	SA	SA
Obs	364,705	350,321	1,934,081	1,851,077
$\mathcal{R}^2$	0.841	0.886	0.746	0.859

Panel B: Including Firm-Time Dummies

	$\ln V_{ijst}$	$\ln P_{ijst}$	$\ln V_{ijst}$	$\ln P_{ijst}$	ι_{ijst}	$\ln V_{ijst}$
	(1)	(2)	(3)	(4)	(5)	(6)
ι_{ijst}	0.476***	-0.035	-0.128	-0.012		
	(0.131)	(0.046)	(0.112)	(0.047)		
$\iota_{ijst} \times ARG$			0.393***	-0.017		0.318
			(0.128)	(0.053)		(1.542)
$Z_{m(i)jt}$					0.052***	
					(0.017)	
Firm-Time FE	Y	Y	Y	Y	Y	Y
Firm-HS4 FE	Y	Y	Y	Y	Y	Y
HS2-Time FE	Y	Y	Y	Y	Y	Y
Dest-Time FE			Y	Y	Y	Y
Firm-Dest FE			Y	Y	Y	Y
First-Stage F					9.40	
Sample	Arg	Arg	SA	SA	SA	SA
Obs	292,729	279,361	1,830,416	1,748,786	1,825,422	1,825,422
Adj. $\mathcal{R}^2$	0.856	0.871	0.792	0.861		

$*$ $p < 0.1$; $**$ $p < 0.05$; $***$ $p < 0.01$. Standard errors clustered at the sector-establishment level. The first two columns of the table reports regressions of the form $y_{ijst} = \alpha + \beta \iota_{ijst} + \mathbf{X}_{ijst}\Gamma + \varepsilon_{ijst}$, where y_{ijst} represents the log value of exports (in USD) or the log price for establishment i in sector s to Argentina at time t. ι_{ijst} is a dummy variable equal to 1 if at least 10% of exports in sector s by firm i to destination j are invoiced in BRL, and ARG_j is a dummy variable equal to 1 if the destination is Argentina. The last column of the table reports regressions of the form $y_{ijst} = \alpha + \beta \iota_{ijst} + \gamma(\iota_{ijst} \times ARG_j) + \mathbf{X}_{ijst}\Gamma + \varepsilon_{ijst}$, where y_{ijst} represents the log value of exports (in USD) for establishment i in sector s to destination j at time t. The difference in observations across specifications reflects the dropping of singleton observations.

Table 7: Heterogeneity Analysis of the Effects of BRL Invoicing

	$\ln V_{ijst}$ (1)	$\ln V_{ijst}$ (2)	$\ln V_{ijst}$ (3)
ι_{ijst}	-0.047*	-0.035	-0.066**
	(0.025)	(0.023)	(0.030)
$\iota_{ijst} \times ARG$	0.048	-0.008	0.258
	(0.176)	(0.083)	(0.190)
$\iota_{ijst} \times ARG \times NonComm$	0.539***		
	(0.094)		
$\iota_{ijst} \times ARG \times ArgShare$		0.454**	
		(0.181)	
$\iota_{ijst} \times ARG \times Large$			0.089
			(0.196)
Firm-HS4 FE	Y	Y	Y
HS2-Time FE	Y	Y	Y
Dest-Time FE	Y	Y	Y
Sample	SA	SA	SA
Obs	1,934,081	1,793,286	1,539,533
$\mathcal{R}^2$	0.744	0.746	0.741

$*$ $p < 0.1$; $**$ $p < 0.05$; $***$ $p < 0.01$. Standard errors clustered at the sector-establishment level. Each column of the table reports regressions of the form $y_{ijst} = \alpha + \beta\iota_{ijst} + \gamma(\iota_{ijst} \times ARG_j) + +\delta(\iota_{ijst} \times ARG_j \times H_{ijst}) + \mathbf{X}_{ijst}\Gamma + \varepsilon_{ijst}$, where y_{ijst} represents the log value of exports (in USD) for establishment i in sector s to destination j at time t, ι_{ijst} is a dummy variable equal to 1 if at least 10% of exports in sector s by firm i to destination j are invoiced in BRL, and ARG_j is a dummy variable equal to 1 if the destination is Argentina, and H_{ijst} represents some level of heterogeneity, either sector, Argentina export share, or size. The difference in observations across specifications reflects the dropping of singleton observations and whether data exists for the heterogeneity analysis.

Table 8: Effect of BRL Invoicing on Firm Export Behavior

	Arg_Share_{ist}		$\ln V_{ist}$	
	(1)	(2)	(3)	(4)
ι_{ist}	0.071***		0.211***	
	(0.010)		(0.080)	
ι_{ist}^{ARG}		0.222***		0.541***
		(0.014)		(0.062)
ι_{ist}^{OTH}		-0.003*		0.052
		(0.002)		(0.093)
Firm-Time FE	Y	Y	Y	Y
Firm-HS4 FE	Y	Y	Y	Y
HS2-Time FE	Y	Y	Y	Y
Obs	1,714,524	1,714,524	1,714,524	1,714,524
$\mathcal{R}^2$	0.639	0.638	0.825	0.825

$*$ $p < 0.1$; $**$ $p < 0.05$; $***$ $p < 0.01$. Standard errors clustered at the establishment level. The table reports regressions of the form $y_{ist} = \alpha + \beta\iota_{ist} + \varepsilon_{ist}$, where y_{ist} represents *total* exports in sector s by firm i at time t across all destinations, and ι_{ist} is equal to one if any ι_{ijst} for firm i in sector s at time t is equal to one.

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A Data Appendix

A.1 Construction of Customs Dataset

Customs transactions are recorded from customs forms, filled out online by Brazilian exporters. These forms include, in particular, the unique 12-digit firm identifier, the CNPJ, the 8-digit HS code for the individual sector and the destination. Individual transactions are summed to the monthly frequency. The data is therefore available at the monthly frequency by firm, eight-digit HS sector, and destination. An example of a customs form is given in Figure (C.1).

The *CNPJ*'s are 14-digit identifier coes representing an establishment. This code is comprised of 8 digits representing the parent firm, then 4 digits representing the specific establishment, with two check digits at the end. Following other work in this area, I report all results at the establishment level.

Each sector is defined by the "Nomenclatura Comum do Mercosul" code, or Mercosul Common Nomenclature code, which is effectively an eight digit HS code. I collapse the data to the 4-digit NCM code, which is the group level in the Harmonized System. For example, while chapter 09 refers to Coffee, Tea, Maté, and Spices, 0902 refers to Tea.

The currency of invoicing is included in the overwhelming majority of cases. For a number of very small transactions, as simplified customs form is used that does not include the currency of invoicing. Conversations with customs officials suggests that these transactions are likely to be invoiced in USD, so I record them as such.

The currency of invoicing is recorded in nearly all cases. Table C.1 reports the share of total value for each currency in the raw sample. Other than USD, Euro, and BRL, no other currency accounts for more than 1% of international trade by volume or by count. As in other emerging markets, the USD accounts for the vast majority of export transactions, over 94% by volume. The count share of approximately 80% does not include the "zero" currencies which are likely USD invoiced. Taken together, the USD accounts for roughly 90% of trade by count. The smaller share of USD transactions by count compared with volume is a similar finding as in other datasets, such as in Belgium in Amiti et al. (2018).

From the monthly data, I filter the sample to eliminate non-firms, which account for roughly 23,849 monthly observations. These observations have *CPF*'s (individual identifiers) rather than having *CNPJ*'s (establishment identifiers). I also eliminate two observations which have zero value recorded. The resulting dataset has 10,595,854 currency-firm-HS8-destination-month observations.

I aggregate the data to four-digit HS sector at the quarterly frequency. The key variables of interest are value, prices, and the currency of invoicing. Value is summed over all months and eight-digit HS sectors within a four-digit HS sector and quarter. Following Chatterjee et al. (2013), within each four-digit sector I check which measure has more non-missing observations between net weight and statistical quantity. For those transactions with non-missing values of the more populated measure, denoted Q. I then collapse the data to the quarterly frequency by firm, destination, and 4-digit sector. For values, I take the sum over all shipments within the cell. As for prices, I take a weighted average across all shipments within the cell. Collapsing to the quarterly dataset as explained above and aggregating across currencies results in a dataset of 4,673,465 firm-HS4-destination-quarter observations. At this quarterly frequency, I then winsorize the data at the 1% and 99% level within a Country-HS2 cell to arrive at value V. Prices are calculated as $P = V/Q$

Figure C.2 plots the number of firms in each quarter in the final sample. Two facts stand out. First, the number of exporting firms is relatively stable following the Great Recession, with the average over time being between 14,000 and 15,000 in any given quarter. Second, there was a decline in the number of firms owing to the Great Recession. Figure C.3 plots the number of transactions in each month, defined as the total exports by firm-sector-destination. The number of transactions is relatively stable over the course of the sample. Figure (C.4) plots total value, both raw and winsorized, over the course of the sample. Other than a significant and short-lived dip during the Great Recession, total exports continued to rise over the course of the sample.

A.2 Additional Summary Statistics

Figure C.5 presents value shares for firm-HS4-destination-quarters with strictly greater than 0% BRL shares and strictly less than 100% BRL shares.

B Additional Empirical Results

B.1 Municipality Evidence: Balancing the Panel

One concern with the results in Figure (6) is that the panel is unbalanced. In periods when municipality-sectors do not export, I treat this data as missing. Ideally, one would condition only on municipality-sector-destinations for which data from all years is available. Unfortunately, this is difficult because the treatment group to limited only 3% of the resulting sample, mainly due to the usage of HS2 level data. Here, I explore a number of alterna-

tive specifications to show that the results are not driven by the unbalanced nature of the panel.

I conduct three alternatives specifications. First, I collapse the data across sectors to the municipality-destination level, condition on continuous municipalities, and plot the triple difference specification. The results are displayed in Figure (C.7). Collapsing the data to the municipality level and conditioning on municipality-destination data with the full sample does not affect the pretrend. The estimated effect of the SML system is a bit more delayed, but quantitatively significant.

Second, I drop municipality-sectors for which there are zero or only one pre-period observations. The results are displayed in Figure (C.6). Conditioning on municipalities with at least observable pre-periods enlarges the standard errors, but the results are qualitatively similar.

B.2 Municipality Evidence: Drop Largest Banks

Anecdotal evidence from Central Bank employees suggests that the largest banks were not likely to use the SML program due to lower revenues. Specifically, the SML system typically relies on the official exchange rate (although it is not required), so banks do not charge any spread on the exchange rate when clients use the SML system. Large banks with a high volume of foreign exchange transactions can take advantage of this spread in ways that smaller banks do not.

This factor implies that the largest banks bias downwards causal estimates of the usage of the SML system in the municipality results in the main text. Binning the measure of treatment into high and low SML usage partially alleviates this issue. However, another way to check whether this story is true is to assume that the largest banks, although they are authorized to use the SML system, do not actually use it. I recalculate the SML_Share_m variables assuming the two largest banks, Banco do Brasil and Itau, were not authorized to use the SML system.

Figure (C.8) presents results for this regression. The pretrend is in fact slightly smoother in the run up to the introduction of the SML system, and the increase in the years immediately following its introduction are more noticeable. While the long-run effects are attenuated, the SML system still has a noticeable effect on export volumes at the municipality level.

B.3 Micro Evidence: Additional Breakdowns

Figure C.9 reports the breakdown of ι for Colombia, while Figure C.10 shows the evolution of ι relative to other export destinations.

B.4 Micro Evidence: Additional Sectoral Figures

Figures (C.11) through Figure (C.30) plot the evolution of ι_{ijst} for $j = ARG$ by two-digit HS sector. While the overall pattern is similar for many sectors, there are also a number of sectors for which there is little to no rise in BRL invoicing.

B.5 Micro Evidence: Alternative Fixed Effect Specifications

To check for the presence of firm-level, I estimate Equation (4) that explicitly controls for time-varying changes at the firm-sector level. Recall both that firms' currency choice is extremely sticky over time, and that most of the variation in ι^{BRL} following the introduction of the SML system occurs across sectors within a firm. There is therefore little variation across sectors or destinations in invoicing currency. The results are displayed in Column (1) of Table (C.2). The coefficient estimate of 0.438 (SE: 0.094) suggests that invoicing in BRL raises the size of an export shipment by 44% relative to export shipments to other destinations not invoiced in BRL in the same 4-digit sector by the same firm at the same time. This estimate is statistically insignificant from the coefficient estimate in Table 6.

For transparency, in Column (2) I interact this measure with a dummy variable for Argentina. While the coefficient on this interaction is negative, the large standard errors on both the main effect and interaction effect suggest that there is not much additional variation in BRL invoicing shares outside of Argentina. In other words, there is almost no variation across destinations within an individual firm's four-digit sector at a given quarter outside that of using the SML system.

