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

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Abstract

This paper studies how the usage of foreign currency in international payments exerts a significant cost in international trade. I leverage the introduction of a payments system between Argentina and Brazil to show that switching away from the United States Dollar to the Brazilian Real as an invoicing currency increases export flows from Brazil to Argentina. I identify the causal effect of changing the invoice currency by leveraging the location of financial institutions eligible to use the payments system. Municipalities with higher access increased their relative exports to Argentina after the implementation of the policy. In complementary evidence using confidential firm data, I find similar effects of changing invoice currency and illustrate which firms increased their exports to Argentina. A back of the envelope calculation suggests exporter risk aversion can explain a significant portion of the findings, while transaction costs in currency markets are unlikely to be a significant factor.

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1 Introduction

Emerging market firms almost exclusively use foreign currency to buy and sell goods abroad. These firms may face substantial costs of foreign currency usage, such as exchange rate risk or currency market frictions. These costs can be large because emerging markets' exchange rates are known to experience high volatility and because markets for many emerging market currencies are relatively thin. Although there is a substantial body of evidence detailing how unexpected movements in exchange rates affect export behavior, we know comparatively less about the direct effects of foreign currency usage on trade itself.

One reason for this knowledge gap is the observed stability of invoicing decisions. Empirically, there is almost no time variation, let alone exogenous time variation, with which to estimate the causal effect of foreign currency usage. Recent evidence has found this to be true both for individual firms and for entire countries (Gopinath 2016; Amiti, Itskhoki, and Konings 2018). There is therefore no clear answer as to whether the usage of foreign currency limits emerging market firms in trading abroad.

This paper finds that the effect of foreign currency usage on export volumes is significant. I leverage the introduction of a payment system between Brazil and Argentina in 2008: the "Local Currency Payments" (SML) system.[1] This optional 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. I show a significant rise in exports due to the SML system in two complementary research designs that control for selection. First, I leverage municipal variation in access to financial institutions that were authorized to use the SML system. Second, I use disaggregated, confidential customs data to study the firm-level effects of taking up the SML system. In the last part of this paper, I discuss potential reasons for the effect I find in the empirical analysis, such as reducing exchange rate risk or eliminating costly FX payments for importers and exporters. I find that risk aversion may account for a sizable share of this effect, although there is likely a sizable unexplained component. Transaction costs likely do not play a role.

The introduction of the SML system reduced reliance on foreign currency for participating Brazilian exporters. By opting into the SML system, Brazilian exporters would receive revenues directly in their currency, 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 BRL. The central banks of the two countries then 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

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

program to slightly less than 10% by 2012.[2]

The first empirical strategy in this paper uses variation in municipalities' historical access to SML-eligible banks. I define access by calculating the share of corporate loans within a municipality that come from SML eligible banks. The empirical approach then amounts to comparing changes in relative exports to Argentina between municipalities with high and low access to SML-eligible banks. 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.

The empirical estimates suggest that a rise in the SML corporate loan share by 1 standard deviation results in relative exports to Argentina rising by approximately 13%. The lack of pretrends provides suggestive evidence that in the absence of the SML system, the growth of export volumes to Argentina would have developed similarly. In addition, by comparing relative exports across municipalities, the research design accounts for any potential confounding effects from aggregate shocks such as the global recession or the depreciation of the BRL. 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.

The second empirical strategy uses firm-level data. Because exporters that used the SML system were required to invoice in BRL, I can study the effects of the policy by observing changes in BRL invoicing behavior. I use confidential firm level data available from the Brazilian customs administration that records detailed information about international trade including the invoicing currency. 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.

First, I investigate the types of firms that took up the SML system. 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 sectors. 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 leverage the highly disaggregated customs data and use a restrictive fixed effect design that aims to

2. In this paper, I focus on Brazilian exports to Argentina. 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 receive payment in USD. The variation I exploit in my empirical analysis is orthogonal to such effects, which allows me to estimate the effects on export behavior.

control for any endogenous selection effects 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. I also include 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. 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. This result holds even when including firm-time fixed effects. I find small negative yet insignificant effects on prices, which suggests that either posted prices do not incorporate frictions involved in foreign currency usage or that both importers and exporters benefited.

I then 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.

In the last part of this paper, I discuss potential reasons for this finding. I investigate whether risk aversion or the depth of financial markets can explain the magnitude of the changes in exports. While the SML system reduced uncertainty mainly for exporters, both importers and exporters could benefit from avoiding foreign currency usage, which may come with additional costs. While previous evidence of the effects of risk aversion on trade have been mixed, this channel may play a role in my setting. However, it is unlikely to account for the entire effect. On the other hand, imperfections in spot markets likely do not play a role, which should caution policymakers focused on the trade effects of improving the efficiency of cross-border payments.

Brazil is an exceptional laboratory to study cross-border payments. As a larger emerging market, there is useful variation to study the effect of aggregate policies such as the SML system. Brazilian exports are diversified across sectors, with both commodity and non-commodity exports. Brazil is not reliant on any specific country as an export destination so there is meaningful variation along this dimension as well. As such, the results in this paper are likely to generalize to other countries. However, Brazil is distinct in some important ways. It is relatively closed compared with other emerging markets as measured by export to GDP ratios. Brazil also has tighter capital controls in some respects, for example in limiting foreign currency

borrowing.

Literature Review

This paper contributes to the growing literature on the real costs of USD usage in international trade, on which little is known. In their survey of the sources of trade costs in developing countries, Atkin and Khandelwal (2020) note that while the dominant role of the USD as an invoicing currency and its subsequent role in affecting exchange rate pass-through has been well documented in Boz et al. (2018), less is known about the role of the USD as a trade cost more generally.

One potential cost of USD usage is exchange rate risk. In their review of the literature, Auboin and Ruta (2013) find that the effects of exchange rate volatility on international trade are thus far inconclusive. Tenreyro (2007) argues that exchange rate volatility has no significant effect on trade flows. However, this result is challenged by more recent work that finds negative effects due to specific factors, such sectoral heterogeneity (Steinbach 2021) or credit constraints (Lin, Shi, and Ye 2018). Additionally, the export effect of joining the euro area have been estimated to be positive, however the magnitude of the effect is still debated, and likely includes more effects than just creating a common currency (Rose 2014). My paper suggests that there are costs of exchange rate volatility in that exporters appear risk-averse.

There is rapidly growing interest in better understanding the potential costs of cross-border payments, which have been found to be expensive in emerging markets (Committee on Payments and Market Infrastructures 2018). Indeed, one impetus for central banks to develop digital currencies is to improve perceived inefficiencies in settling cross-border trade (Auer, Haene, and Holden 2021). My setting is one of the first to identify the costs of using foreign currency in executing cross-border payments. By studying how introducing cross-border payments systems shapes patterns of trade, this paper contributes to an active debate on how technological progress in the payments sphere can be beneficial for firms around the world. My results suggest that while transaction costs in thin FX markets may not be large, there are instead other indirect costs of using foreign currency that limit export behavior by firms in emerging markets.

Finally this paper also speaks the role of common currencies in trade. First, the creation of the euro area spawned a number of empirical studies that try to identify the effect of currency unions. This literature is motivated by the creation of the euro area, however estimates of this literature can be large in part due to capturing the effects of a number of other structural changes Rose (2014, 2017) and Rose and Stanley (2005). This paper contributes to this debate by analyzing a payments system that approximates the usage of a common currency but leaves all other institutional features unchanged.

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)

Until at least 2002, Brazil had tight exchange controls in place due to relatively high interest rates attracting foreign capital (Chamon and Garcia 2016).[3] In 1992, the BCB released the Consolidation of Foreign Exchange Standards (In Portuguese: Consolidação das Normas Cambiais). As a result of this regulation, exports by Brazil were required to be settled in foreign currency and accompanied by a foreign exchange contract.Central Bank of Brazil (1992) Foreign exchange contracts were written and directly linked to the export operation recorded by the trade registry. This foreign currency was typically the USD.

In the 2000s, the Central Bank of Brazil relaxed capital and exchange rate controls. In 2005, the BCB permitted exports to be settled in BRL so long as they are recorded (invoiced) as such in the trade register (Central Bank of Brazil 2005a, 2005b). Still, over 95% of total Brazilian trade in the subsequent years was invoiced in USD. The BCB also relaxed their monitoring of issues related to foreign exchange receipts by exporters.

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 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 their local currency, the Argentine peso (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.

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 substantial amounts of paperwork and documentation such

3. Latin America has a long history of managing foreign currency usage in regional trade dating back to at least the 1960s. For a brief history, see Appendix A.1

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.

To understand how the SML system works, consider Figure (1), which compares a transaction without the SML system with a transaction through the SML system. When receiving payment, an Argentina importer (who holds an account at an Argentine bank) will send payment through the corresponding banking network to the Brazilian bank who releases the funds to the Brazilian exporter's account. Costs of this exchange include the currency translation and the cross-border payment, which may be expensive (Committee on Payments and Market Infrastructures 2018). In addition, when invoicing and settling in foreign currency, exchange rate risk may matter if settlement takes place after the price is set.

The bottom panel shows a transaction through the SML system. 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. 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.

The exchange rate for the transaction is known as the SML rate. Figure A1 plots this exchange rate relative to the BRL-ARS spot exchange rate. The SML rate is derived from two USD-linked transactions: one for the real and one for the peso. The real rate is PTAX, which is the reference rate quoted by the BCB. The BCB advertises this rate as being more favorable as it originates from interbank transactions. The peso rate is derived from the BCA's reference rate (Tipo de Cambio de Referencia Com A 3500) in the wholesale market, which is calculated from wholesale transactions by Argentine banks, and so is also supposedly more favorable. Figure A1 also plots the spot exchange rate in wholesale markets, and the high correlation is apparent.

Usage of the SML system steadily rose following its introduction (Reiss 2015). Figure (2) plots take-up of the SML system as a share of total exports to Argentina.[4] Following the introduction of the policy, the share of exports through the SML system rose to nearly 8% by 2012, and has remained elevated. 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.

There are at least three reasons why all firms did not choose to take up the SML system. First, firms that rely on imported intermediate goods from other locations may benefit from the natural hedge that dollar export revenues provide. 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, Titelman, and Tomassian (2013) argue that even by 2014, many firms may have been unaware of the system's existence.

3 Causal Evidence from Municipality Data

3.1 Data and Methodology

As discussed in Section 2,a firm must use the SML system through an authorized financial institution. Spatial variation across Brazilian municipalities of these SML authorized financial institutions creates plausibly exogenous variation that can be used to estimate the causal effects of the SML system on municipality-level exports.

I use customs and banking data at the municipality level. Customs data is available through COMEX and

4. See Appendix B for data sources.

includes export values at the destination-sector-date level. Bank balance sheet data at the municipality level is available from the BCB. More information on the sample construction is available in Appendix B.

I construct a measure of treatment by using the share of corporate loans by SML eligible banks within a municipality. In the benchmark specification, I focus on the variable "financiamentos." I focus only on the set of financial institutions that were authorized to participate in the SML system by the end of 2008 and ignore subsequent additions. This controls for entry into the SML system by financial institutions who may have responded to local demand for the SML system. Table (1) lists the largest 10 banks in Brazil by assets in December 2005, along with their overall loan share and whether or not they are authorized to use the SML system. The largest banks were most likely to be authorized to use the SML system. However, SML authorized banks were not overwhelmingly the largest for the loan measure used. SML authorized institutions account for only 55% of the total outstanding corporate loans.

I construct the SML loan share by municipality in December 2005, nearly three years prior to the launch of the SML system and before any official announcement had been made. Formally, let L_{bmt} denote outstanding loans by bank b in municipality m at time t. The market share of loans by SML eligible banks in municipality m is given by

$$SML\_Share_m = \frac{\sum_b L_{b,m,2005} \times SML_b}{\sum_b L_{b,m,2005}}$$

where b indexes banks and SML_b is a dummy equal to one if the bank is initially part of the SML system.

Figure (3) maps the spatial distribution of SML market shares for exporting municipalities 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. Finally, while a majority of exporting municipalities are in the Southeast, where economic activity is predominantly located, there are also a fair number in the North of the country as well.

Armed with a measure of SML intensity by municipality, I now turn to estimating the causal effect of the SML system on municipality export behavior. I hypothesize that municipalities with larger SML loan shares had relatively larger growth in exports 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.

$$y_{mjt} = \alpha_{jt} + \delta_{mj} + \theta_{jt} + \beta_t \left(ARG_j \times SML\_Share_m \right) + \varepsilon_{mjt} \tag{1}$$

where y_{mjt} denotes the log export value for municipality m to destination j in year t. ε_{mjt} is the regression residual. In this benchmark specification, I include municipality-time, destination-time, an municipality-destination fixed effects.

The coefficients of interest are the vector $\{\beta_t\}$. I normalize these coefficients to be relative to β_{2007}, which is the year prior to the launch of the SML system. β_t for $t > 2007$ therefore represents the relative increase in exports to Argentina following the introduction of the SML system in high SML loan share municipalities.

I focus on exports to South American countries throughout this paper.[5] I do so for three reasons. First, as discussed in Section A.1, South American countries had historically developed multilateral mechanisms to account for currency issues in international trade. Second, 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.

In order for the coefficients β_t to have a causal interpretation, the identifying assumption is that the evolution of relative log exports to Argentina across high and low SML loan share municipalities would have been the same in the absence of the introduction of the SML system. This is the parallel trends assumption common in many difference in difference specifications. The regression specification is effectively comparing otherwise identical municipalities (up to destination-time specific changes by municipality) except for the fact that there is variation in exposure to the SML sytem.

There are four main threats to identification that my regression specification can directly account for. First, the reason municipalities have a large share of SML authorized banks may be because of demand by local firms. One concern is that municipalities with high SML authorized market shares simply had a higher relative growth rate of exports to Argentina, thus pushing their local firms to demand SML authorization. Such a concern can be addressed by inspecting the estimated pretrends. Alternatively, 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

5. The South American sample includes Argentina, Bolivia, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Uruguay, and Venezuela.

adjust at the same time as the the introduction of the SML system. 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 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 alleviates this concern by comparing exports to Argentina relative to other export destinations conditional on both municipality-time and 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.

Third, 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.

Finally, regarding the usage of nominal values as the outcome variable, the inclusion of destination-time fixed effects effectively controls for changes in export price indices at the destination level.

3.2 Results

Figure (4) plots the coefficients β_t from estimating Equation (1). Standard errors are clustered by municipality and are plotted at the 95% level.

Following the introduction of the SML system in 2008, there is a significant rise in log export values to

around 0.10 log points following one year of an insignificant effect. The immediate effect in 2008 being very small is expected as the SML system did not open until October of 2008. The lack of any significant pretrend prior to the launch of the SML system between 2003-2007. All coefficients are insignificantly different than zero, suggesting that there is no relative difference across municipalities with respect to relative exports to Argentina by SML loan market share. The horizontal dotted line drawn over this period shows the average of these pre-period coefficients, which is very close to zero. This lack of significant pretrend 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.

I have argued that the parallel trends assumption is likely to hold due to both the presence of balanced pretrends and, given the potential confounders, the regression specification. Still, it is useful to conduct a series of placebo tests to show that the relative effect I find is exclusive to Argentina. I now present further evidence of the parallel trends assumption by demonstrating that there is no heterogeneity in export growth within the set of control countries.

To simplify, I estimate the following specification

$$y_{mjt} = \alpha_{jt} + \delta_{mj} + \theta_{jt} + \beta \left(POST_t \times ARG_j \times SML\_Share_m \right) + \varepsilon_{mjt} \tag{2}$$

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 periods $t \geq 2008$.

The first column of Table (2) presents results for this estimation. The coefficient estimate of 0.13 (SE: 0.055) implies that following the introduction of the SML system, increasing the SML loan market share by 1 standard deviation raised relative exports to Argentina by 10%. Across exporting municipalities, one standard deviation is approximately 30 percentage points. This is a large change in loan shares, so while this effect is significant, it is not implausibly large.

I next drop Argentina from the sample and re-estimate Equation (2) for each control destination. Specifically, I replace the Argentina dummy ARG_J with a dummy for each other Latin American country one by one, and re-estimate the effect of the SML system. There should be no significant effect on exports for any of these alternative export destination. If there were, then the SML loan market share is correlated with some other determinant of export activity, suggesting the measure is endogenous in some way.

In the remaining columns of Table (2), I test the effect of the SML system on relative exports to other

South American destinations: Bolivia, Chile, Colombia, Ecuador, Paraguay, Peru, and Uruguay. In all other columns, the coefficient of interest is smaller in magnitude and never significant, suggesting there is little effect of the SML system on exports to other destinations.

In the appendix, I perform a number of robustness checks. Results are robust to dropping municipalities for which SML banks have high market shares to control for selection concerns on the part of the financial institutions. If exports to Argentina are growing in municipalities with large SML loan shares, these municipalities may have been more likely to successfully lobby their local banks to become authorized. I also show that results hold at the sector level when including sector-time fixed effects. These fixed effects control for unobserved price changes at the sector level. Additional robustness checks include considering a larger geographic region (the microregion), controlling for imports, and dropping Uruguay which entered into an SML agreement in 2015.

4 Micro Evidence of the SML System

4.1 Brazilian Transaction-Level Export Data

I use confidential and administrative export data from the Brazilian customs administration, Secretariat of Foreign Trade (SECEX), to construct a quarterly database of export transactions.[6] Each transaction is identified by the 14-digit establishment identifier (*CNPJ*), the eight-digit commodity code (NCM)[7], and the destination country. For each transaction, I observe the value of the trade in USD, a measure of quantity, and the currency of invoicing.[8] More information on the data construction is available in the appendix.

I first present aggregate statistics on currency choice across South American export destinations. Table 3 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. This result is consistent with other locations, for example in the study of Belgium by Amiti, Itskhoki, and Konings (2018).

6. I did not have direct access to this administrative data. Code was written and sent to SECEX. SECEX ran the code, and only results were returned.

7. The NCM code includes the standard Harmonized System (HS) code for the first six digits plus two additional digits

8. 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.

4.2 Time-Varying Invoicing Decision

I construct a time-varying measure of participation in the SML system. SML statistics are recorded by the Central Bank, but I only observe customs data. 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. Because I observe the currency of invoicing in the confidential customs data, I define SML usage by Brazilian exporters to Argentina as whether or not the export is invoiced in BRL.[9]

SML usage for firm i in sector s exporting to destination j at over time period t, is given by a dummy ι_{isjt} equal to 1 if at least 50% of exports are invoiced in BRL:

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

V_{isjt}^{BRL} denotes the total dollar value of the transaction invoiced in BRL and V_{ijst} is the total dollar value of exports in any currency.[10]

The left panel of Figure (5) plots the quarterly average value of SML usage, ι_{isjt}, for exports to 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.[11] This increase is specific to Argentina. The right panel of Figure 5 plots the evolution of ι_{isjt} for Colombia. The share of transactions invoiced in BRL is orders of magnitude smaller, and there is no obvious break following the introduction of the SML system.

I next decompose ι_{isARGt} along three dimensions: sector, size, and number of destinations. As mentioned, 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 instead find that a variety of types of exporters used the SML system. Figure 6 decomposes the ι_{isARGt} along three different dimensions. 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 rates, even firms in the top half of the size distribution took up the SML system. The top-right panel decomposes the rise in ι_{isARGt}

9. Figure B5 in the appendix compares 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, and both evolve similarly.

10. The data is constructed by aggregating monthly data by 8-digit sector to quarterly data by 4-digit sector. I choose a threshold greater than 0 to ensure that no small month or 8-digit sector drives results. The vast majority of bins are either 0% or 100%.

11. This rise is even larger when looking at the share of *firms*, as opposed to firm-sectors, that switch to BRL invoicing. Figure B3 shows that the ι share across firms rises to nearly 10%.

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.[12] 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).[13]

4.3 Evidence from Customs Data

I now complement the municipality-level evidence with customs evidence showing that exports rose for firms that took up the SML system. 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. The regression specification relates either the log value of exports or the log price (in dollars) to the time-varying invoicing decision at the shipment level.

$$y_{isjt} = \alpha_{is} + \alpha_{S(s)t} + \alpha_{jt} + \beta\iota_{isjt} + \gamma\left(\iota_{isjt} \times ARG_{jt}\right) + \varepsilon_{isjt} \tag{3}$$

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. 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, transactions through the SML system to Argentina are compared with a counterfactual transaction by the same firm in the same sector, holding constant aggregate economic conditions. I estimate Equation (3) including exports to all South American destinations. This specification leverages both time-variation within a given firm-sector but also the variation across destinations within a given firm-sector.

The main coefficient of interest is γ. While β represents the marginal effect of BRL invoicing across all export destinations, 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, the coefficient γ can be interpreted as the effect of the SML system itself relative to non-SML transactions. It is hypothesized that $\gamma > 0$ following the municipality evidence of Section 3.

For endogenous selection to bias estimates of the SML system, it must be the case that the reason for taking up the SML system is time-varying at the firm-sector level and unrelated to either sector-specific

12. Commodity exports are defined as in Boz et al. (2018). See the appendix for more details.
13. See Appendix B for more information.

or destination specific factors. Time-invariant determinants of selection are controlled for by firm-sector fixed effects. So, if firms select into the SML system due to, say, managerial expertise regarding exchange rate processes, this would be controlled for. Aggregate threats due to omitted variable bias can be directly controlled for. First, there is the effect of the Global Recession. 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 desination-time and sector-time fixed effects should control for aggregate changes in economic activity, including the demand and supply effects of the trade collapse by sector. 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.

The main threat to causal identification involves endogenous selection into the SML system due to time-varying, destination-specific factors that are unique to the firm. These selection effects can bias the estimate of the SML system upwards or downwards. For example, if firms are more likely to select into the SML system because sales are growing anyway, and expect the SML system to continue improving their export prospects, then the estimated effect will be biased upwards.

Column (1) of Table (4) shows the results for estimating Equation (3). 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%. Additionally, 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.

Including firm-time and firm-municipality fixed effects does little to this point estimate, as shown in column (2). As most firms switched invoice behavior across all sectors, the inclusion of firm-time fixed effects effectively compares exports across export destination by the same firm that used the SML system to switch invoice currency. This controls for endogeneity concerns such as import intensity or foreign currency borrowing. 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.[14] While most Brazilian non-financial corporate firms do not directly borrow in USD

14. 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.

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 the appendix, I perform a series of robustness checks. I show that the results hold in an event study framework when restricting to exports to Argentina. This specification also demonstrates balanced pretrends, which provide suggestive evidence that the parallel trends assumption holds. I also explore results when conditioning on firms that export every quarter.

The customs data permit a closer look at firm-level indicators to better understand the mechanism behind this increase in export volumes. I construct a measure of prices as unit values, taking the ratio of total value to quantity measured using the net weight in kilograms or the statistical quantity depending on data availability. Columns (3)-(4) of Table (4) repeats the estimation using the log price (in dollars) 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, Itskhoki, and Rigobon (2010), who argue that in the presence of nominal rigidities, optimal price setting is not a function of currency choice.

Finally, I 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.[15]

Results of the heterogeneity analysis are in Columns (5)-(7) of Table (4).In columns (5) and (6), 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.

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

4.4 Firm-Level Effects

Did Brazilian firms export more in total or simply shift sales to Argentina from other destinations? An empirical specification at the firm-sector-time level can offer an answer. I estimate the following specification

$$y_{ist} = \alpha_{is} + \alpha_{S(s)t} + \beta\iota_{ist} + \varepsilon_{ist} \tag{4}$$

where the outcome variable is now either total log value of exports in sector s by firm i at time t to *any* destination (including outside of South America) denoted $\ln V_{ist}$, or the share of total exports in sector s by 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. 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 (3), 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 (3), 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. 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:

$$y_{ist} = \alpha + \beta_1\iota_{ist}^{ARG} + \beta_2\iota_{ist}^{OTH} + \mathbf{X}_{ist}\Gamma\varepsilon_{ist} \tag{5}$$

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 (4) 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 (4).

Columns (1) of Table (5) reports the results of estimating Equation (4) 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 (5) 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 (4). 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%.

5 Discussion

5.1 Currency-Related Frictions in International Trade

In this section, I explore whether two specific types of frictions, thin bilateral markets in emerging market currencies and exporter risk aversion, can explain why the introduction of the SML system increases export volumes. To frame the discussion, consider the following stylized model.

Setup There exists an exporter located in country x and an importer located in country m, with associated currencies similarly denoted. S_ℓ^m is the exchange rate between the importer's currency and currency ℓ, such that an increase in S_ℓ^m is a depreciation of the importer's currency. S_ℓ^x is the exporter exchange rate, similarly defined. Assume that each exchange rate is a random variable that is log-normally distributed $\ln S_j^i \sim N(\mu_{ij}, \sigma_{ij}^2)$ with standard deviation σ_{ij}^2. I normalize the mean $\mu_{ij} = -\frac{1}{2}\sigma_{ij}^2$ so that $E[S_j^i] = 1$.

Importers Importers purchase a bundle of goods indexed by ω according to CES preferences with elasticity of bustitution given by ρ. The price for good ω faced by the importer in invoice currency ℓ is given by $P^\ell(\omega)$. The importer observes the exchange rate prior to purchasing some quantity $Q(\omega)$. Importers' maximization

problem is given by

$$\max \left(\int Q(\omega)^{(\rho-1)/\rho} \right)^{\frac{\rho}{\rho-1}}$$
$$\text{s.t. } I = \int \left(S_\ell^M P^\ell(\omega) Q(\omega) + \tau_\ell^M S_\ell^M P^\ell(\omega) Q(\omega) \right) d\omega$$

τ_ℓ^M denotes frictions in the currency market. The importer must pay some fraction of the nominal payment (in local currency M).

Standard maximization techniques give rise to the import demand curve[16]

$$Q(\omega) = \left((1+\tau_\ell^M) S_\ell^M P^\ell \right)^{-\rho} \mathcal{P}^{\rho-1} I \tag{6}$$

where $\mathcal{P} = \left(\int \left((1+\tau_{\ell'}^M)(S_{\ell'}^M) P(\omega') \right)^{1-\rho} d\omega' \right)^{\frac{1}{1-\rho}}$ is the import price index. Quantity demanded is decreasing in the price as well as the cost to use currency ℓ.

Exporters Potentially risk-averse exporters have market power and choose the price $P^\ell(\omega)$ in the (exogenously given) currency of invoicing ℓ. For simplicity, production utilizes only domestic sources. Prices are set one period in advance, so there is uncertainty over the realization of local currency profits if denoted in foreign currency. Profits are given by

$$\pi(P^\ell) = S_\ell^X P^\ell Q - C(Q) - \tau_\ell^X P^\ell Q$$

where τ_ℓ^X is the exporter cost of using currency ℓ. The exporter takes demand as given and sets prices by maximizing expected utility over profits, given by $E[U(\pi(P^\ell))]$, where I assume $U_\pi > 0$ and $U_{\pi\pi} < 0$.

Taking a second order Taylor expansion of utility around expected profits gives

$$U(\pi) \approx U(E[\pi]) + U'(E[\pi])(\pi - E[\pi]) + \frac{1}{2} U''(E[\pi])(\pi - E[\pi])^2$$

Assume $U''(E[\pi])$ is a constant. The exporter maximizes this utility function subject to demand (6). The optimal price can be written as

$$P^\ell = \frac{1}{1 - \tau_\ell^X - \frac{1}{2}\gamma\sigma_\ell^2} \mu W \tag{7}$$

where $\gamma = E[U''(E[\pi])/U'(E[\pi])]$ is the coefficient of absolute risk aversion, $\rho = -\frac{\partial E[Q]}{\partial P} \frac{P}{E[Q]}$ is the elasticity

16. See Appendix E for all derivations

of demand, $\mu = \frac{\rho}{\rho-1}$ is the markup and $W = C'(E[Q])$ are expected marginal costs.

Plugging the optimal price (7) into demand (6), quantity sold is given by

$$Q = (1+\tau_\ell^M)^{-\rho}(S_\ell^M)^{-\rho}\left(\frac{1}{1-\tau_\ell^X-\frac{1}{2}\gamma\sigma_\ell^2}\mu W\right)^{-\rho}\mathbf{P}^\rho I$$

Note that quantities respond negatively to exporter currency costs and uncertainty.

Empirical Analogue Log-differencing quantity sold, but holding exchange rates, domestic costs W, income I, and the aggregate price index $\mathbf{P}$ constant, gives

$$\Delta \ln Q \approx -\rho\left(+\Delta\tau_\ell + \Delta\tau_\ell^X + \frac{\gamma}{2}\Delta\sigma_\ell^2\right) \tag{8}$$

I decompose the change in export volumes using this expression in a back-of-the-envelope calculation to understand how risk aversion and transaction costs affect international trade. Risk aversion is represented by the term $\frac{\gamma}{2}\sigma_\ell^2$. Intuitively, quantities are negative correlated with exporters must be compensated for bearing some risk in international trade.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.[17] To quantify the extent of risk aversion for the exporter, I calculate the variance of the BRL-USD exchange rate. Over the period 2005-2015, the variance is roughly $\sigma^2_{BRLUSD} = 0.04$.

The second friction in Equation 8 is transaction costs in currency markets given by τ_ℓ^i, for $i \in \{X, M\}$. Cross-border payments are known to be expensive (Committee on Payments and Market Infrastructures 2018). One reason for this cost are transaction costs due to thin markets in non-vehicle currency exchanges. The SML rate, compiled based on underlying dollar reference rates, is updated daily and so reflects market changes in dollar exchange rates. The SML system potentially lowers costs of trade by permitting firms to access the market rate for a direct currency translation. To understand the potential magnitude of such foreign currency costs, I use bid-ask spreads on daily real-peso trades.[18] Under the assumption that firms are offered a choice between invoicing and settling in some vehicle currency (the USD) versus using the importer's/exporter's currency, the spreads in this market should reflect equilibrium markups in the USD FX market.The median spread in this market is approximately 50 basis points.