C Model Appendix

C.1 Derivation of Equilibrium Price

The program for the exporter is given by

$$\begin{aligned}&\max_{P^\ell} \frac{S_X^\ell P^\ell Q}{1+\tau_X} - C(Q)\\ &\text{s.t. } Q = f(S_M^\ell P^\ell (1+\tau_M))\end{aligned}$$

The first-order condition can be written succinctly as

$$0 = \frac{S_X^\ell}{1+\tau_X}\left(P^\ell \frac{\partial Q}{\partial P^\ell} + Q\right) - C'(Q)\frac{\partial Q}{\partial P^\ell}$$

Recall that demand and costs are given by

$$\begin{aligned}Q^D =& (S_M^\ell P^\ell (1+\tau_M))^{-\rho}\mathbf{X}, \quad \rho > 1\\ C(Q) =& W Q^{\frac{1}{\alpha}}\end{aligned}$$

Plugging these in and rearranging gives the optimal price as

$$P^\ell = \frac{(1+\tau_X)}{S_X^\ell}\frac{\rho}{\rho-1}\frac{W}{\alpha}\left((S_M^\ell P^\ell (1+\tau_M))^{-\rho}\mathbf{X}\right)^{\frac{1-\alpha}{\alpha}} \tag{9}$$

Because firms commit to supplying as much product as possible at the foregoing price, plugging in for demand into equation (9) under this specification and rearranging gives the equilibrium price

$$P^\ell = \left[\frac{(1+\tau_X)/S_X^\ell}{(S_M(1+\tau_M))^{\rho\frac{1-\alpha}{\alpha}}}\frac{\rho}{\rho-1}\frac{W}{\alpha}\mathbf{X}^{\frac{1-\alpha}{\alpha}}\right]^{\frac{1}{1+\rho\frac{1-\alpha}{\alpha}}}$$

C.2 Exporter Risk Aversion

There exist a set of risk-averse exporters, indexed by ω. Profits in a given invoice currency ℓ, $\pi^\ell(\omega)$, are given by the difference between revenues and costs[48]

$$\pi^\ell(\omega) = (S_\ell p^\ell(\omega) - C(\omega))Q(\omega, \ell) \tag{10}$$

where $p^\ell(\omega)$ is the price in currency ℓ, $C(\omega)$ denotes constant marginal costs for firm ω and $Q(\omega, \ell)$ is total production. These costs depend only on ω and not the invoice currency ℓ. S_ℓ is the exporter's exchange rate relative to currency ℓ, such that an increase in S_ℓ is a depreciation of the exporters' currency.

I assume that exporters are risk averse. Following Mann (1989), I assume firms' objective functions are the sum of expected profits $E[\pi^\ell(\omega)]$ and the negative of the standard deviation of profits $[V(\pi^\ell(\omega))]^{1/2}$, with the latter scaled by $\gamma > 0$.[49] Firms choose prices to maximize this objective function subject to demand and the definition of profits Equation (10).

$$\max_{p^\ell} E[\pi^\ell(\omega)] - \gamma[V(\pi^\ell(\omega))]^{1/2} \text{ s.t. } Q(\omega) = \mathcal{D}(\omega, \ell)$$

where $\mathcal{D}(\omega, \ell)$ denotes the demand function for the exporter's good.

Solving this equation gives the optimal price as

$$p^\ell(\omega) = \frac{1}{1 - \gamma\sigma_\ell} \frac{\eta_D(\omega, \ell)}{\eta_D(\omega, \ell) - 1} C(\omega) \tag{11}$$

where σ_ℓ is the standard deviation of the exchange rate and $\eta_D(\omega, \ell)$ is the elasticity of demand. With exporter risk-aversion, a higher variability of the relevant exchange rate directly affects the price charged by the exporter. Specifically, higher exchange rate volatility is associated with higher prices. Intuitively, the exporter must be compensated for bearing some risk. Here, $1 + \tau_X = \frac{1}{1-\gamma\sigma_\ell}$.

[48] As this section is meant to be illustrative regarding the effects of the SML system, I assume the invoicing decision is exogenous. I therefore solve the exporter problem by finding the optimal price conditional on currency ℓ.

[49] This ad-hoc assumption ensures that there is an analytical solution due to the result that risk scales linearly with demand. The resulting solution is therefore easily interpretable, but should be seen as qualitative.

C.3 Imperfect Markets in Foreign Currency

A representative importer purchases quantity $X(\omega)$ of varieties ω that are bundled according to a CES production technology. Cost minimization over the import bundle is

$$\min \int F_\ell P^\ell(\omega) X(\omega) d\omega$$
$$s.t. X = \left(\int X(\omega)^{\frac{\rho-1}{\rho}} d\omega \right)^{\frac{\rho}{\rho-1}}$$

The price of an individual variety involves two components. First, there is the invoice price $P^\ell(\omega)$, taken as given by the importer. Second, if the variety is invoiced in foreign currency, there is the exchange of local currency to currency ℓ, given by the exchange rate F_ℓ, such that an increase in F_ℓ is a depreciation of the local currency.

The demand for any individual variety can be written as

$$X(\omega) = \left(F_\ell P^\ell(\omega) \right)^{-\rho} \mathbf{P}^\rho X$$

where $\mathbf{P} = \left(\int (F_\ell P^\ell(\omega))^{1-\rho} d\omega \right)^{\frac{1}{1-\rho}}$ is the price index. I assume that a sufficiently small number of varieties are invoiced in foreign currency such that changes in the overall price index due to changes in F_ℓ are close to zero, and so can be ignored.

Financial intermediaries convert domestic currency to foreign currency. There exists a monopoly supplier of foreign currency that can access global exchange rates. The monopoly supplier is small relative to global markets, and so can purchase or sell as much currency as possible at the prevailing market exchange rate.

Financial intermediaries choose the exchange rate F_ℓ to maximize profits given by

$$\Pi = F_\ell Q - S_\ell Q$$
$$\text{s.t. } Q = \int P^j(\omega) X(\omega) d\omega = (F_\ell)^{-\rho} \int \left(P^\ell(\omega) \right)^{-\rho} \mathbf{P}^\rho X$$

where S_ℓ is the market exchange rate that only the financial intermediary has access to. The nominal amount of foreign currency to purchase is given by $Q = \int P^j(\omega) X(\omega) d\omega$.

The optimal F_ℓ posted by the foreign currency supplier is

$$F_\ell = \frac{\rho}{\rho - 1} S_\ell$$

Demand for an individual product can then be written as

$$X(\omega) = \left(\frac{\rho}{\rho - 1} S_\ell P^\ell(\omega)\right)^{-\rho} \mathbf{P}^\rho X$$

Here, $1 + \tau_M = \frac{\rho}{\rho - 1}$ is given by the markup charged by financial intermediaries. The SML system acts to potentially lower this markup by allowing firms to access the market exchange rate. The posted price by the exporter includes a markup by the financial sector, which the importer interprets as a higher overall price.

C.4 Foreign Currency Loans

Importers are either retailers or domestic producers, who purchase some quantity of the final good X at price in invoice currency P^ℓ, where ℓ denotes the currency of invoicing. To purchase this quantity, importers must borrow in advance the amount in the invoice currency, $B = P^\ell X$. The interest on the loan is given by r_ℓ, signifying that it is the cost of borrowing in currency ℓ. This loan is then repaid with interest and accounting for realized movements in exchange rates at the end of the period, when sales are realized.

Formally, the total cost of this loan is given by the difference between what is realized (principal and interest adjusted for the exchange rate) minus the initial principal borrowed.

$$\left((1+r_\ell)\left(\frac{\Delta S'_\ell}{S_\ell}+1\right)-1\right)B \approx \left(r_\ell+\frac{\Delta S'_\ell}{S_\ell}\right)B$$

Suppose that the importer is perfectly competitive and sells output Q at domestic price $\tilde{P}$ with production technology given by $Q = X^\alpha L^{1-\alpha}$, where $\alpha \in (0,1)$ and L denotes domestic input. Letting W denote the cost of the domestic input, cost minimization can be written as

$$\begin{gathered}\min\left(1+\left(r_\ell+\frac{E\Delta S'_\ell}{S_\ell}\right)\right)P^\ell X + WL \\ \text{s.t. } Q = X^\alpha L^{1-\alpha}\end{gathered}$$

where the expectations operator enters because the firm makes production decisions prior to the realization of the exchange rate.

The first-order condition for an interior solution can be written as

$$\frac{\left(1+\left(r_\ell+\frac{E\Delta S'_\ell}{S_\ell}\right)\right)P^\ell}{W} = \frac{\alpha}{1-\alpha}\frac{L}{X}$$

Plugging back into the production function gives

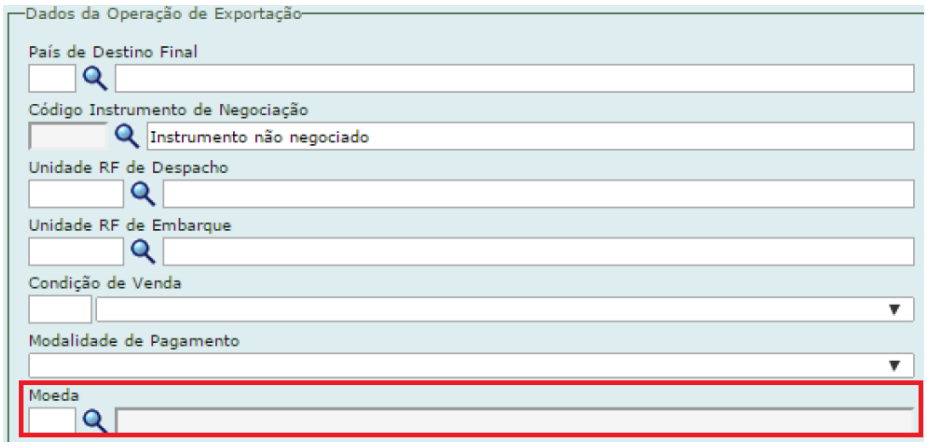
$$Q = X^\alpha\left(\frac{\left(1+\left(r_\ell+\frac{E\Delta S'_\ell}{S_\ell}\right)\right)P^\ell}{W}\frac{1-\alpha}{\alpha}X\right)^{1-\alpha}$$

Rearranging gives the conditional import demand function as

$$X = \left(1 + \left(r_\ell + \frac{E\Delta S'_\ell}{S_\ell}\right)\right)^{\alpha-1} \left(\frac{W}{P^\ell}\right)^{1-\alpha} \tilde{\alpha} Q$$

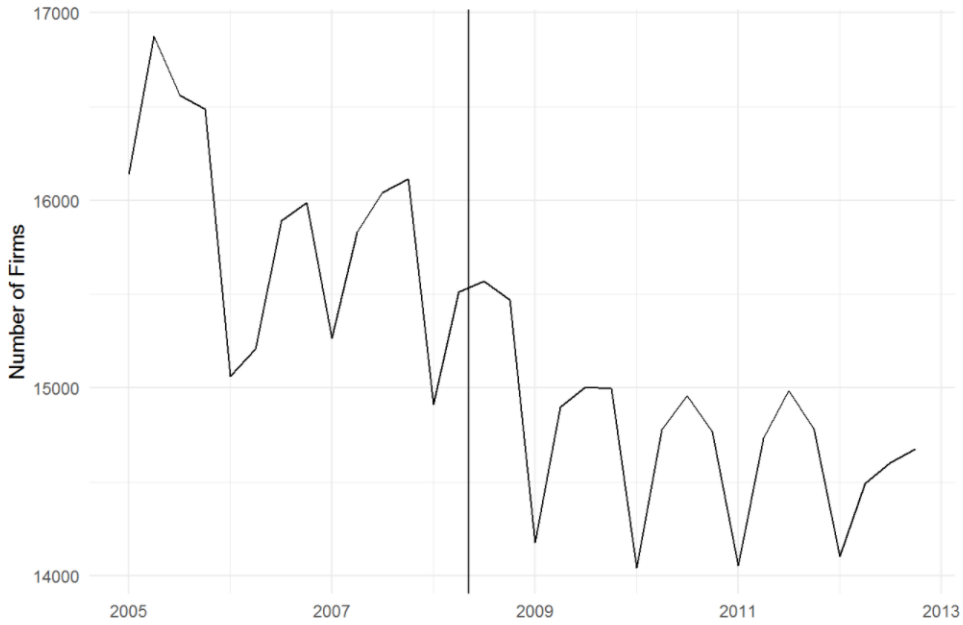
where $\tilde{\alpha} = \left(\frac{\alpha}{1-\alpha}\right)^{\alpha-1}$. Here $1 + \tau_M = \left(1 + \left(r_\ell + \frac{E\Delta S'_\ell}{S_\ell}\right)\right)^{\alpha-1}$. Ignore the cost of financing r_ℓ, which is a common output in working capital assumptions such as this framework. Expected depreciations in local exchange rates affect demand for imports by directly increasing their marginal cost. The importer takes into account such potential price changes when choosing to purchase from an exporter. If the currency is expected to depreciate, the importer interprets it as a higher cost.

Figure C.1: Customs Form (Online)



Screenshot of a customs form to be filled out by an exporter. The key field denoting the currency of invoicing, labeled "moeda", is outlined in red by the author. **Source:** SECEX.

Figure C.2: Number of Firms Over Time

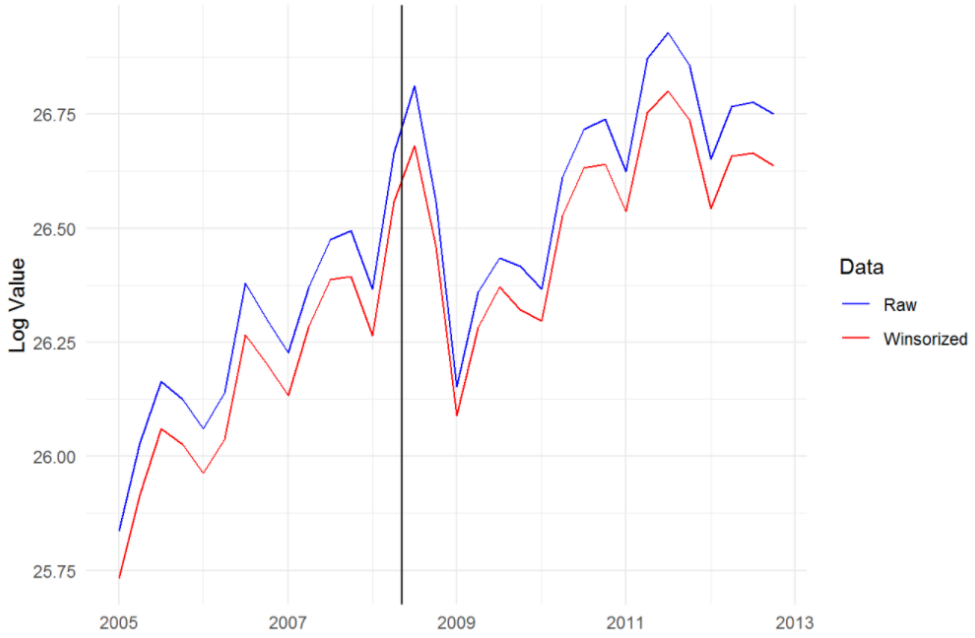


This figure plots the number of unique firms each quarter in the final sample. **Source:** SECEX.

Figure C.3: Number of Transaction Over Time

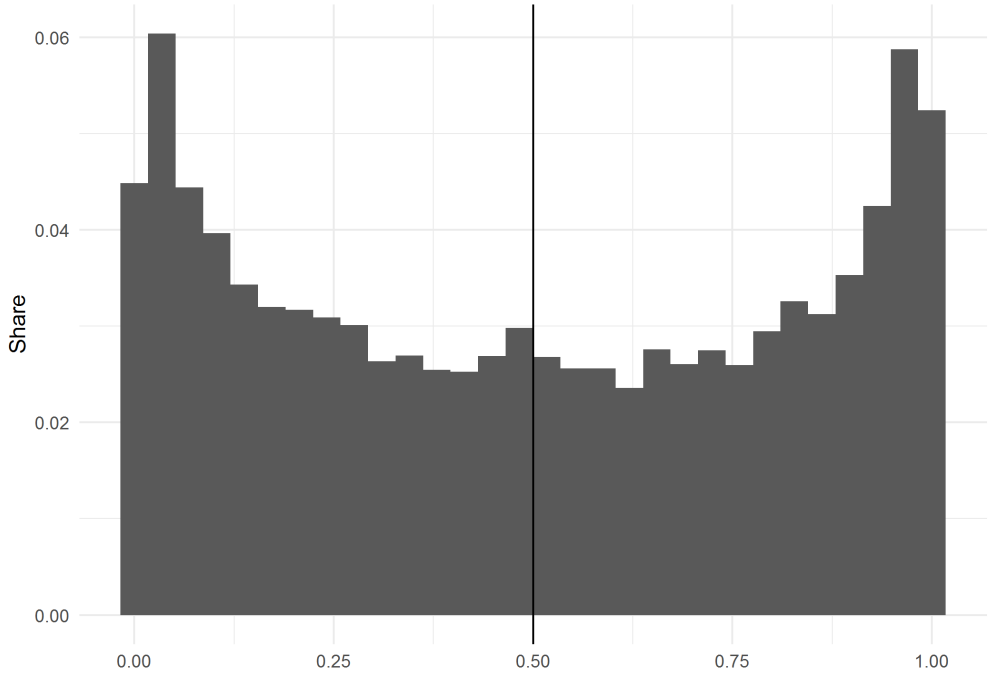
This figure plots the number of transactions each quarter in the final sample. **Source:** SECEX.

Figure C.4: Value Over Time



This figure plots the total value of each quarter in the final sample. The line labeled "raw" denotes the raw value. The line labeled "winsorized" winsorizes the raw data at the 1% and 99% levels within each HS2-Destination cell. **Source:** SECEX.

Figure C.5: BRL Value Shares (Greater than zero and less than one)



This figure plots the share of exports invoiced in BRL for shipments with strictly greater than 0% and strictly less than 100%. **Source:** SECEX.