17. 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 benefited from this channel by simply paying in reais.

18. Data comes from Bloomberg; see Appendix B.

Finally, consider the parameter ρ. When aggregating across firms, ρ is effectively the frequently studied trade elasticity, whose structural interpretation is related to the specific underlying trade model. At the firm-level, the elasticity depends on the structural interpretation (e.g., in Melitz (2003)/Chaney (2008) models of trade, the intensive margin elasticity is given by $1 - \rho$.) The estimates in the firm-level section correspond to an intensive margin effect due to the inclusion of firm fixed effects. This elasticity is also related to the gains from variety parameter. Broda and Weinstein (2006), using sector-destination export data, estimate the median value of this parameter to be between 2-3. Fitzgerald and Haller (2018) or Fontagné, Martin, and Orefice (2018), using firm-level data, find the elasticity using tariffs is approximately 2, which implies a similar aggregate elasticity. I set $\rho = 2.5$. I focus on the estimate of approximately 0.40 in column (2) of Table 4. Unlike the results from the municipality data in Table 2, the estimate using the customs data measures the change in exports following the introduction of the SML system, which I take be eliminating uncertainty (σ_ℓ) and transaction costs τ_B.

Returning to equation 8, transaction costs explain a very modest share of the increase in trading values after the introduction of the SML system. The SML system also allows importers to pay in domestic currency. Eliminating the bid-ask spread for Brazilian exporters and Argentine importers would, through the lens of the model, only 5% of the change in exports. However, this estimate is likely a lower bound. The bid-ask spread likely underestimates the measure of transaction costs. Other costs related to maintaining foreign currency accounts, imperfect bank competition, or purchasing hedging products may raise these transaction costs. However, Alfaro, Calani, and Varela (2021) find that in Chile, hedging usage is limited, particularly for smaller firms. It is unlikely that transaction costs will explain the rise in exports.

On the other hand, the model suggests that the level of risk-aversion required to rationalize the change in exports through eliminating exchange rate uncertainty would be $\gamma \approx 8$. This estimate of risk-aversion is large, but not implausibly so. First, evidence on the effect of exchange rate volatility on exports is mixed. In their review of the literature, Auboin and Ruta (2013) conclude that the effects of exchange rate volatility on international trade are inconclusive but on average negative.[19]

The remainder of the effect likely represents other aspects that are unobserved in my setting.This remainder may be potentially explained by the elimination of trade finance costs (Chahrour and Valchev 2021; Amiti and Weinstein 2011), however I do not observe financing by firms. Financing costs can have significant effects

19. In addtion, the usage of financial instruments to hedge risk has been found to be costly, especially for smaller exporters (Lyonnet, Martin, and Mejean 2016; Alfaro, Calani, and Varela 2021). Most firms are therefore directly exposed to foreign currency fluctuations. Berthou, Horny, and Mésonnier (2022) find French firms reduced their exports following the increase in hedging costs during the 2011 European dollar funding strain. This paper does not focus only on hedging (as it is unobserved), but instead leverages time variation in the settlement/invoicing currency to understand more broadly the real frictions involved with the usage of USD in trade.

on firm exports, as argued by Manova (2013) or Paravisini et al. (2015). Alternatively, the SML system may have increased productivity for importer-exporter pairs by alleviating currency pressures within the supply chain (Bruno, Kim, and Shin 2018). Unfortunately I do not observe the identity of the importer and cannot test this channel.

5.2 Relation to Endogenous Invoicing Literature

There is a large literature on the determinants and effects of invoicing currency. While this paper is mainly about the role of a payments system, the results may help inform this literature regarding determinants of invoicing. Engel (2006), Gopinath, Itskhoki, and Rigobon (2010), and Mukhin (2018) have argued that currency choice is endogenous and determined by minimizing variation around optimal prices. Early work in this area, such as Obstfeld and Rogoff (1995) or Betts and Devereux (2000) studied how invoicing currency affects optimal monetary policy, but took the invoicing decision as given.

My paper provides empirical support for two classes of models: contracting problems between buyers and sellers. (e.g. Doepke and Schneider 2017; Drenik, Perez, and Kirpalani 2019; Chahrour and Valchev 2021) or nominal rigidities (e.g. Engel 2006; Gopinath, Itskhoki, and Rigobon 2010; Mukhin 2018. Contracting models explore how the formation optimal contracts between buyers and sellers incorporate currency risks. In the setting studied in this paper, using the SML System allows for the exporter to eliminate price risk coming from foreign currency movements and likely reduces other costs of settling cross-border transactions.

Alternatively, models that emphasize nominal frictions in price setting, arguing that the pass-through of exchange rates to optimal prices (via e.g. strategic complementarities in pricing or imported intermediate inputs) determines the optimal currency choice (Engel 2006; Gopinath, Itskhoki, and Rigobon 2010; Mukhin 2018).[20] One assumption embedded in the models that incorporate nominal frictions is that without nominal frictions, currency choice is irrelevant. That I find a first-order effect of changing currencies ever after a year, when prices have typically adjusted, suggests instead that currency choice has first-order effects. My paper also suggests that models featuring returns to scale in currency trading as a determinant of currency choice (e.g. Krugman 1980; Rey 2001) are limited in explaining patterns of invoicing. In these models, the cost of international payments declines as one vehicle currency is used more frequently. However, the small transaction costs in the BRL-USD market compared with the sizable effects suggests this channel is likely

20. With nominal rigidities, invoice currency plays an important role in explaining short-term deviations from the law of one price, which has implications for purchasing power parity. This literature has at its roots the seminal argument of Friedman (1953) that exchange flexibility can be a source of needed relative price adjustment in response to negative economic shocks. 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, Itskhoki, and Konings (2014)).

limited.

5.3 Conclusion

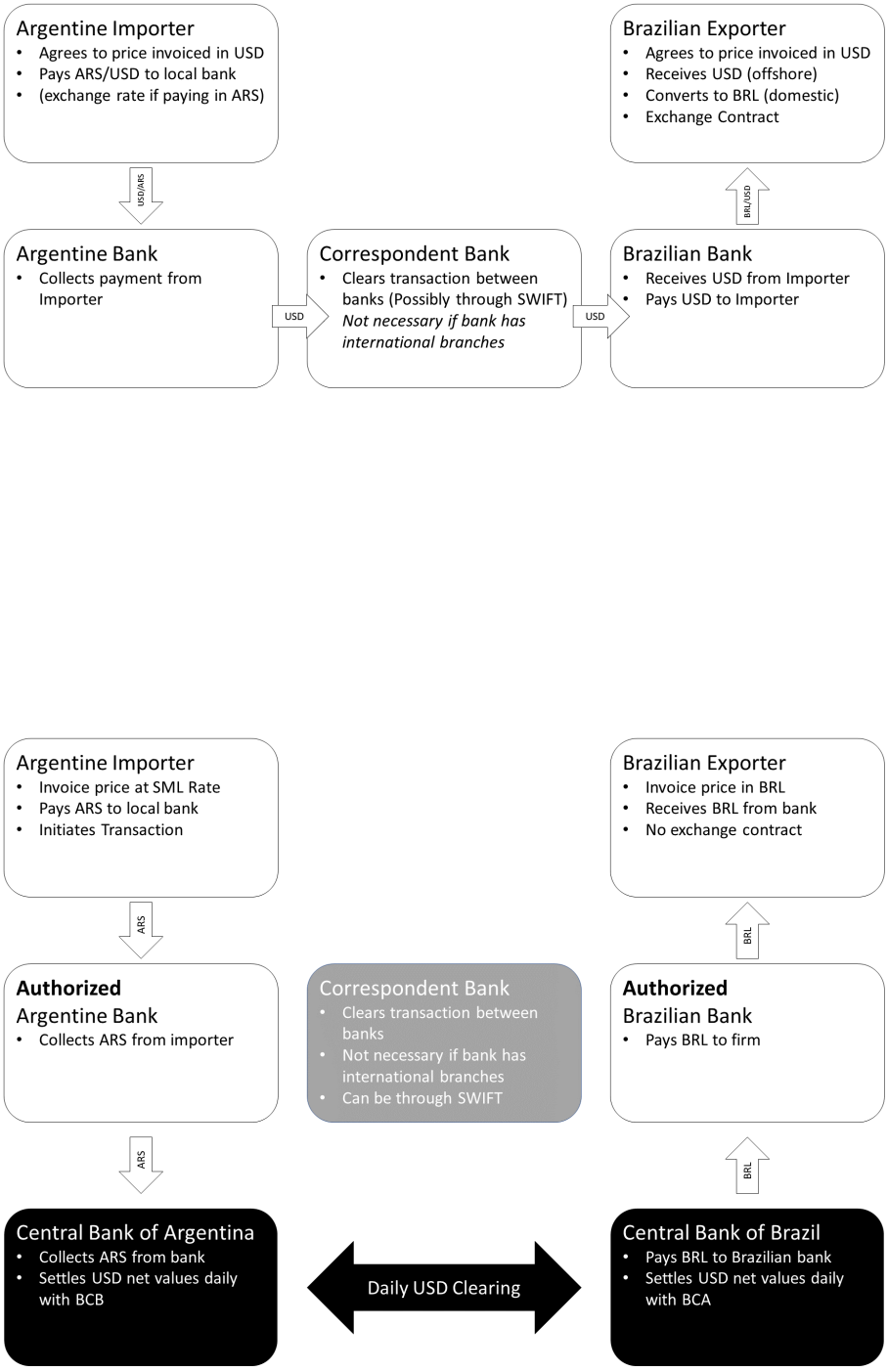
The high cost of cross-border payments is a concern for policymakers around the world (Federal Reserve Board 2022; Bank for International Settlements 2014; Committee on Payments and Market Infrastructures 2018) It is accepted wisdom that cross-border payments involve a host of potential settlement and accessibility issues relating to currency exchange, differences in legal environments, technical infrastructure, and coordination among the necessary actors. Quantifying the extent to which these costs affect the movement of funds for international trade, remittances, and other financial transactions is crucial to enhance the efficacy of the global financial system.

This paper's contribution is to study the role of foreign currency usage as a potential 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 respectively. Using municipal variation in quasi-randomly assigned SML system access, I find that municipalities with a higher share of SML authorized institutions saw relative exports to Argentina rise by significantly more following the introduction of the SML system relative to municipalities with a lower share of SML authorized institutions. A complementary analysis using confidential customs data that includes the currency of invoicing finds similar results.

These results suggest that the costs associated with cross-border trades are not small. I argue that exporter risk-aversion is a cost to trade, but likely does not account for the full effect found in this paper. Frictions in spot exchange markets likely do not play a role, suggesting some caution for policymakers looking to improve trade by making cross-border payments more efficient. Quantifying the costs of cross-border payments remains an important area of research.

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. 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. In addition, a number of countries in Southeast Asia, such as Indonesia, Malaysia, and Thailand have also begun to implement local currency payment systems.

Figure 1: Export Transaction (without the usage of the SML System)



The top panel shows the flow of payments from an Argentine importer to a Brazilian exporter when not using the SML system. The bottom panel shows how the SML System affects this transaction. **Source**: Caldentey, Titelman, and Tomassian (2013)

Figure 2: Take-up of the SML System

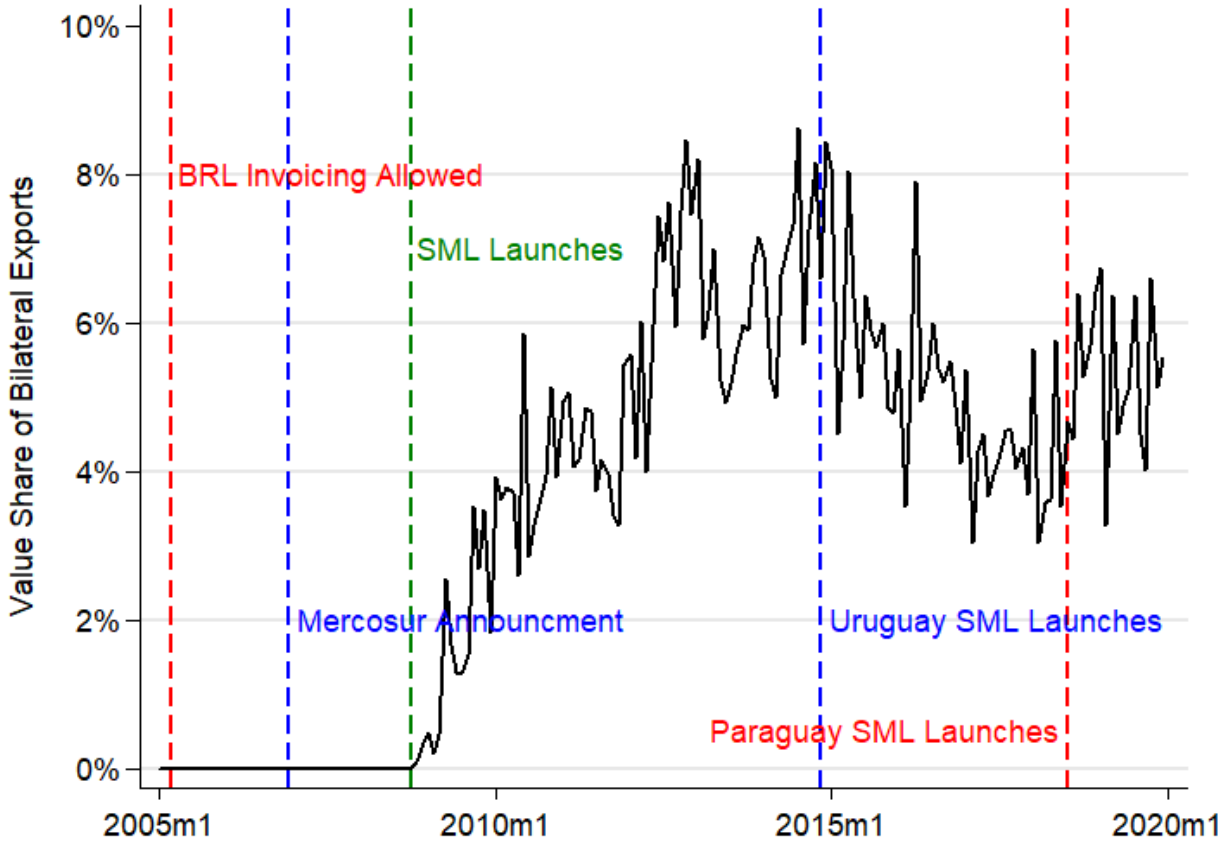
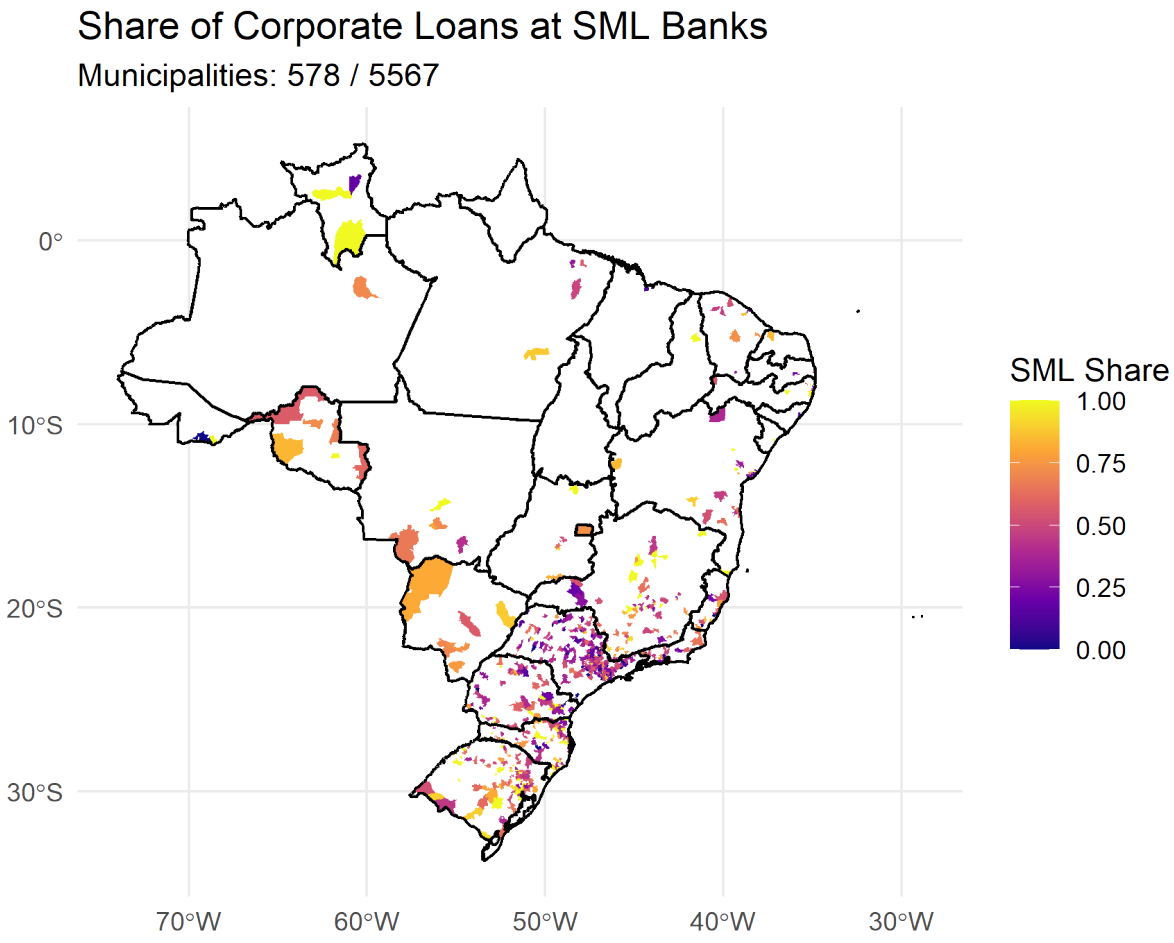