Figure C.6: Results with at least one pre-period observation

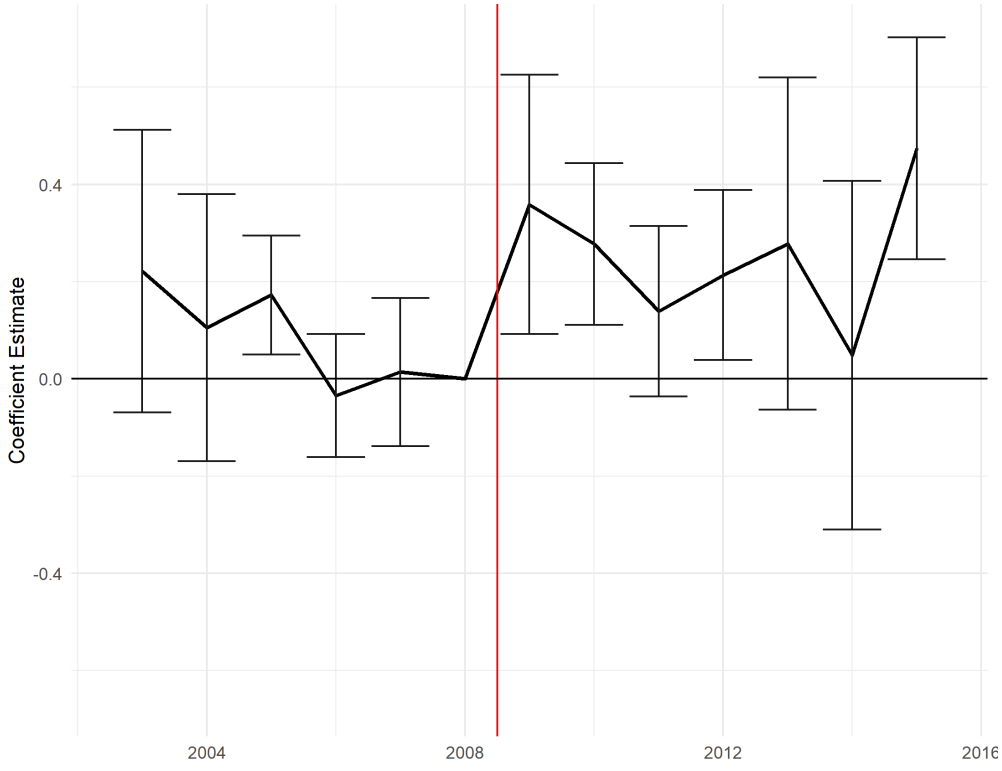


Figure C.7: Results at municipality level conditional on having all data

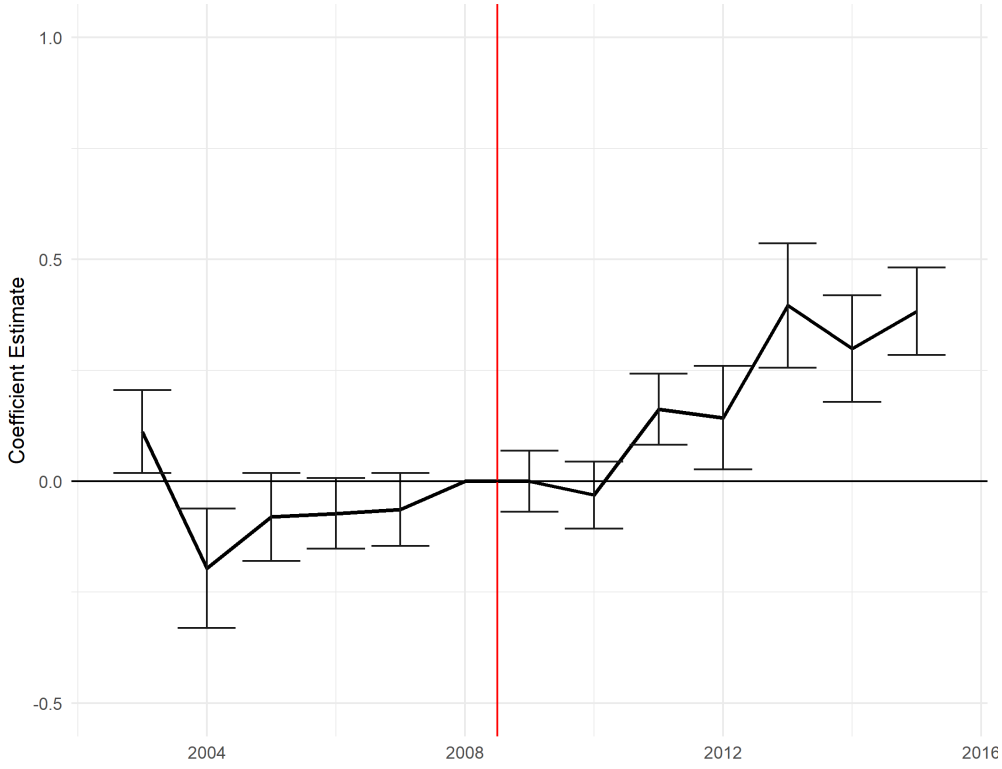


Figure C.8: Results assuming largest banks do not use the SML system

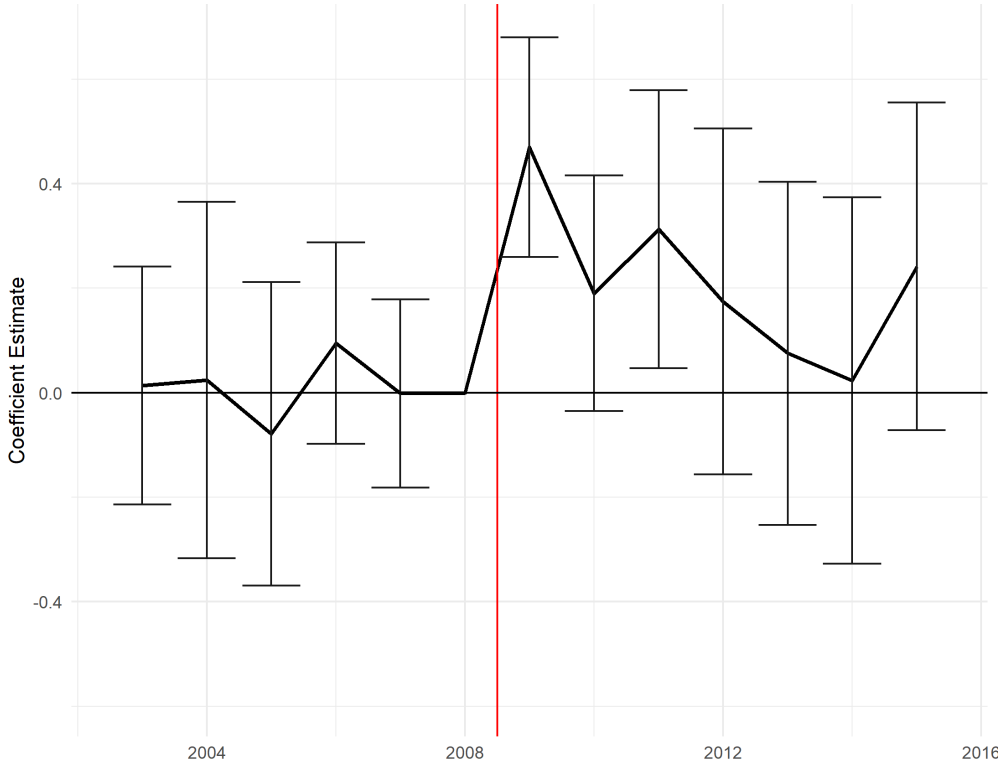


Figure C.9: Colombia ι Shares

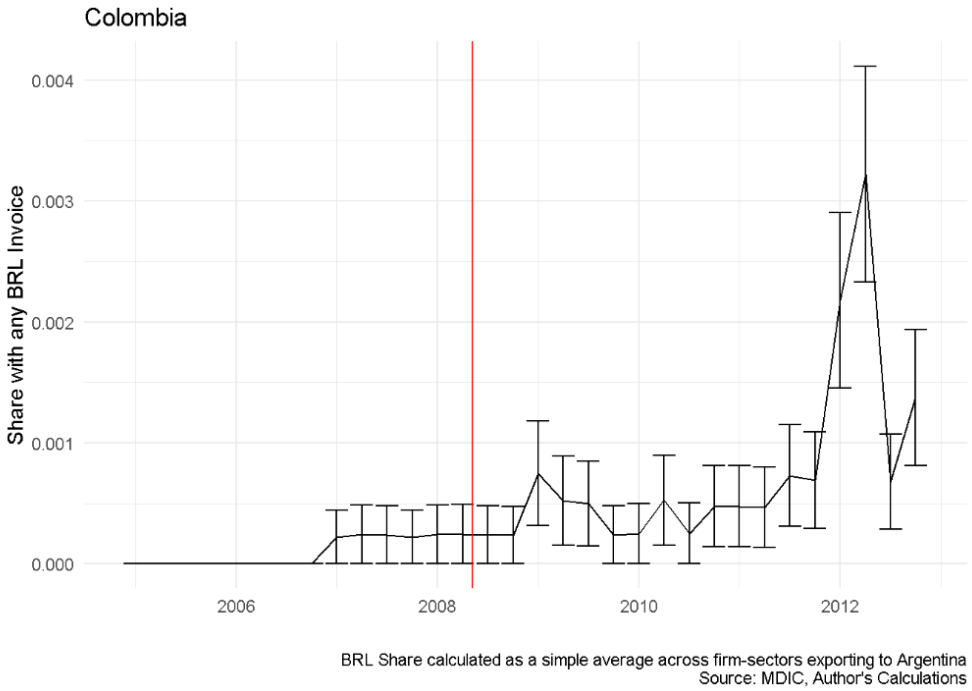


Figure C.10: Argentina ι shares relative to other Latin America countries

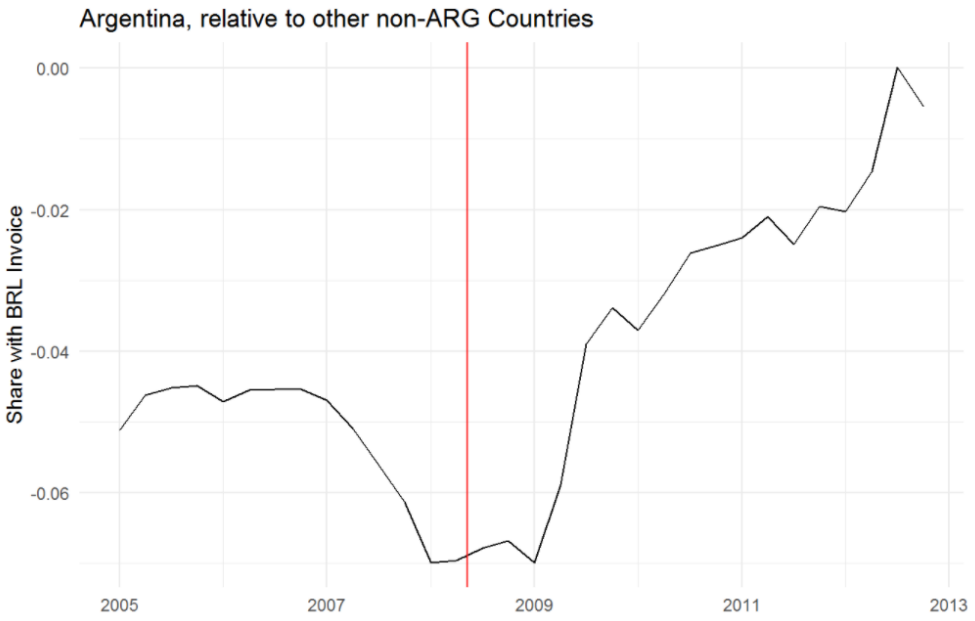


Figure C.11: Section 1: Live Animals

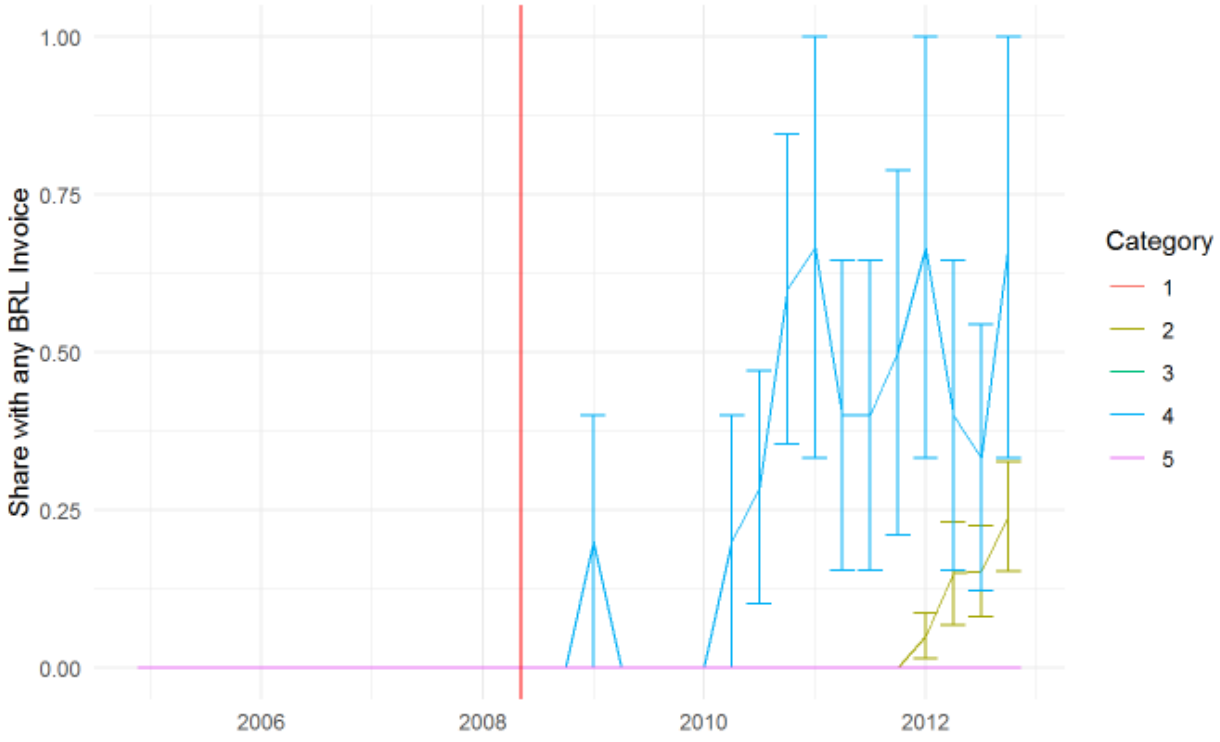


Figure C.12: Section 2: Vegetable Products

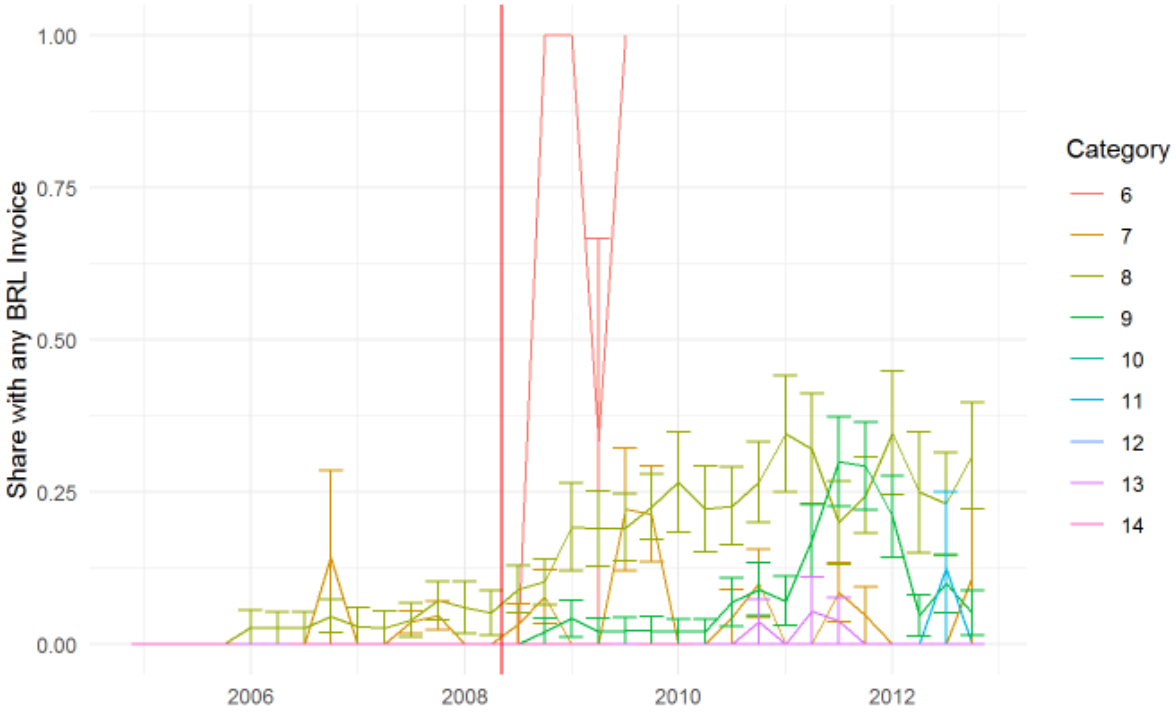


Figure C.13: Section 3: Animal and Vegetable Fats and Oils