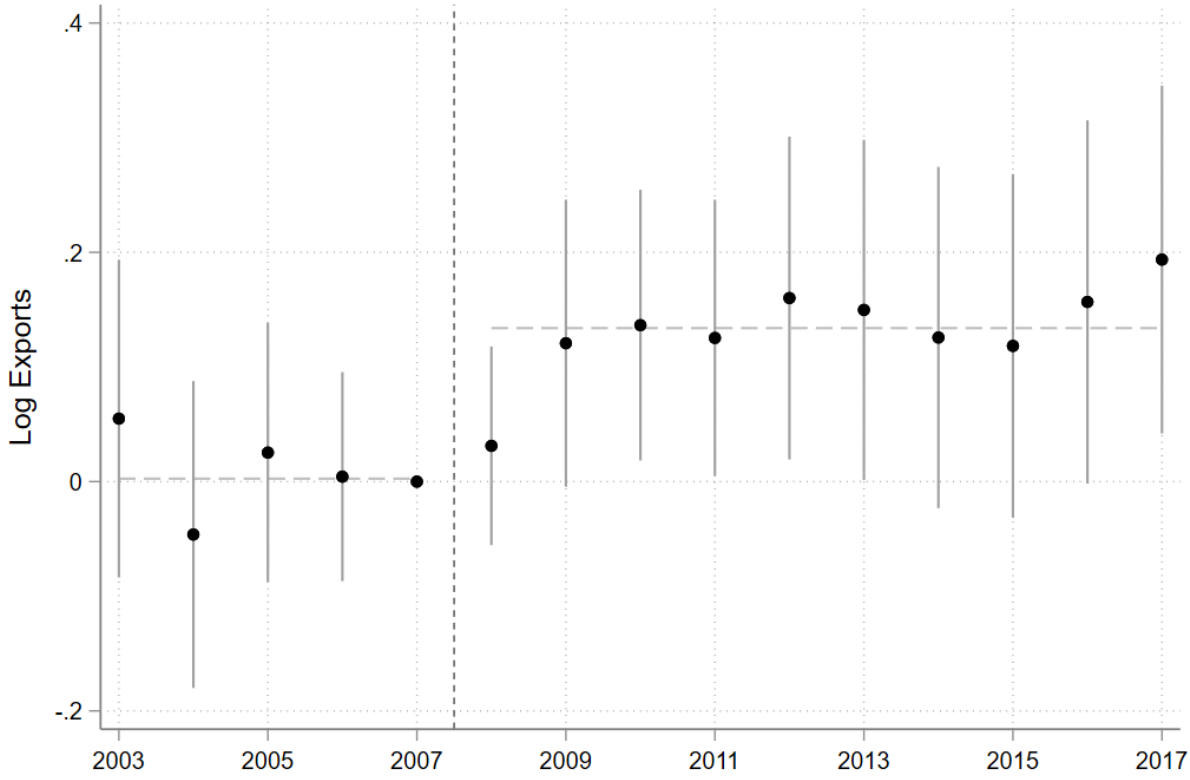
Figure plots SML usage as a share of total exports to Argentina. **Source**: Brazilian Central Bank, World Bank, SECEX

Figure 3: Map of SML Shares



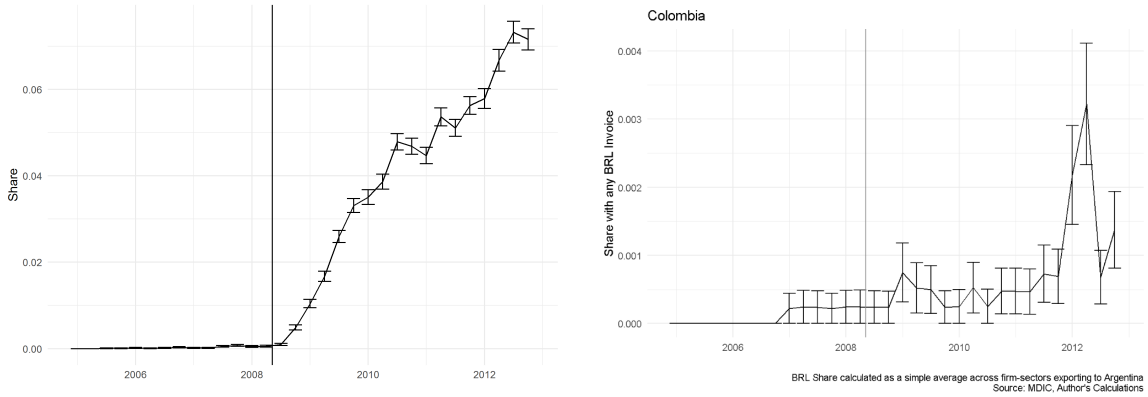
Each polygon within the figure denotes a municipality in Brazil. The color of the municipality signifies the market share of loans at SML authorized institutions. Municipalities with either no financial data or no export data are in white. **Source**: Brazilian Central Bank, SECEX

Figure 4: Relative Effect of SML Financial Institutions



This figure presents results from estimating the triple difference specification given by equation (9): $y_{msjt} = \alpha_{jt} + \delta_{mj} + \theta_{mst} + \beta_t (ARG_j \times SML\_Share_m) + \varepsilon_{msjt}$, where the outcome y_{msjt} is log exports in HS2 sector s from municipality m in year t to destination j, SML_Share_m is the corporate loan market share of SML banks in municipality m, and ARG_j is a dummy equal to 1 if the destination is Argentina. Standard errors are clustered by municipality. **Source**: Brazilian Central Bank, SECEX

Figure 5: BRL-Invoiced Exports to Argentina

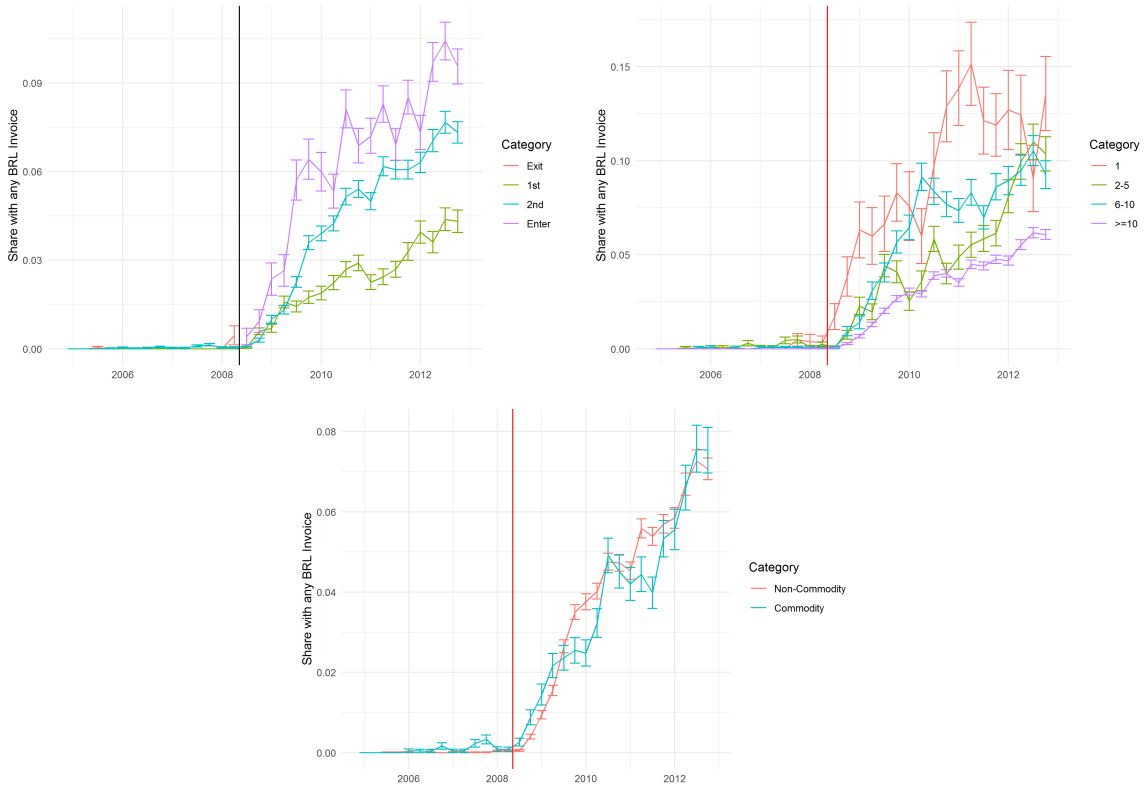


(a) Argentina

(b) Colombia

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 6: 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: 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 in 2008. **Source**: BCB

Table 2: Placebo Tests

	ARG	BOL	CHL	COL	ECU	PAR	PER	URY
Interaction Term	0.13**	-0.05	0.08	-0.08	-0.11	0.05	-0.02	0.03
	(0.055)	(0.060)	(0.056)	(0.071)	(0.085)	(0.070)	(0.062)	(0.083)
N	39,195	33,090	33,090	33,090	33,090	33,090	33,090	33,090
Adjusted R^2	0.84	0.82	0.82	0.82	0.82	0.82	0.82	0.82
Muni-Time FE	Y	Y	Y	Y	Y	Y	Y	Y
Country-Time FE	Y	Y	Y	Y	Y	Y	Y	Y
Muni-Country FE	Y	Y	Y	Y	Y	Y	Y	Y

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

. This table presents results from estimating the triple-difference specification given by Equation (2) $\ln y_{mjt} = \alpha_{jt} + \delta_{mj} + \theta_{jt} + \beta\left(POST_t \times SML\_Share_m \times Dest_j\right) + \varepsilon_{msjt}$. 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 from the sample. **Source**: SECEX

. $* \; p < 0.1$; $** \; p < 0.05$; $* * * \; p < 0.01$. Standard errors are clustered by municipality.

Table 3: 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 4: Shipment-Level Effects of BRL Invoicing on Values

	$\ln V_{ijst}$ (1)	$\ln V_{ijst}$ (2)	$\ln P_{ijst}$ (3)	$\ln P_{ijst}$ (4)	$\ln V_{ijst}$ (5)	$\ln V_{ijst}$ (6)	$\ln V_{ijst}$ (7)
ι_{ijst}	-0.035	-0.128	0.007	-0.012	-0.047*	-0.035	-0.066**
	(0.089)	(0.112)	(0.089)	(0.047)	(0.025)	(0.023)	(0.030)
$\iota_{ijst} \times ARG$	0.437***	0.393***	-0.034	-0.017	0.048	-0.008	0.258
	(0.118)	(0.128)	(0.035)	(0.053)	(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	Y	Y	Y	Y
HS2-Time FE	Y	Y	Y	Y	Y	Y	Y
Dest-Time FE	Y	Y	Y	Y	Y	Y	Y
Firm-Time FE		Y		Y			
Firm-Dest FE		Y		Y			
Obs	1,934,081	1,748,786	1,851,077	1,748,786	1,934,081	1,793,286	1,539,533
Adj. $\mathcal{R}^2$	0.746	0.792	0.792	0.861	0.744	0.746	0.741

The first two columns of the table reports regressions of the form $y_{ijst} = \alpha + \beta\iota_{ijst} + \gamma(\iota_{ijst} \times ARG_j) + \varepsilon_{ijst}$, 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 50% 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. α denote fixed effects indicated at the bottom of the table. **Source**: SECEX, Brazilian Central Bank

$*$ $p < 0.1$; $**$ $p < 0.05$; $***$ $p < 0.01$. Standard errors clustered at the sector-establishment level.

Table 5: 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

. This 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. **Source**: SECEX

. $* p < 0.1$; $** p < 0.05$; $*** p < 0.01$. Standard errors clustered at the establishment level.

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A Additional Historical Background

A.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).[21] In 1965, a multilateral mechanism was created, known as the Reciprocal Payments and Credit Agreement (CPCR).[22] 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 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

21. 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.

22. This and the following paragraphs rely heavily on information from Flax-Davidson (1985) and Caldentey, Titelman, and Tomassian (2013)

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. [23]

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.[24] 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 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.[25] 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.[26]

23. Link
24. Another subregional South American cluster is the Andean Community of Nations, which involves Bolivia, Colombia, Ecuador, and Peru.
25. 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.
26. See, for example, Edwards (2006)

A.2 Additional Background on the SML System

Figure A1 plots the daily SML rate as reported by the BCB, and the spot exchange rate. The close correlation between the two exchange rates is evident.

Table A1 includes select translated texts with the original quotations in Portuguese.

Official Sources

- CIRCULAR No. 003406
- RESOLUTION No. 003608
- More Information

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. It was not until 2006 that the *requirement* for foreign exchange coverage was eliminated due to the increased costs to Brazilian firms who wished to use foreign currency receipts to purchase imports (Presidência da República 2006). Instead, the Reçeita Federal began tracking foreign currency coverage and for tax purposes. (Central Bank of Brazil and Reçeita Federal 2006)

Figure A1: SML Rate and Spot Market Rate

Source:

Table A1: Translated Quotes

English	Portuguese	Source
transfers of funds in US dollars Between the Central Bank of Brazil and the Central Bank of Republic of Argentina, as a result of the daily compensation of transfers of funds relating to the receipts and payments of which deal with items II and III of this article.	as transferências de fundos, em dólares dos Estados Unidos, entre o Banco Central do Brasil e o Banco Central da República Argentina, em decorrência das compensações diárias das transferências de fundos relativas aos recebimentos e pagamentos de que tratam os incisos II e III deste artigo.	
reference rate: US dollar exchange rate Argentine pesos, published daily by the Bank Central of the Argentine Republic;	taxa de referência: taxa de câmbio do dólar dos Estados Unidos, em pesos argentinos, divulgada diariamente pelo Banco Central da República Argentina;	
PTAX rate: simple arithmetic mean between the rates US dollar buying and selling PTAX disclosed daily in the closing bulletin, by the Central Bank of Brazil by transaction PTAX 800, option 1;	taxa PTAX: média aritmética simples entre as taxas PTAX de compra e de venda do dólar dos Estados Unidos, divulgadas diariamente no boletim de fechamento, pelo Banco Central do Brasil pela transação PTAX 800, opção 1;	
SML rate: exchange rate for pesos conversion Argentines in Reais, released by the Central Bank of Brazil in the until 6.30 pm to be used in the relations between the national authorized institutions and the Central Bank of Brazil, referring to Brazilian imports processed in the SML.	taxa SML: taxa de câmbio para conversão de pesos argentinos em reais, divulgada pelo Banco Central do Brasil nos dias úteis, até as 18h30, a ser utilizada nas relações entre as instituições autorizadas nacionais e o Banco Central do Brasil, referente a importações brasileiras processadas no SML.	

B Data Appendix

B.1 Aggregate Data

Aggregate data used in Figure 2 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 monthly and in USD, so I convert to BRL using the monthly average exchange rate available from FRED (mnemonic "DEXBZUS").

Daily spot, bid, and ask exchange rate data used in Section 5 is from Bloomberg.

B.2 Municipality Data

Municipality data comes from.. A financial institution is defined as a unique 8-digit CNPJ. Table B1 displays summary statistics.

I acquire the list of SML authorized firms from the BCB website. In Brazil, the Brazilian Central Bank (BCB) maintains a list of authorized institutions on its website. The list posted on the BCB's website contains only 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.

I balance the sample and focus only on municipalities with non-zero exports for the period 2004-2015.

Figure (B1) 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.

Figure B4 presents value shares for firm-HS4-destination-quarters with strictly greater than 0% BRL shares and strictly less than 100% BRL shares.

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.

Figure B10 plots the increase in ι_{isjt} relative to other Latin American countries, showing that the rise is unique to Argentina.

B.3 Firm-Level Data

B.3.1 Data construction

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 (B6).

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, a 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. Table B2 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, Itskhoki, and Konings (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, Dix-Carneiro, and Vichyanond (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 B7 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 B8 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 (B9) 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.

Table B3 reports summary statistics for the full sample, the South American sample, and Argentina. South America accounts for nearly half of all export transactions. Argentina accounts for around 20% of export transactions to South America. Exports to Argentina are also much larger than exports to other South American countries.

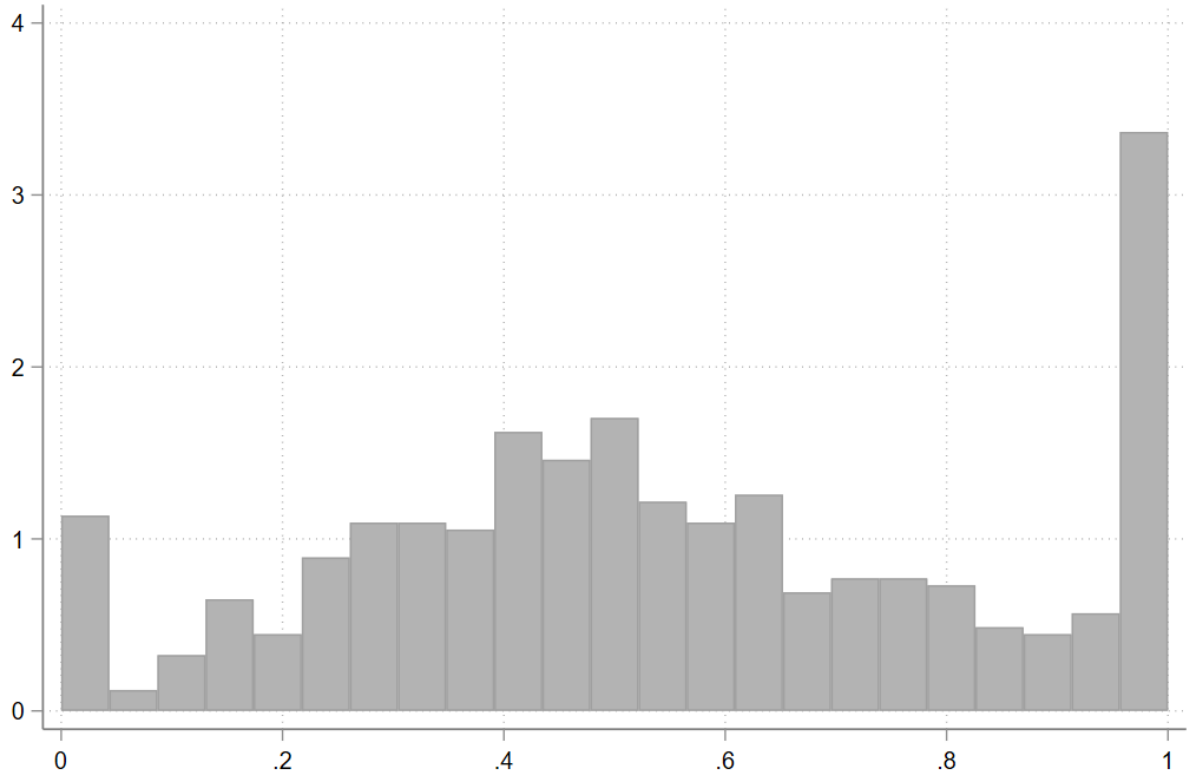
B.3.2 Relative Increases in Invoicing

Figure B10 shows the evolution of ι relative to other export destinations at the firm level. This figure is calculated by taking the average invoicing share across other South American export destinations and subtracting this value from the Argentina invoicing share. As can be seen, the BRL share is below zero in the pre-period but is very stable. That it is zero largely reflect the inclusion of Paraguay, which has a relatively largely BRL invoicing share. Following the introduction of the SML System, the share follows similar dynamics as Figure (5).

B.3.3 Additional Sector Figures

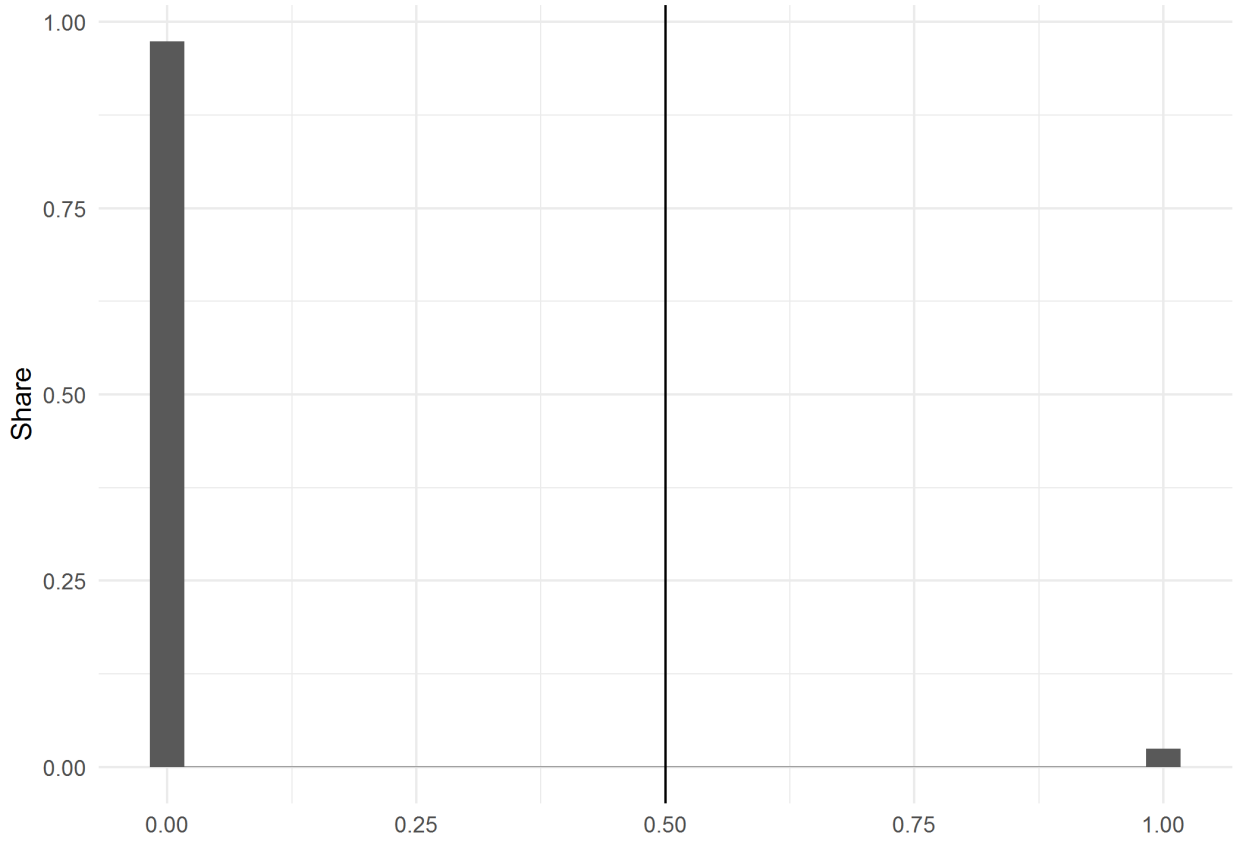
Figures (B11a) through Figure (B11t) plot the evolution of ι_{ijst} for $j = ARG$ by two-digit HS sector. While the overall pattern is similar for many sectors, there are also a number of sectors for which there is little to no rise in BRL invoicing.

Figure B1: Distribution of SML Shares



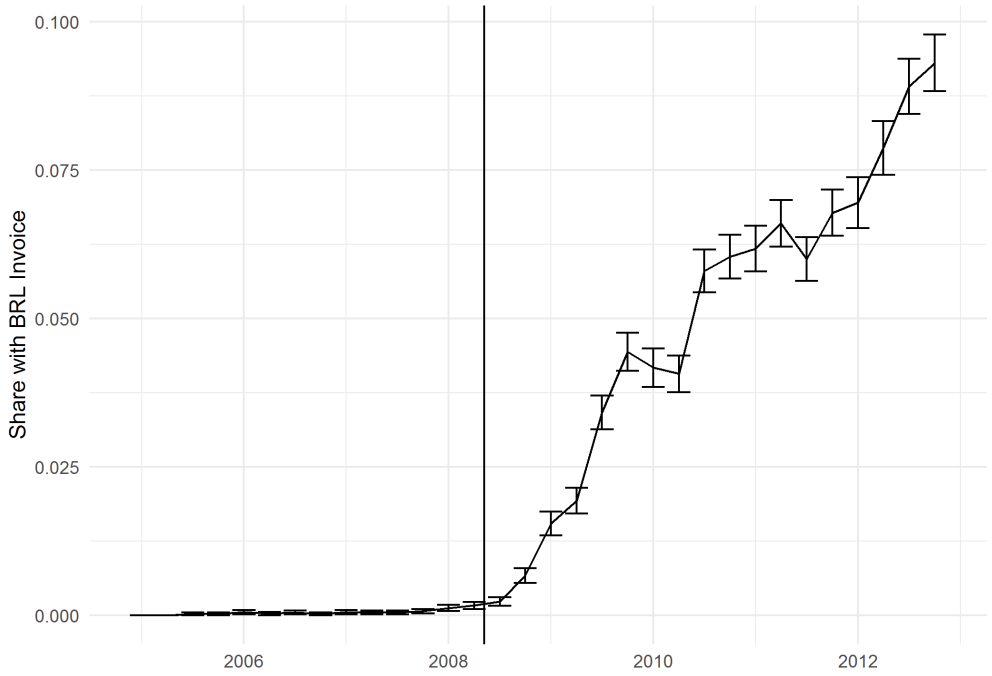
. This figure plots the distribution of SML_Share_m. **Source**: Brazilian Central Bank

Figure B2: Distribution of BRL Shares of Transactions



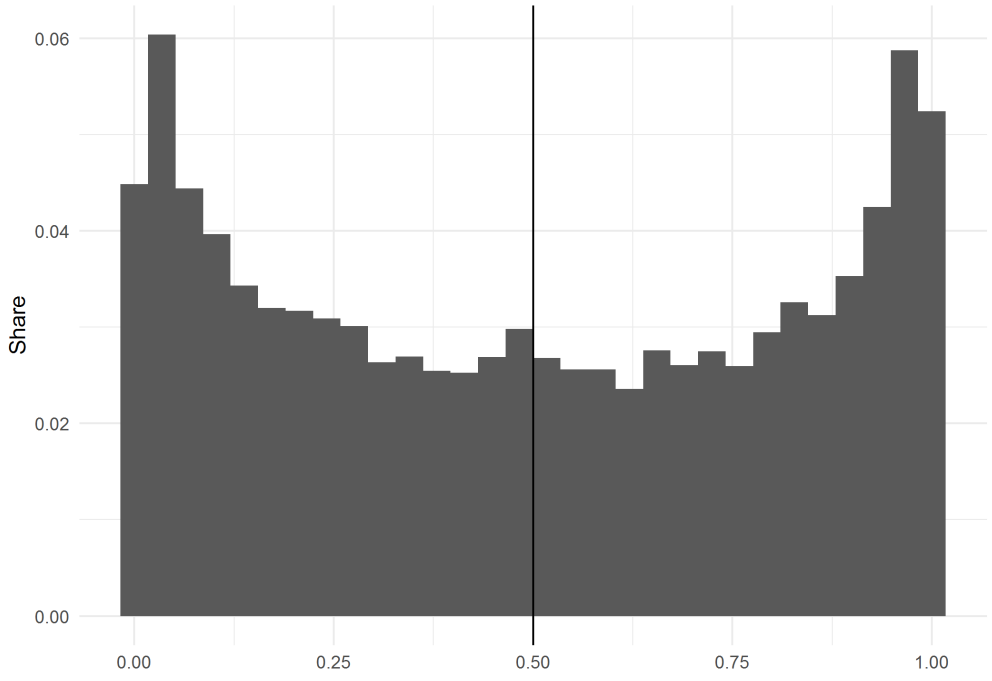
. Histogram of BRL-invoicing for exports, V_{ijst}^{BRL}/V_{ijst}. V_{ijst} is the dollar value of total exports to destination j by firm i in 4-digit sector s in quarter t. V_{ijst}^{BRL} is the dollar value of BRL-invoiced exports. (Values strictly greater than 0 or strictly less than 1 are available in Figure (B4)) **Source**: SECEX