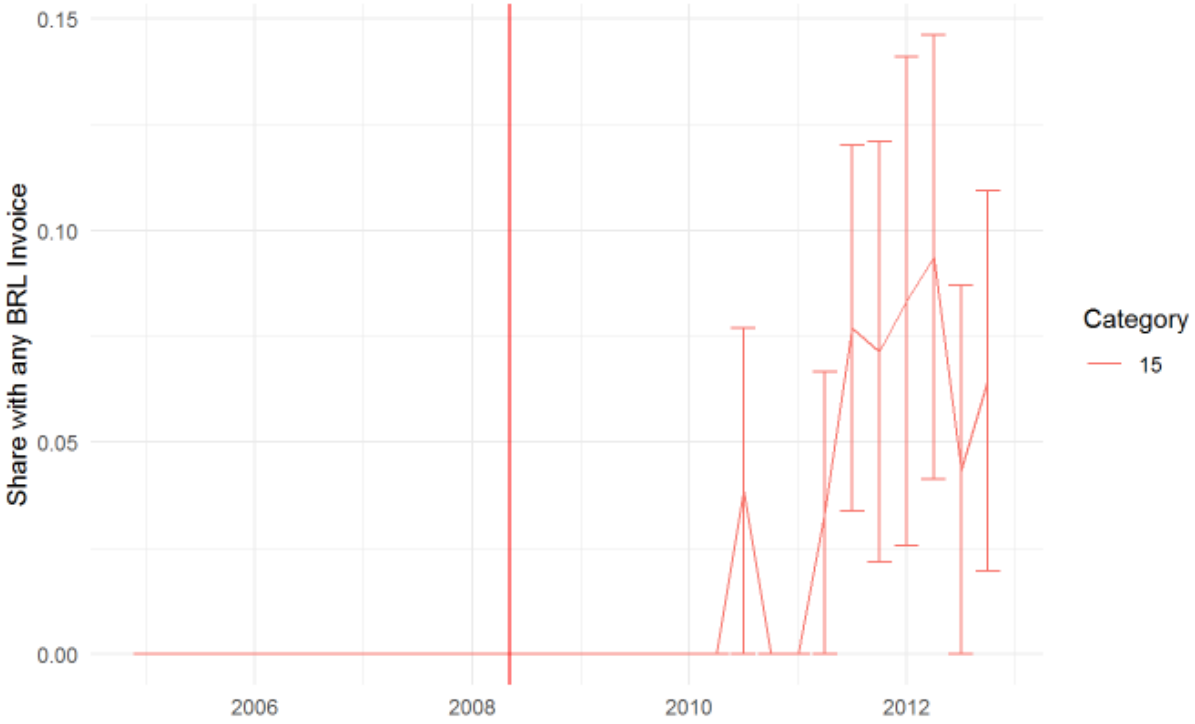


Figure C.14: Section 4: Prepared Foodstuffs, Beverages, and Tobacco

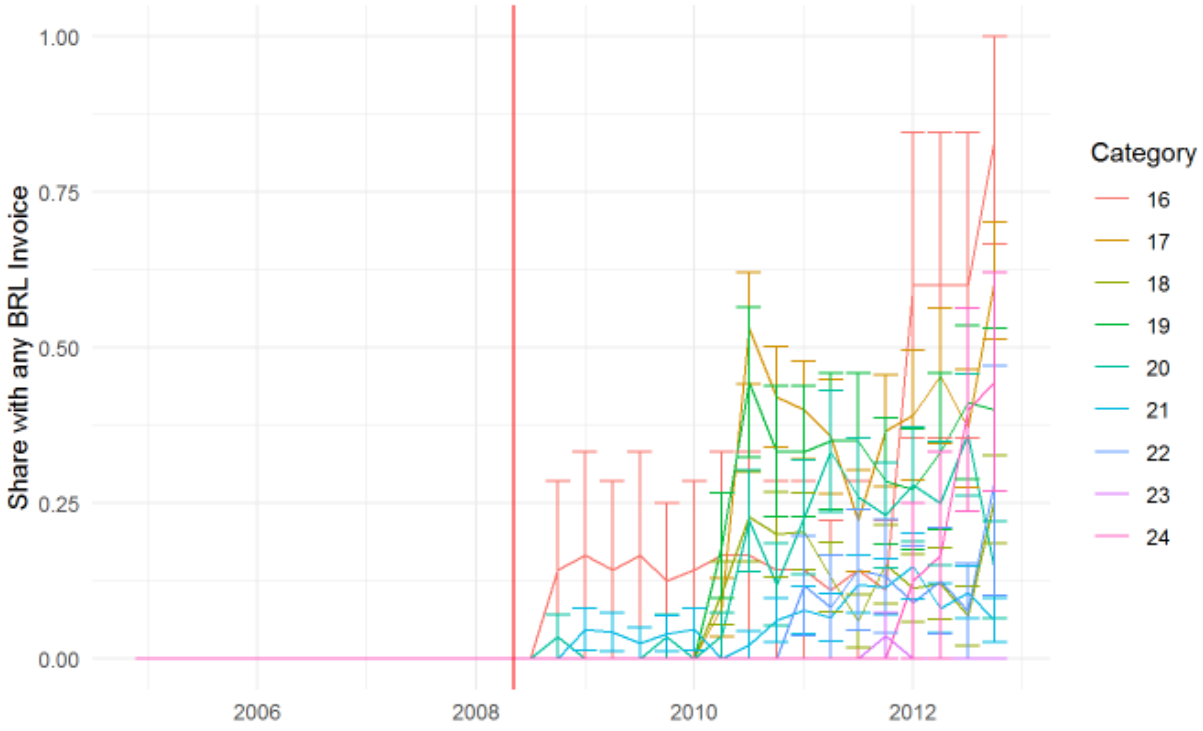


Figure C.15: Section 5: Minerals

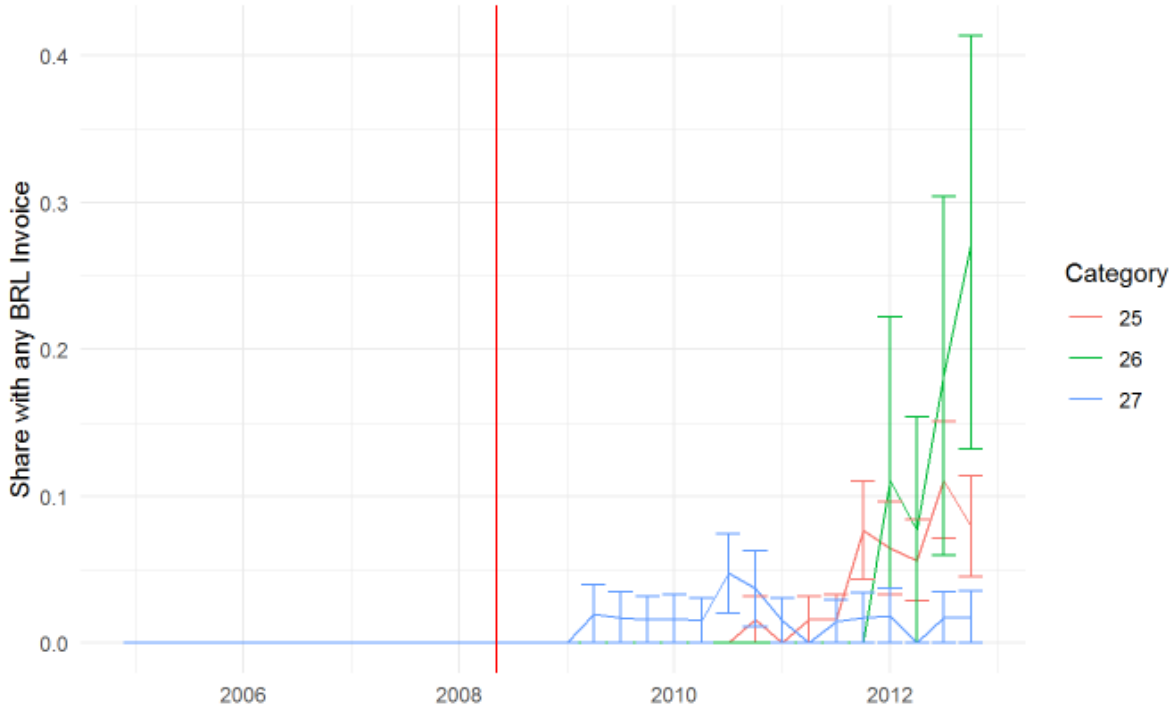


Figure C.16: Section 6: Chemical Products

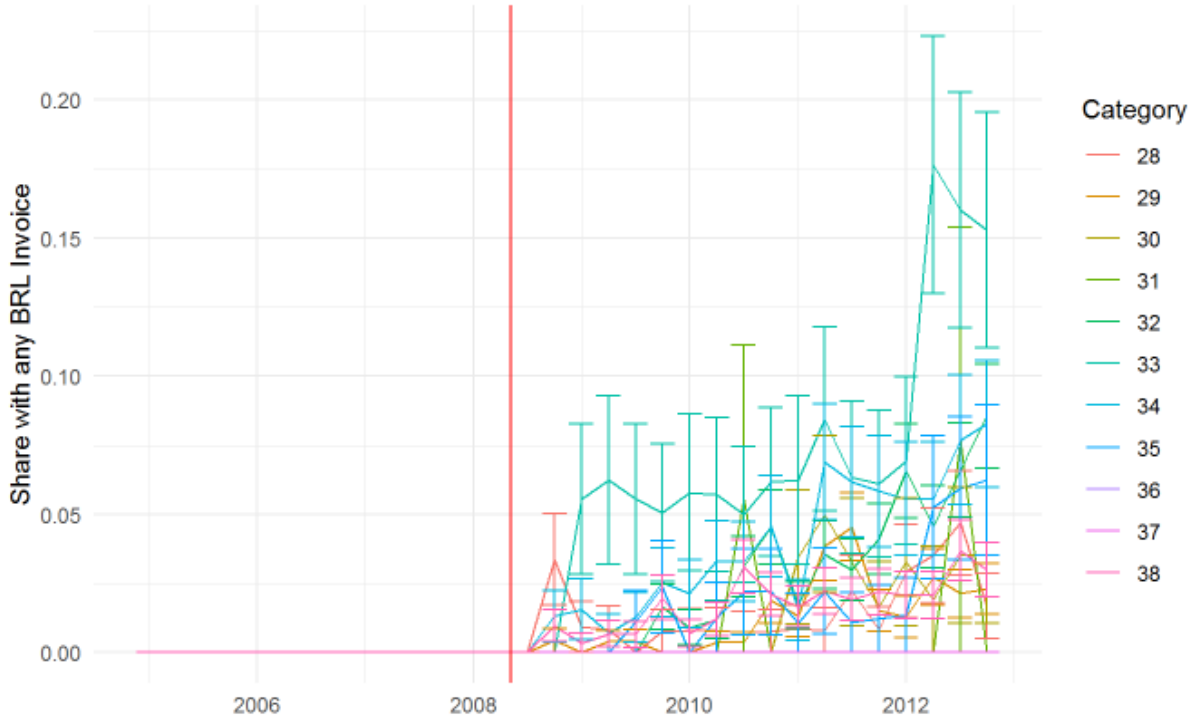


Figure C.17: Section 7: Plastic and Rubber Products

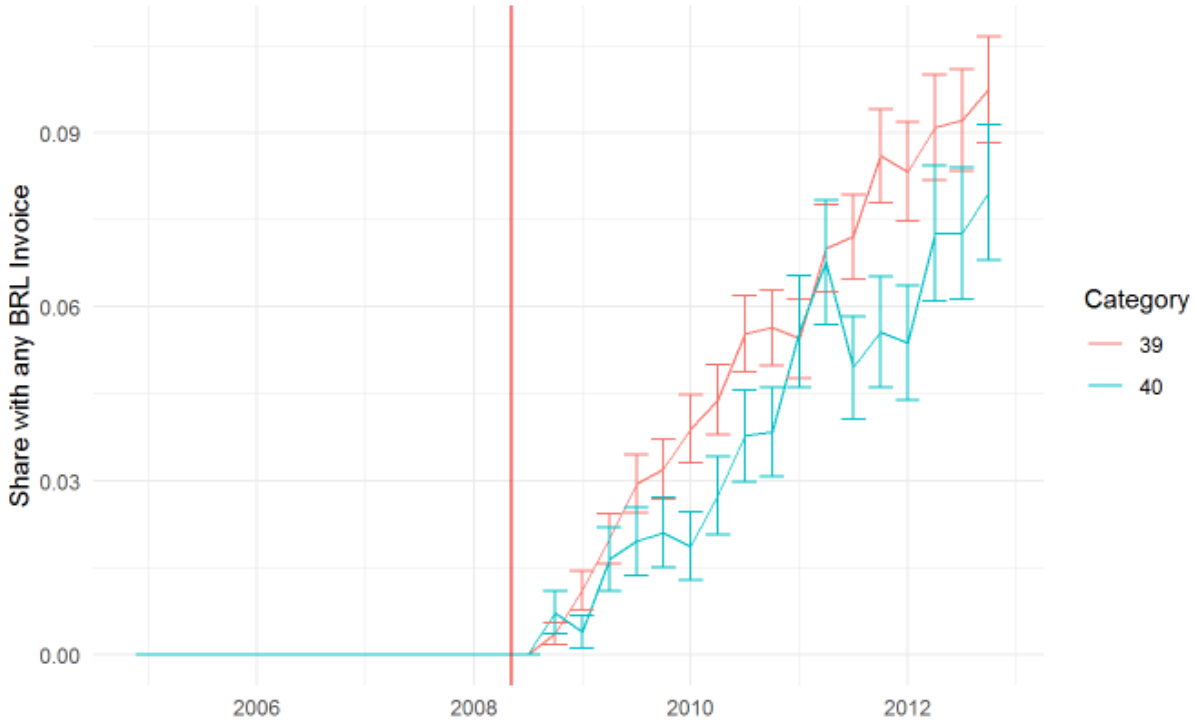


Figure C.18: Section 8: Raw Hides

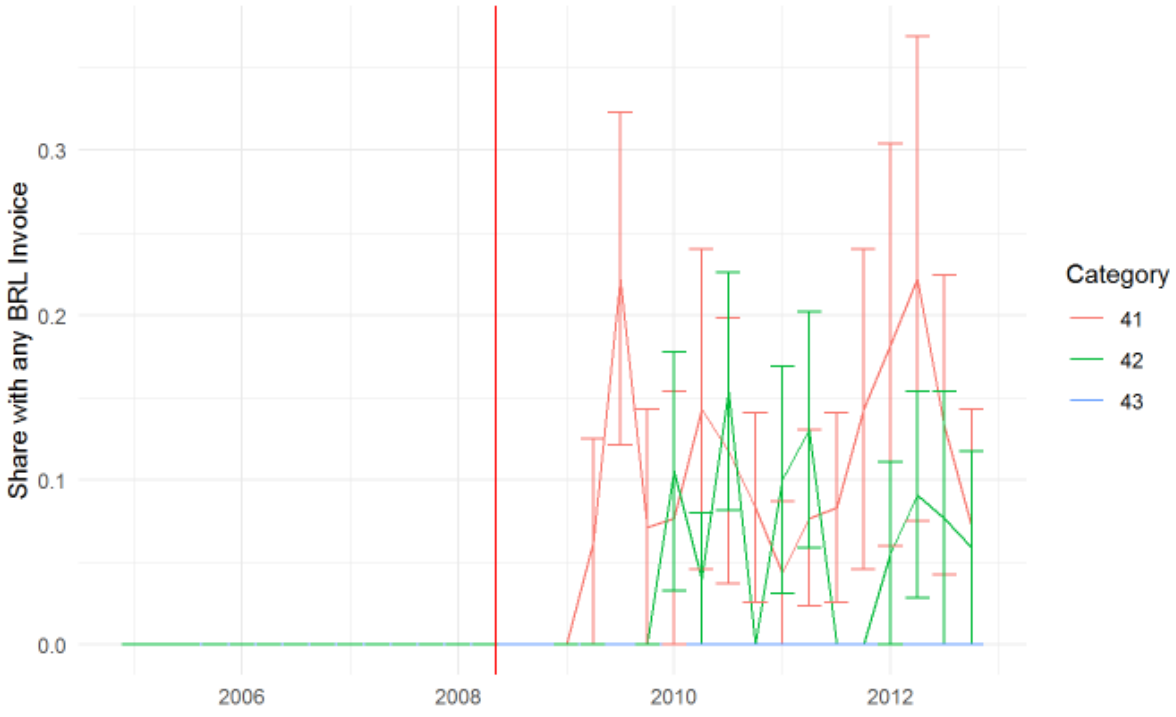


Figure C.19: Section 9: Wood Products

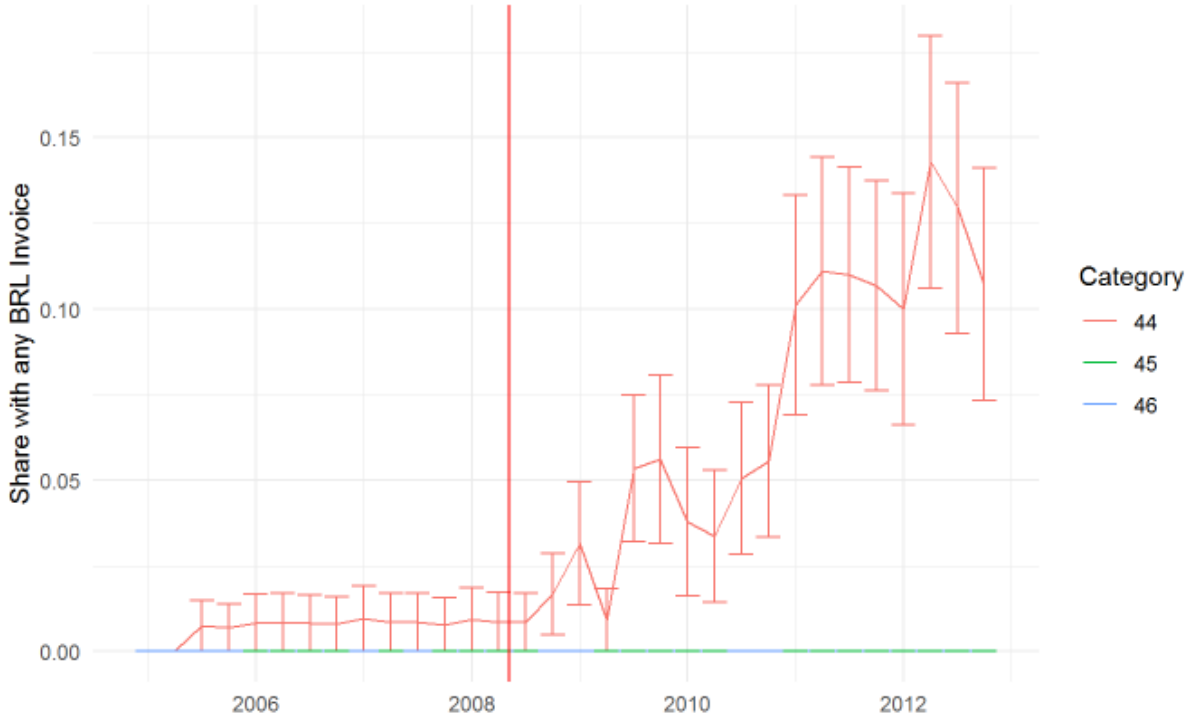


Figure C.20: Section 10: Paper Products

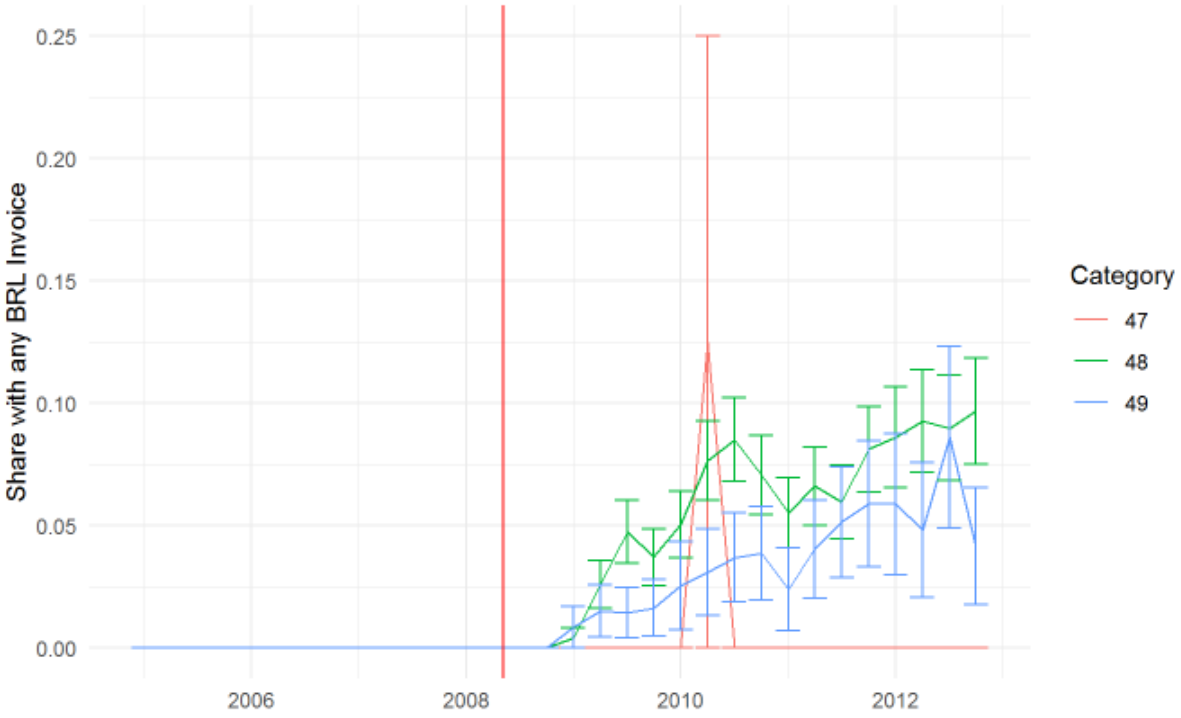


Figure C.21: Section 11: Textiles

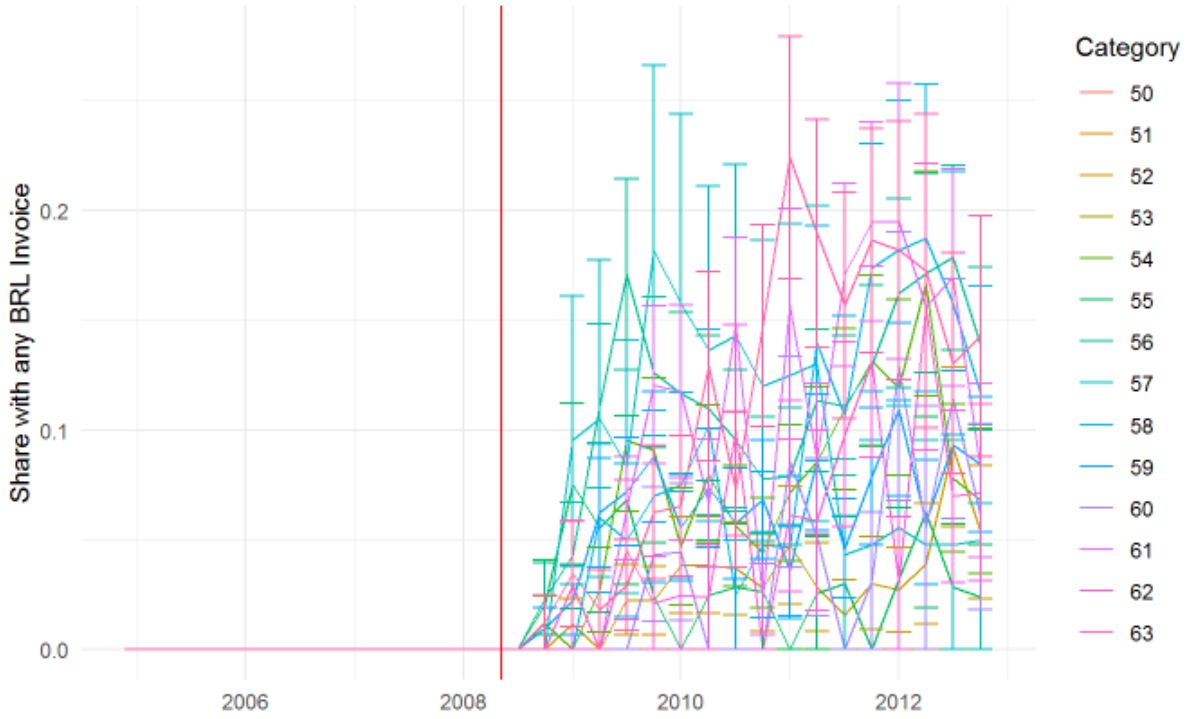