Figure B3: Argentina ι Shares by Firm



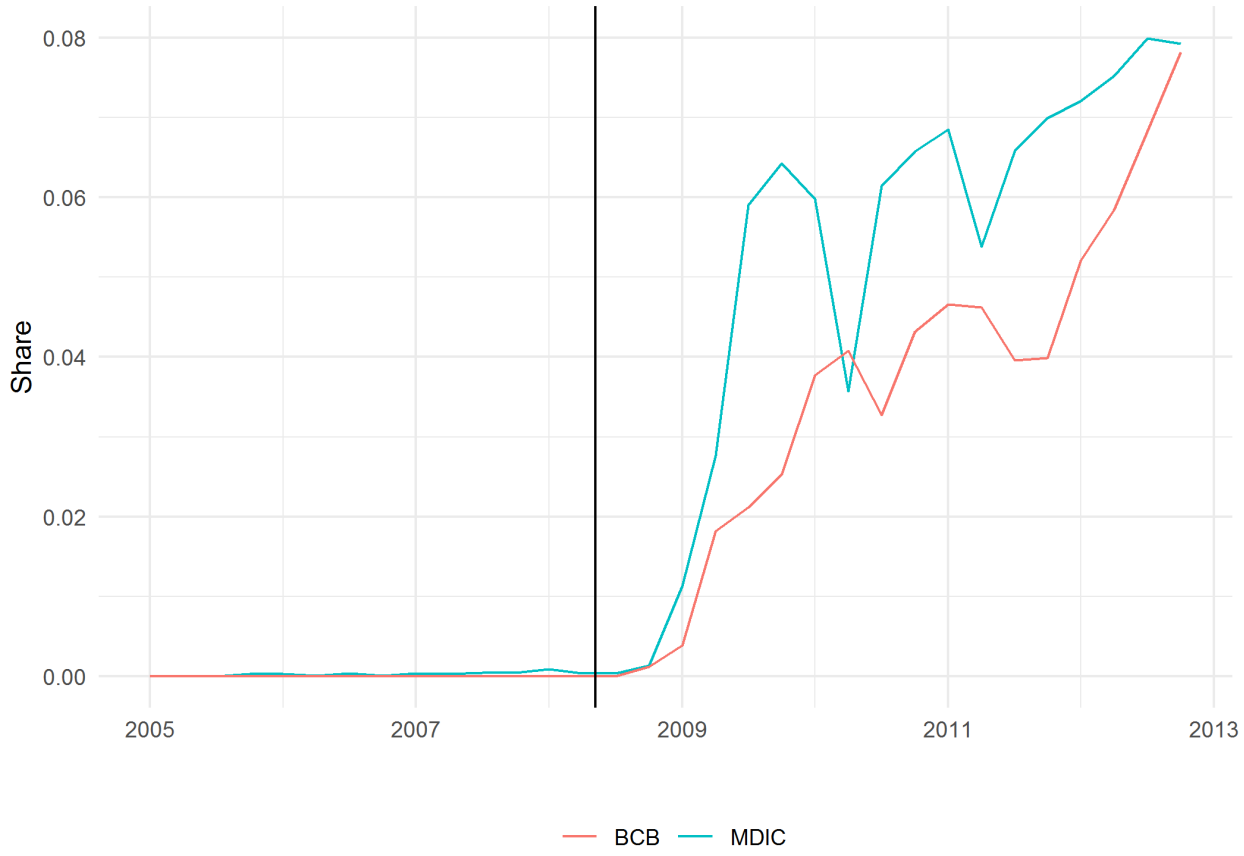
. Figure shows the mean and standard deviation bands of the value of ι_{iARGt}. ι_{iARGt} is a dummy variable equal to one if for at least one sector exported by for i to Argentina in quarter t has at least 50% of the value of exports invoiced in BRL. **Source**: SECEX

Figure B4: BRL Value Shares (Greater than zero and less than one)



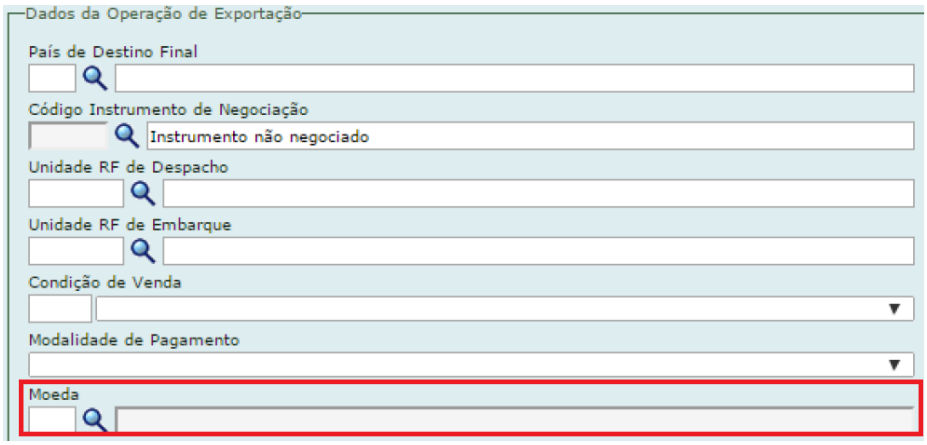
. This figure plots the share of exports invoiced in BRL for shipments with strictly greater than 0% and strictly less than 100%. **Source:** SECEX.

Figure B5: BRL Invoicing and SML Usage



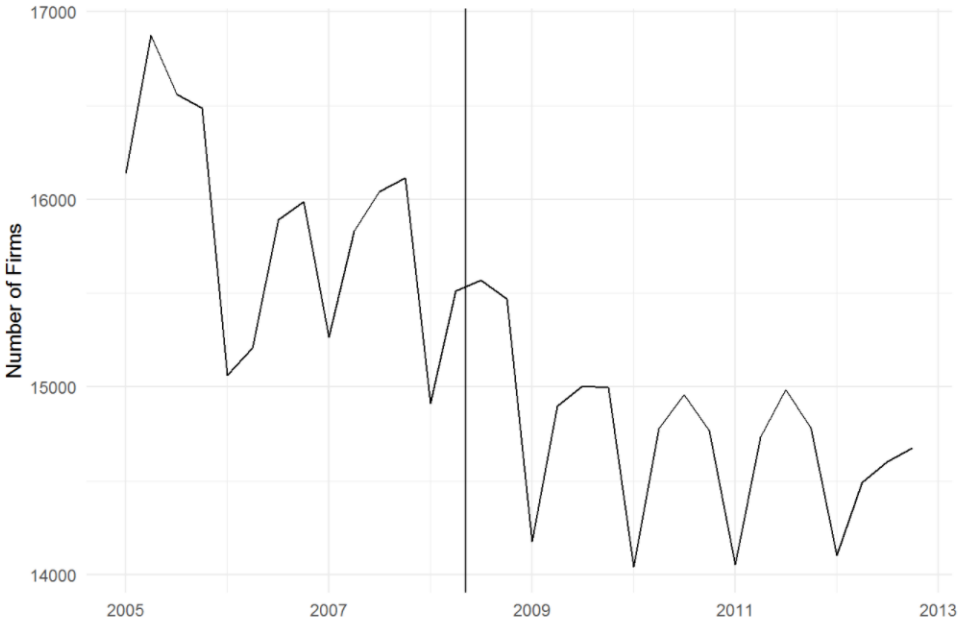
. This figure compares the share of exports invoiced in BRL from the customs data with the share of total exports reported as SML exports via the Central Bank of Brazil. **Source**: Brazilian Central Bank, SECEX

Figure B6: Customs Form (Online)



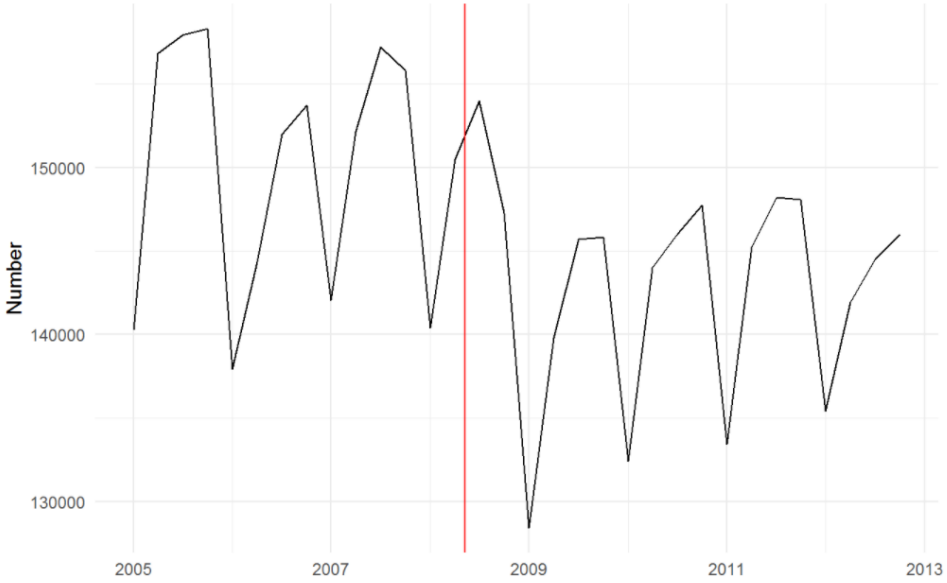
. Screenshot of a customs form to be filled out by an exporter. The key field denoting the currency of invoicing, labeled "moeda", is outlined in red by the author. **Source:** SECEX.

Figure B7: Number of Firms Over Time



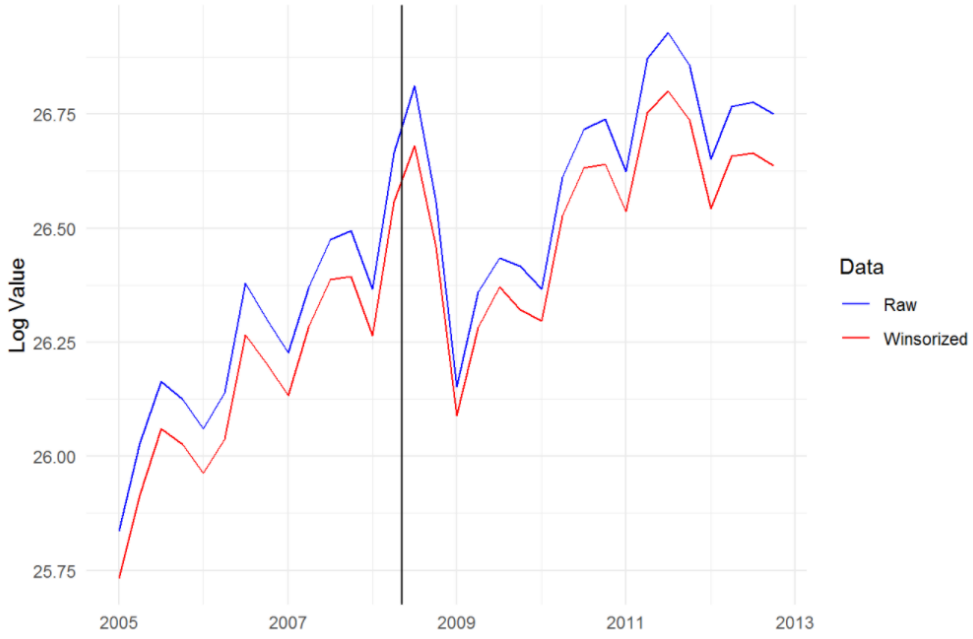
. This figure plots the number of unique firms each quarter in the final sample. **Source:** SECEX.

Figure B8: Number of Transaction Over Time



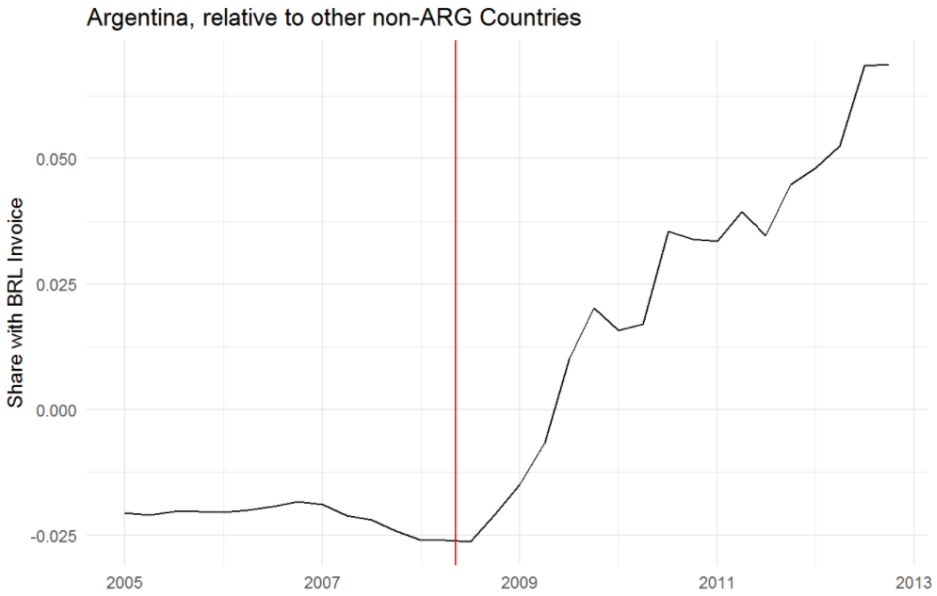
. This figure plots the number of transactions each quarter in the final sample. **Source:** SECEX.

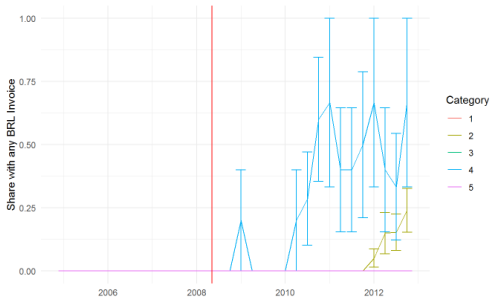
Figure B9: Value Over Time



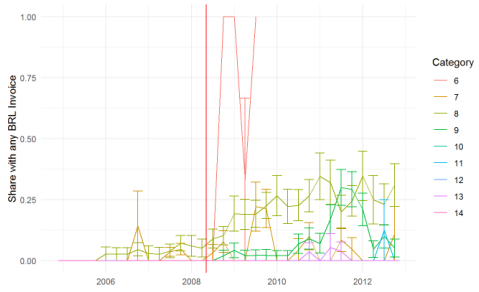
. This figure plots the total value of each quarter in the final sample. The line labeled "raw" denotes the raw value. The line labeled "winsorized" winsorizes the raw data at the 1% and 99% levels within each HS2-Destination cell. **Source:** SECEX.

Figure B10: Argentina ι shares relative to other Latin America countries

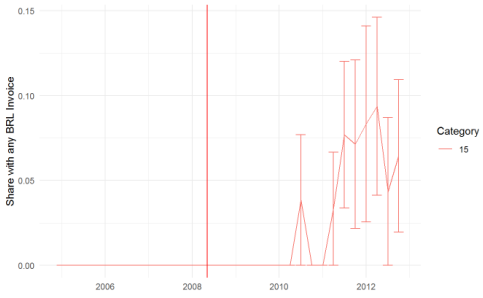




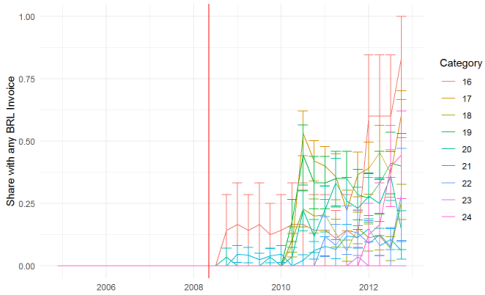
(a) Section 1: Live Animals



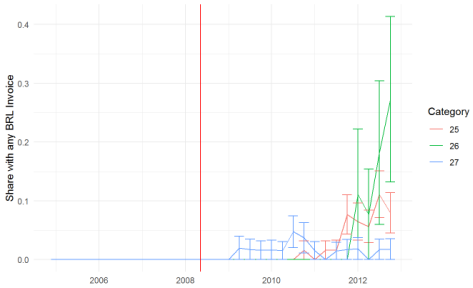
(b) Section 2: Vegetable Products



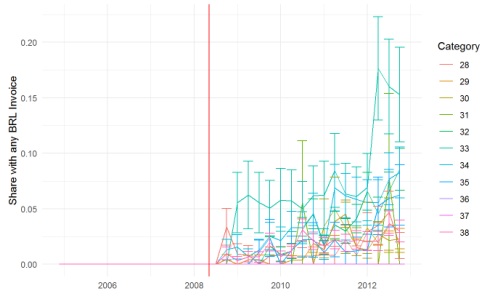
(c) Section 3: Animal and Vegetable Fats and Oils



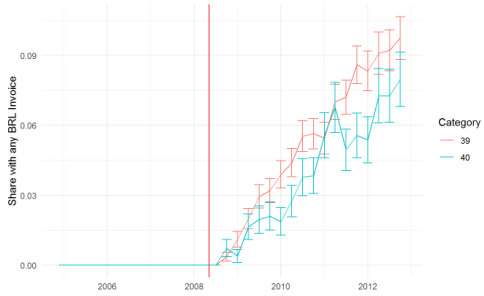
(d) Section 4: Prepared Foodstuffs, Beverages, and Tobacco



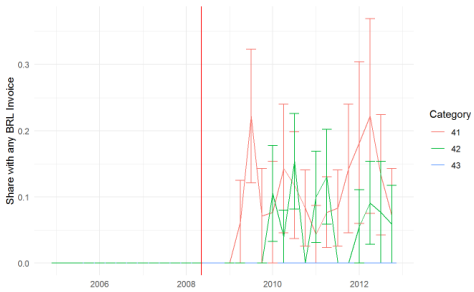
(e) Section 5: Minerals



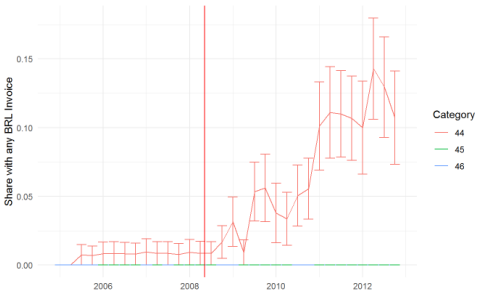
(f) Section 6: Chemical Products



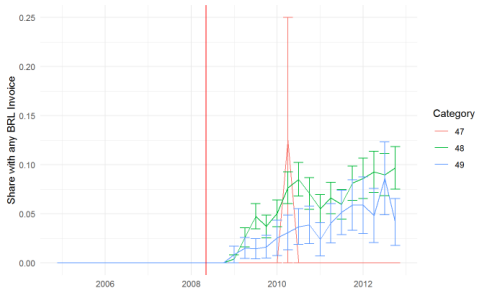
(g) Section 7: Plastic and Rubber Products



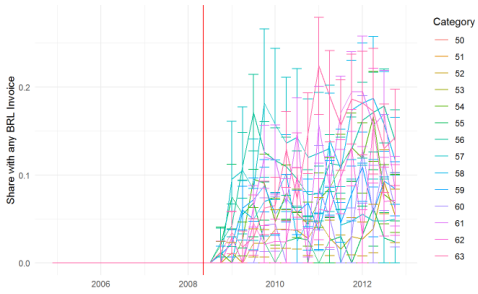
(h) Section 8: Raw Hides



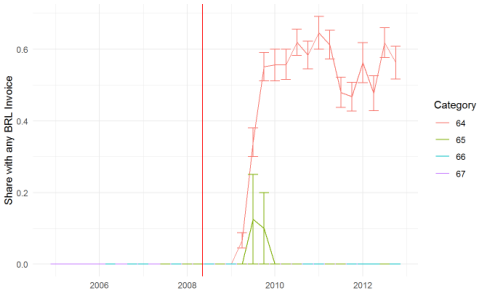
(i) Section 9: Wood Products



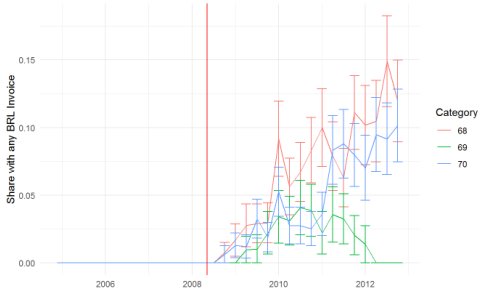
(j) Section 10: Paper Products



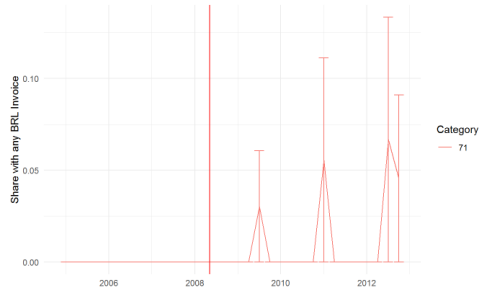
(k) Section 11: Textiles



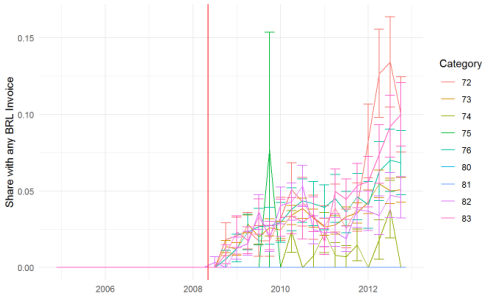
(l) Section 12: Footwear



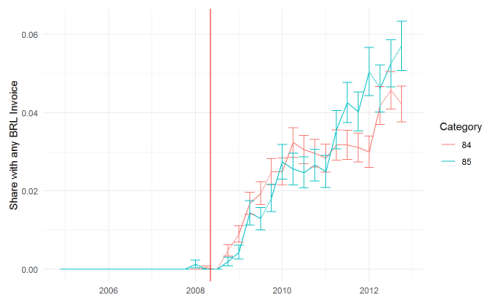
(m) Section 13: Stone



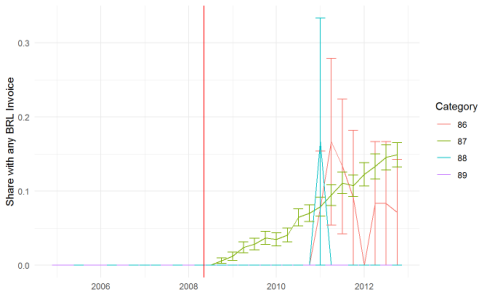
(n) Section 14: Precious Metals



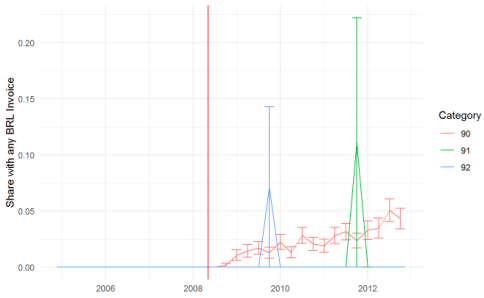
(o) Section 15: Base Metals



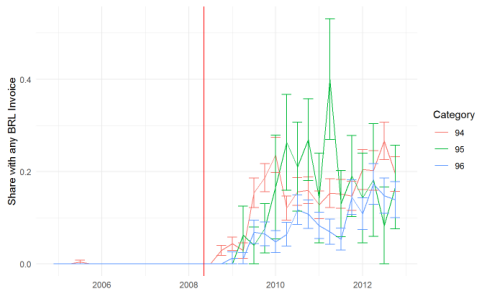
(p) Section 16: Machinery



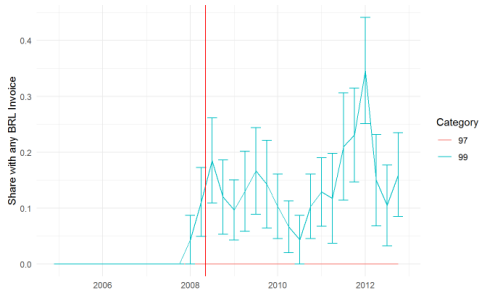
(q) Section 17: Transportation



(r) Section 18: Optical



(s) Section 20: Misc. Manufacturing



(t) Section 21: Art and Other

Table B1: Municipality Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	P50
Argentina	36972	.158	.364	0	1	0
SML Loan Share	36972	.489	.251	0	1	.466
Log Value	36972	13.902	2.108	3.829	21.518	13.903

Table B2: 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 B3: 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

C Municipality Robustness Checks

C.1 Local Demand for the SML System

A second concern with these results is that individual financial institutions may have opted into the SML system due to persuasion efforts by their clients. The identification strategy in this paper relies on the fact that the decision to join the SML system was a national one, exogenous to any individual municipality. However, individual firms may still have lobbied their financial institutions to participate. If these firms are located in municipalities with relatively high expected growth of exports to Argentina, this endogenous selection problem of firms may bias upwards the causal effect of the SML system.

To account for this concern, I exploit the fact that the decision to opt into the SML system was a national one from the perspective of banks. Assuming that the pressure exerted by a municipality for a bank to join the SML system is proportional to its portfolio share, I can simply drop those municipalities that account for a significant share of an SML eligible institution' national portfolio and only inspect the effect of the SML system on municipalities that likely had little influence. I drop municipalities for which the share of total loans by the financial institution is equal to or above 1%. Figure (C1) shows the results from dropping these municipalities. As can be seen, the results are little changed from dropping these large municipalities.

C.2 Municipality Evidence: Sector Controls

A final concern with the main specification in this paper is that it relies on converting nominal values to real values by controlling for destination-time and municipality-time fixed effects, thereby deflating values by both an aggregate destination-specific export price index or a municipality-specific price index. Composition differences across municipalities in terms of the types of goods exported may make using aggregate price indices inappropriate.

I utilize the disaggregated municipality export data from Brazil that breaks exports down by two-digit HS sector. I then augment Equation (1) to include sector-specific fixed effects as follows

$$y_{msjt} = \alpha_{jt} + \delta_{mj} + \theta_{mst} + \beta_t \left(ARG_j \times SML\_Share_m \right) + \varepsilon_{msjt} \tag{9}$$

where the notation s denotes two-digit HS sector. The key difference now is the inclusion of municipality-time-sector fixed effects, which more accurately reflect the relevant price indices for individual firms. Figure (C2) presents the results of this estimation, which are little changed from the benchmark specification.

C.3 Municipality Evidence: Other

In Figure C3, I drop Uruguay as an export destination. Uruguay entered into an SML agreemeng in 2015, and so there may be some effect on exports by including this as an export destination. Instead, we see a similar pattern for exports.

In Figure C4, I control for log imports. Controlling for imports ensures that the effect found is not due to general changes in trade behavior that may be correlated with the SML loan shares. As can be seen, the effect on exports is little changed.

In Figure C5, I estimate a specification at the microregion level:

$$y_{Mjt} = \alpha_{jt} + \delta_{Mj} + \gamma_t SML\_Share_M + \beta_t \left(ARG_j \times SML\_Share_M\right) + \varepsilon_{Mjt}$$

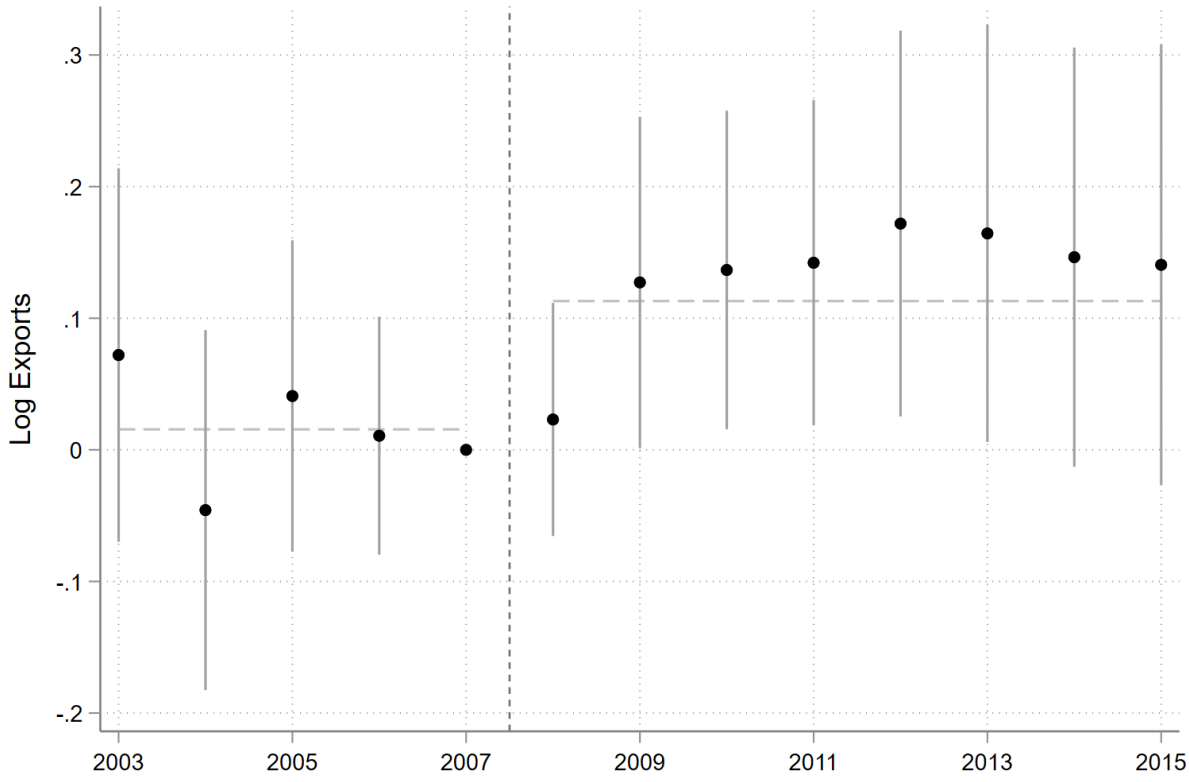
Municipalities are small, and so individual firms may actually be obtaining credit from firms outside of their municipality. While the number of microregions in the sample is relatively small (widening standard errors), the relative effect is little changed.