Figure C.22: Section 12: Footwear

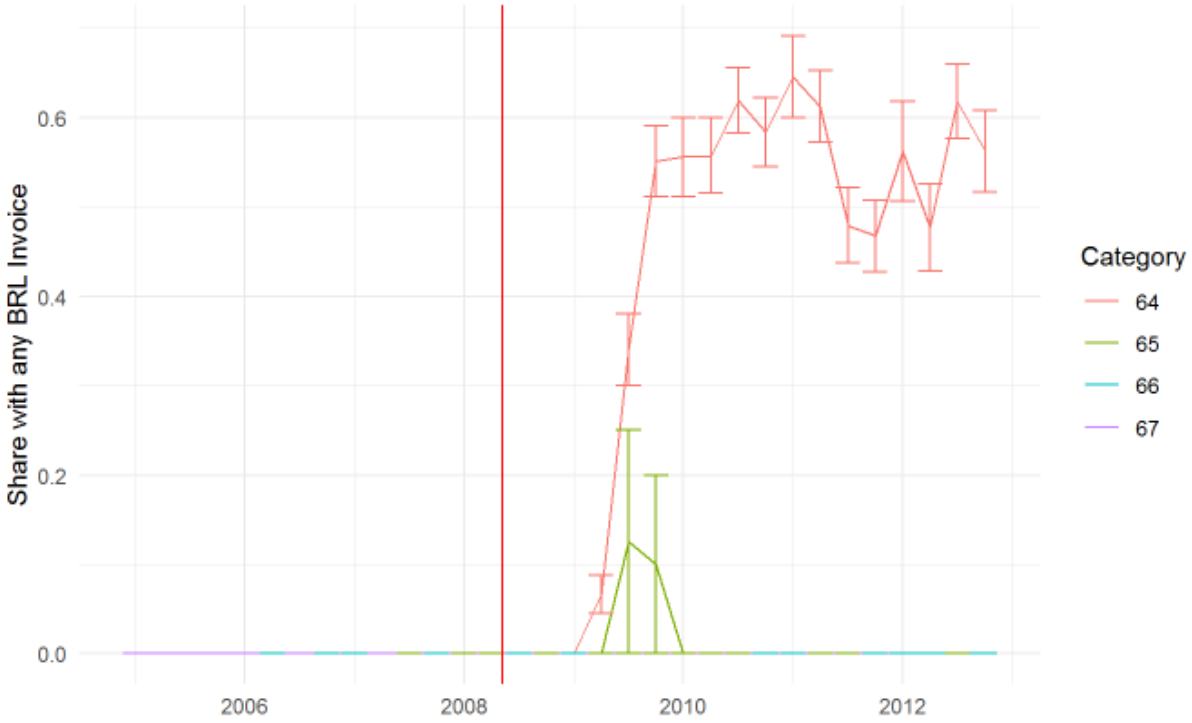


Figure C.23: Section 13: Stone

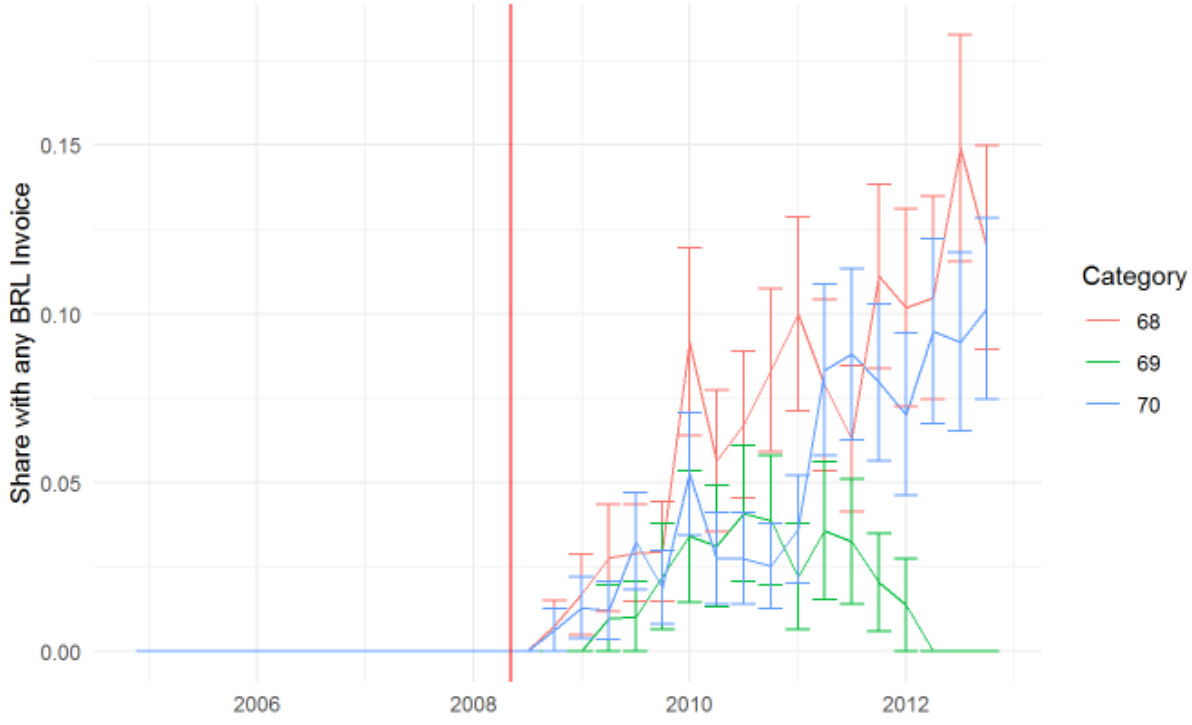


Figure C.24: Section 14: Precious Metals

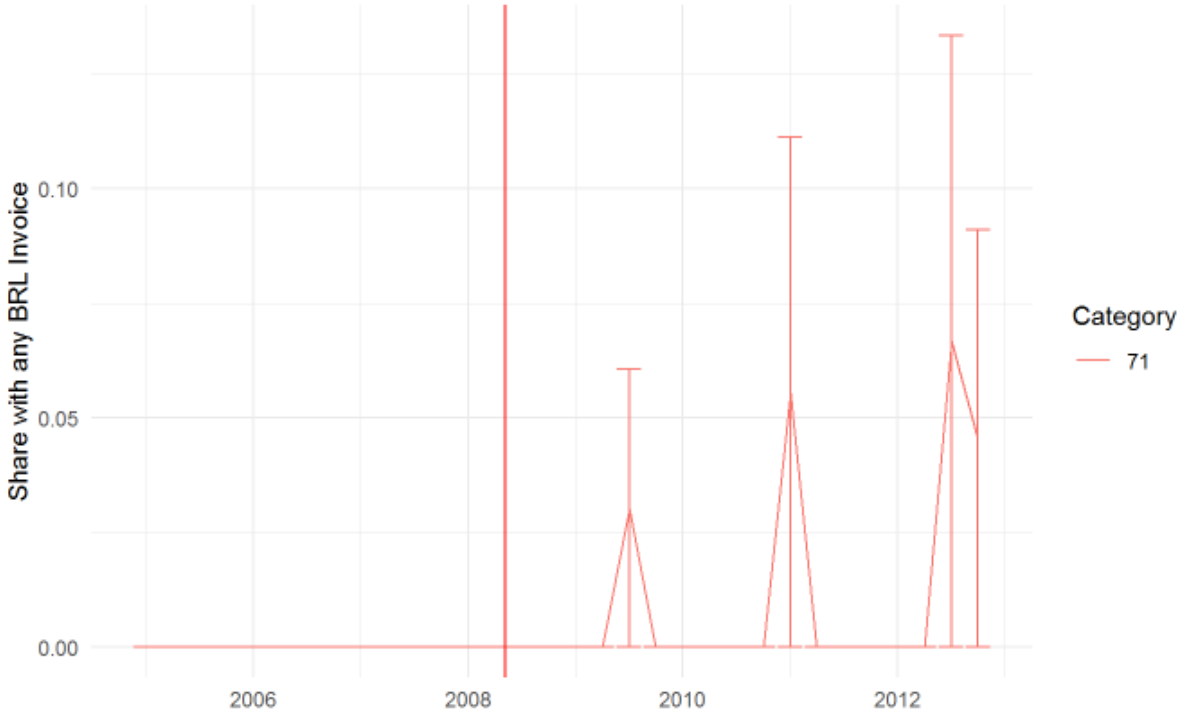


Figure C.25: Section 15: Base Metals

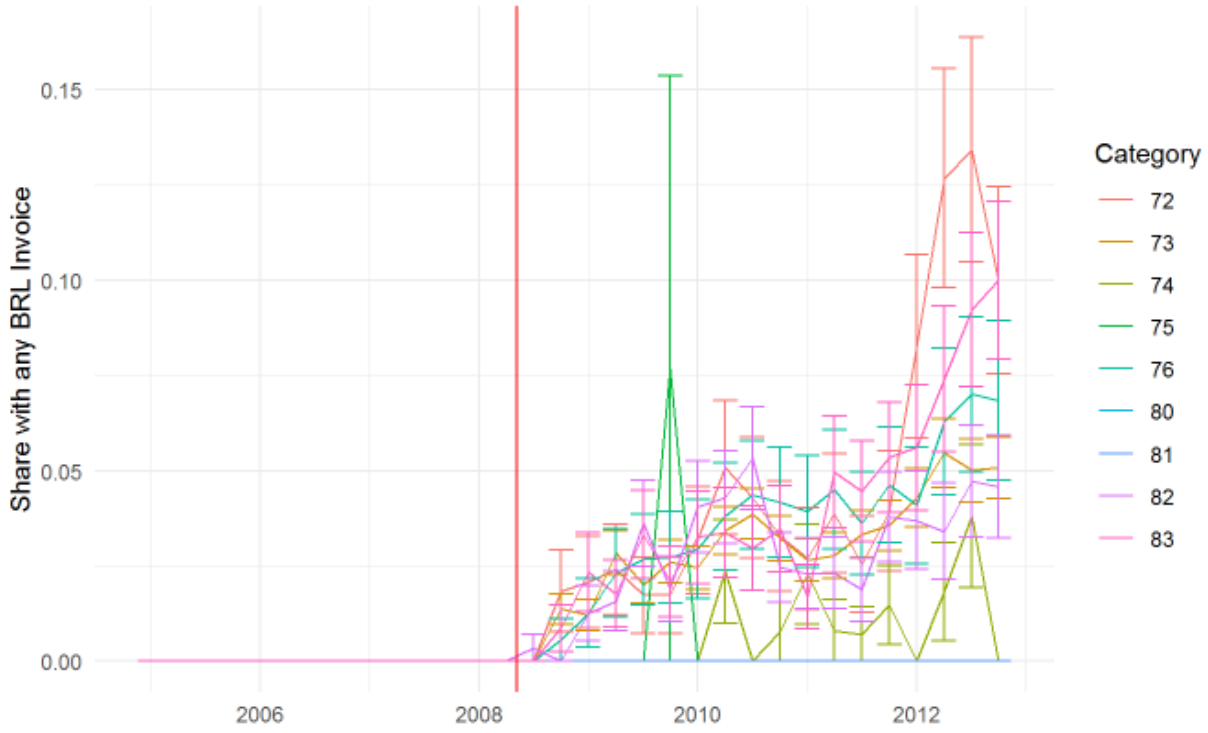


Figure C.26: Section 16: Machinery

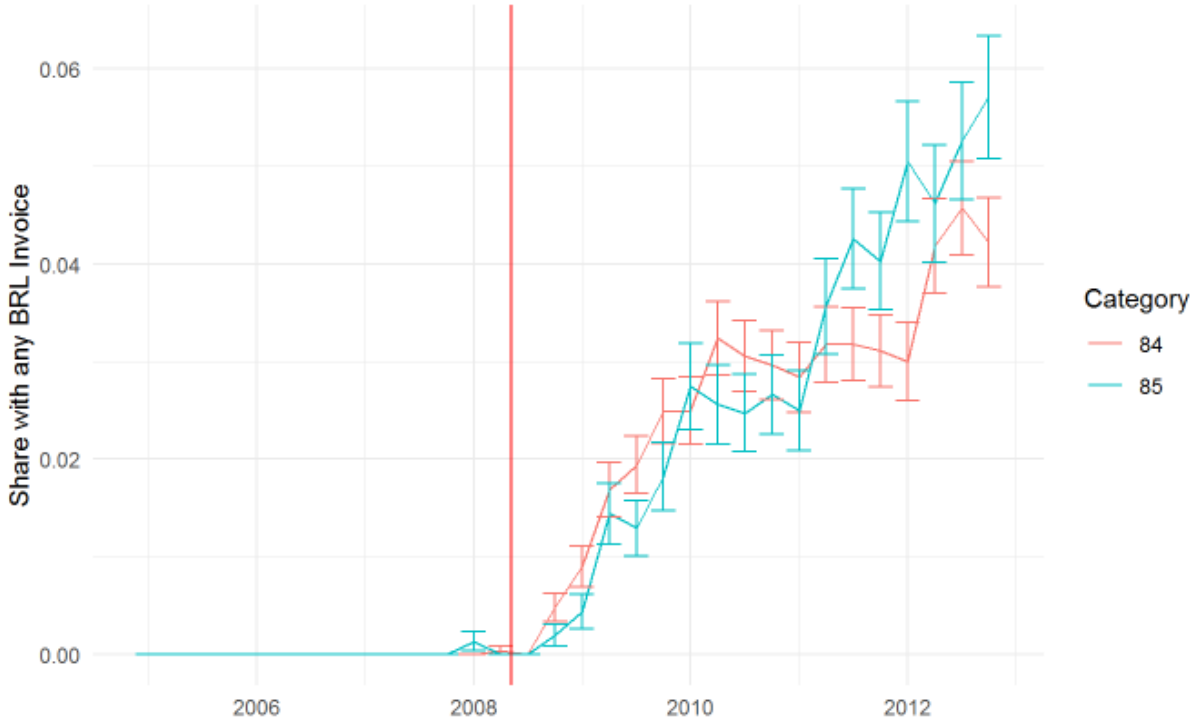


Figure C.27: Section 17: Transportation

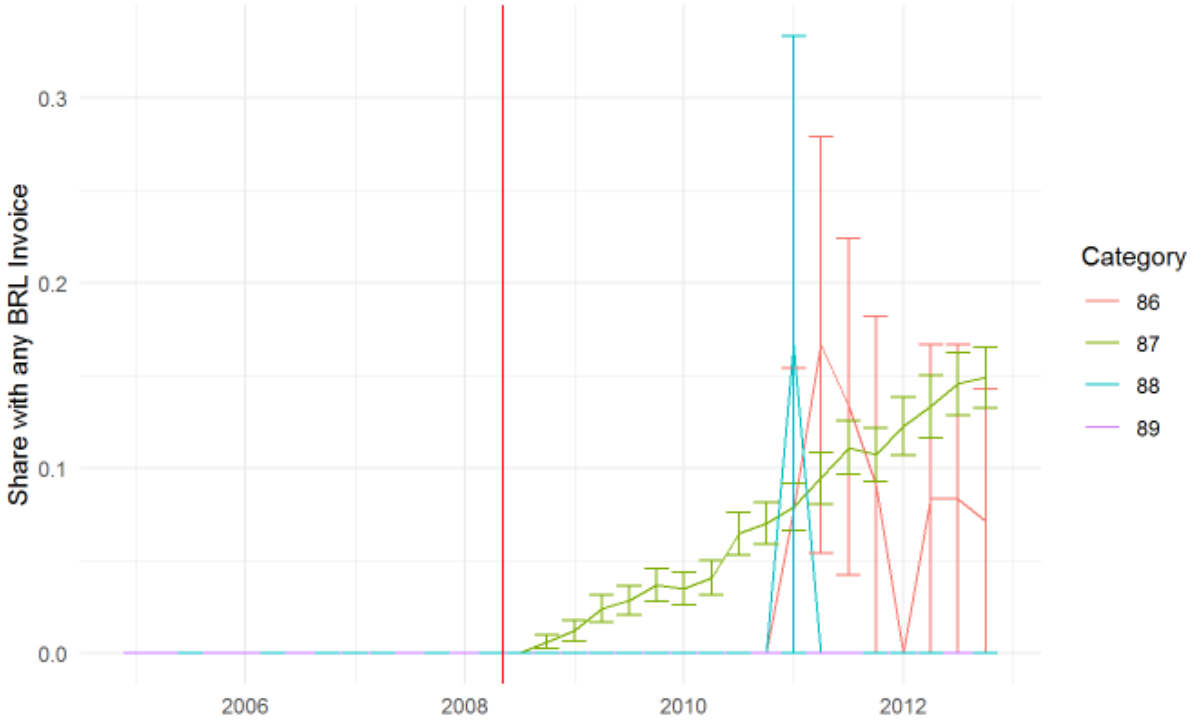


Figure C.28: Section 18: Optical

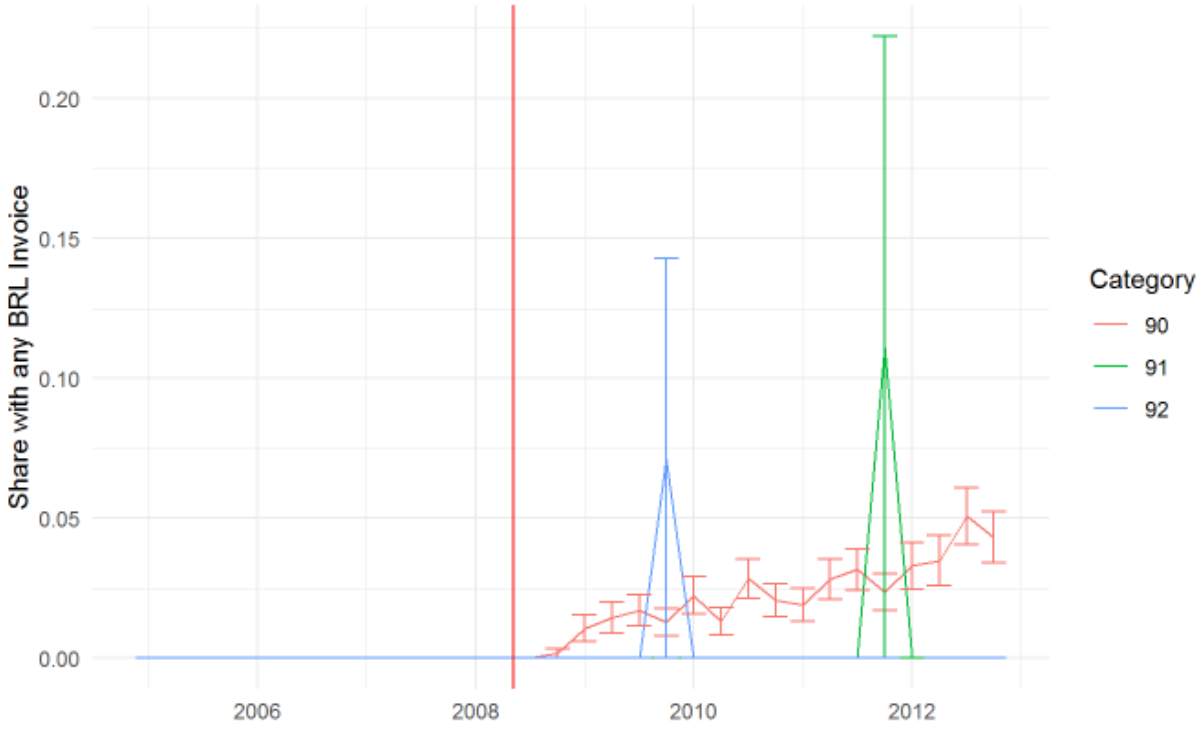


Figure C.29: Section 20: Misc. Manufacturing

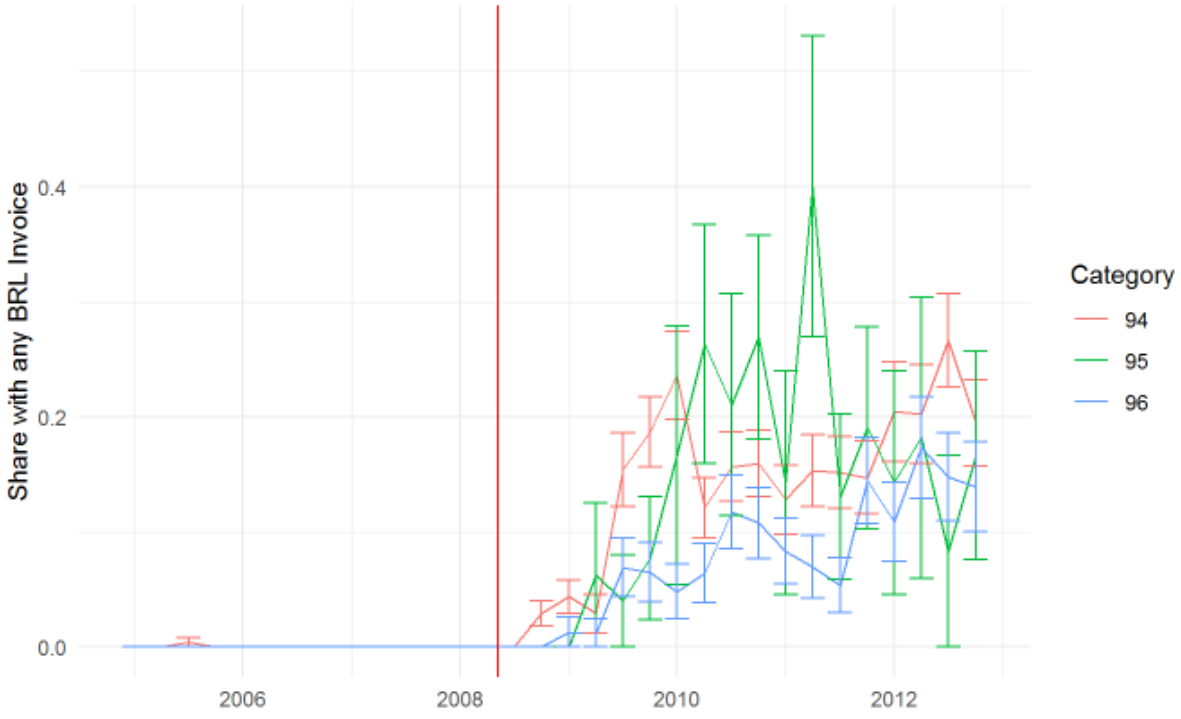


Figure C.30: Section 21: Art and Other

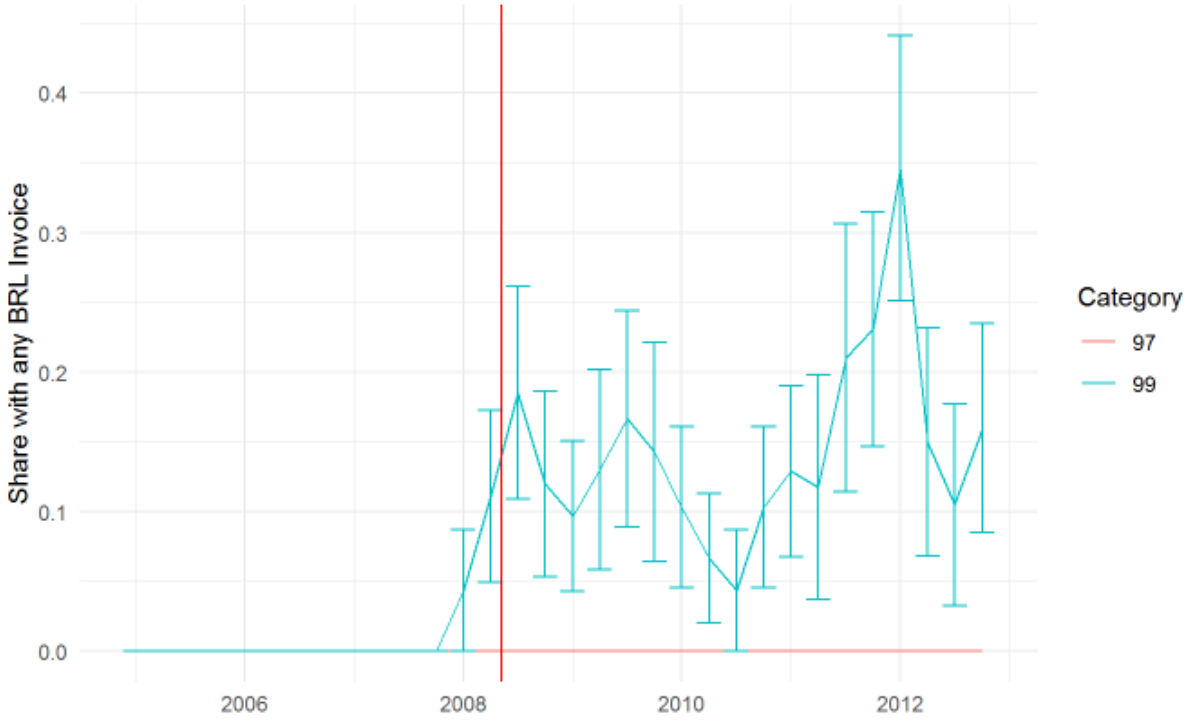


Table C.1: Currency Share in Raw Sample

Currency	Value	Count
United States Dollar	94.04%	80.86
Euro	4.07	4.95
Brazilian Real	1.11	3.02
Great British Pound	0.27	0.15
Japanese Yen	0.14	0.04
Swedish Krona	0.03	0.05
Canadian Dollar	0.02	0.02
Australian Dollar	0.02	0.03
Swiss Franc	0.01	0.02
Norwegian Krona	0.00	0.00
Danish Krona	0.00	0.00
Other (0)	0.30	10.86

Share of raw data by currency. Currencies report include at least four firms for disclosure reasons. Other (0) indicates that the currency is not recorded. Zero's are the result of rounding. Zero's are likely invoiced in USD.

Table C.2: Leveraging Cross-Country Variation

	$\ln V_{ijst}$	
	(1)	(2)
ι_{ijst}	0.433***	0.866***
	(0.098)	(0.316)
$\iota_{ijst} \times ARG_j$		-0.478
		(0.326)
Firm-HS4-Time FE	Y	Y
Dest FE	Y	Y
Obs	1,266,628	1,266,628
$\mathcal{R}^2$	0.728	0.728

$* \ p < 0.1$; $** \ p < 0.05$; $*** \ p < 0.01$. Standard errors clustered at the establishment level. Column (1) of this table reports regressions of the form $y_{ijst} = \alpha_{ijs} + \alpha_{jt} + \beta\iota_{ijst} + \varepsilon_{ijst}$, where y_{ijst} represents the log value of exports (in USD) for establishment i in sector s to destination j at time t. ι_{ijst} is a dummy variable equal to 1 if at least 10% of exports in sector s by firm i to destination j are invoiced in BRL. In Column (2), I estimate the equation $y_{ijst} = \alpha_{ijs} + \alpha_{jt} + \beta\iota_{ijst} + \gamma(ARG_j \times \iota_{ijst}) + \varepsilon_{ijst}$, where y_{ijst}