In Figure C6, I use the share of lending using code 161, or "empréstimos e títulos descontados." The correlation between the two loan shares is approximately 53%, but as the figure shows the increase in export values is still of a similar level, albeit with slightly higher standard errors.

Figure C7 drops the two largest banks (Itau and Banco do Brasil) and re-calculates the SML loan shares. The results are again similar.

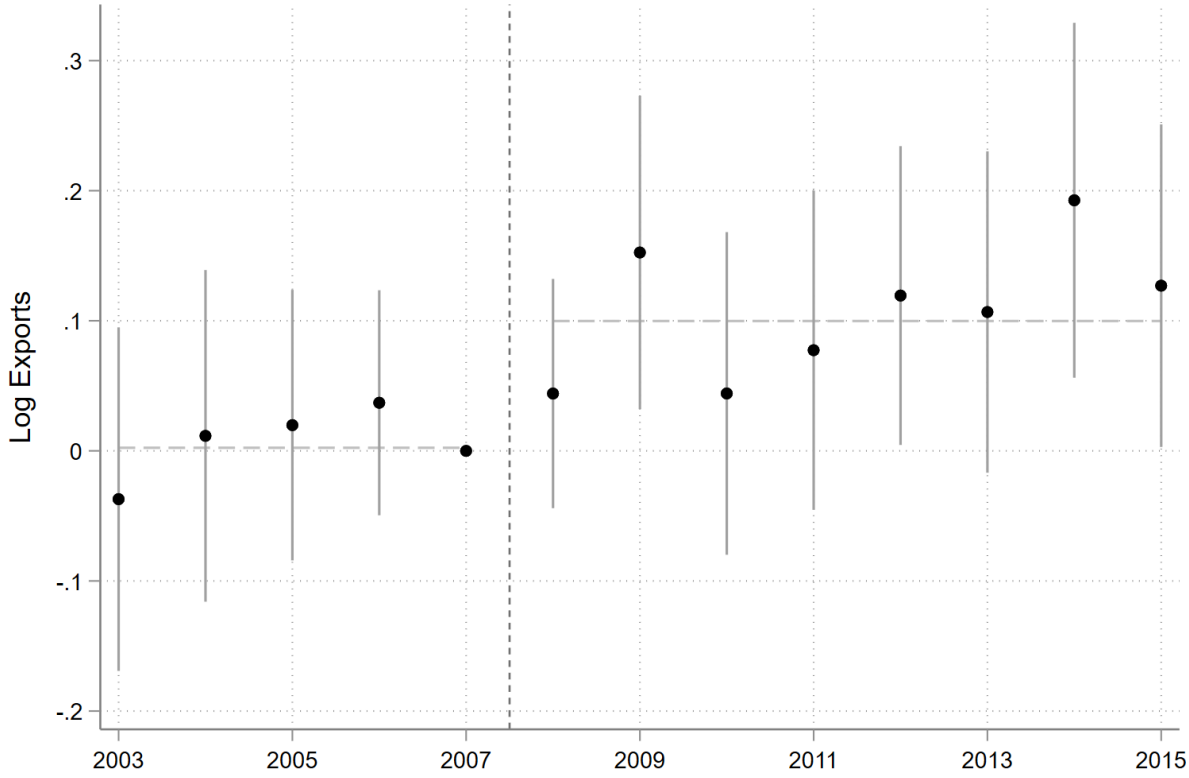
Figure C8 use an unbalanced panel, and the results are similar.

Figure C1: Dropping Municipalities with Greater Than 1% Market Share



This figure presents results from estimating the triple difference specification given by equation (9): $y_{mjt} = \alpha_{jt} + \delta_{mj} + \theta_{mt} + \beta_t (ARG_j \times SML\_Share_m) + \varepsilon_{mjt}$, where the outcome y_{mjt} is log exports in HS2 sector s from municipality m in year t to destination j, SML_Share_m is the corporate loan market share of SML banks in municipality m, and ARG_j is a dummy equal to 1 if the destination is Argentina. Municipalities with at least 1% market share of any SML institution are dropped. Standard errors are clustered by municipality. **Source**: Brazilian Central Bank, SECEX

Figure C2: Including Sector Controls



This figure presents results from estimating the triple difference specification given by equation (9): $y_{msjt} = \alpha_{jt} + \delta_{mj} + \theta_{mst} + \beta_t \left(ARG_j \times SML\_Share_m\right) + \varepsilon_{msjt}$, where the outcome y_{msjt} is log exports in HS2 sector s from municipality m in year t to destination j, SML_Share_m is the corporate loan market share of SML banks in municipality m, and ARG_j is a dummy equal to 1 if the destination is Argentina. Standard errors are clustered by municipality. **Source**: Brazilian Central Bank, SECEX

Figure C3: Drop Uruguay

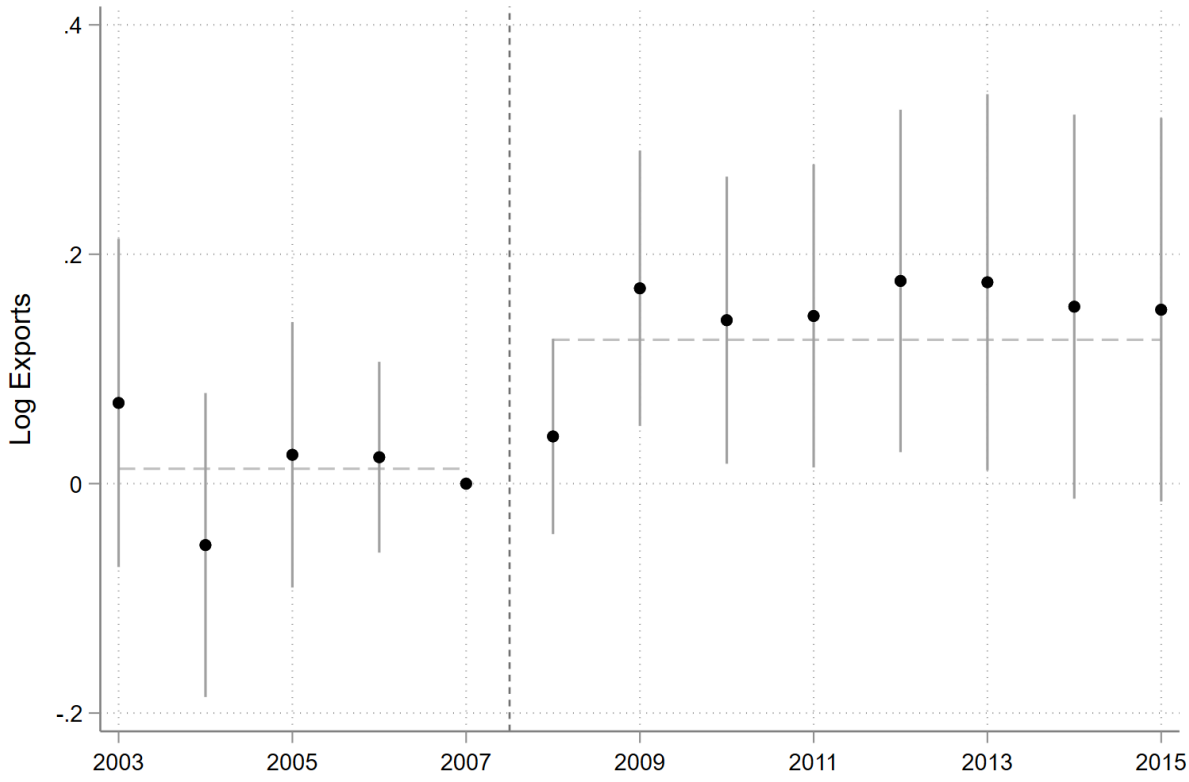


Figure C4: Control Imports

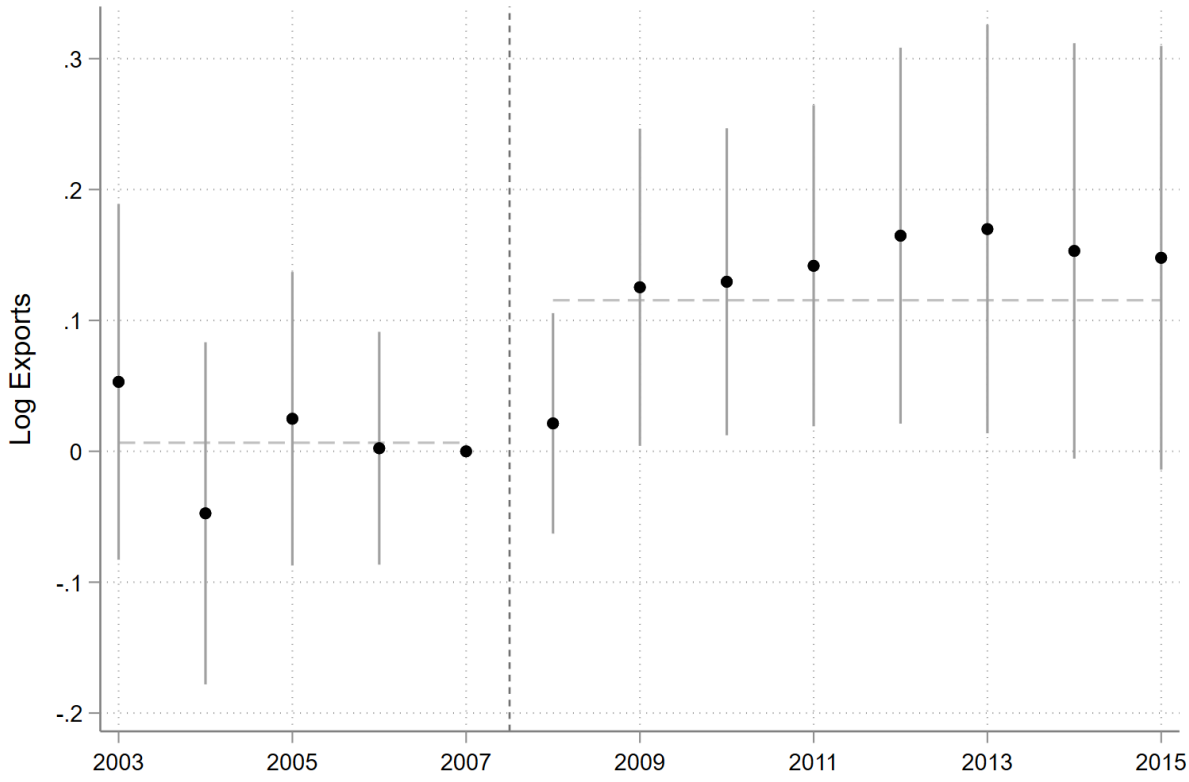


Figure C5: Microregion

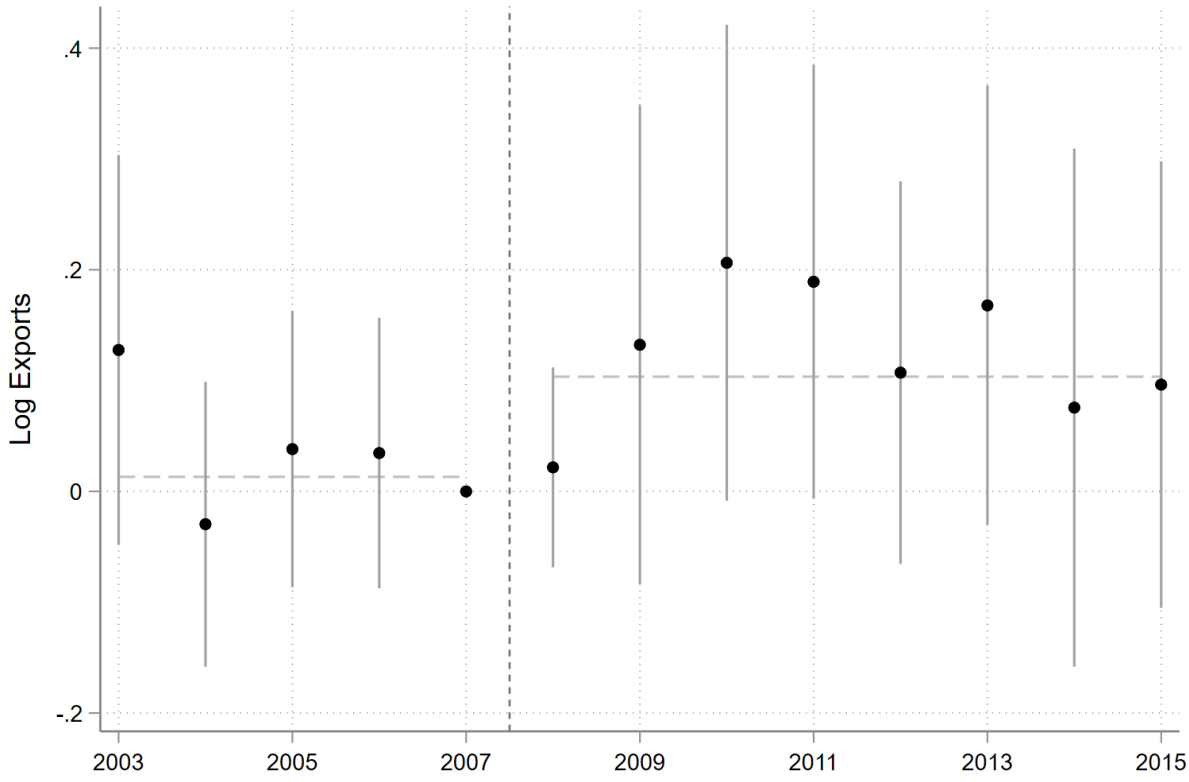


Figure C6: Alternate Definition of Corporate Loan Share

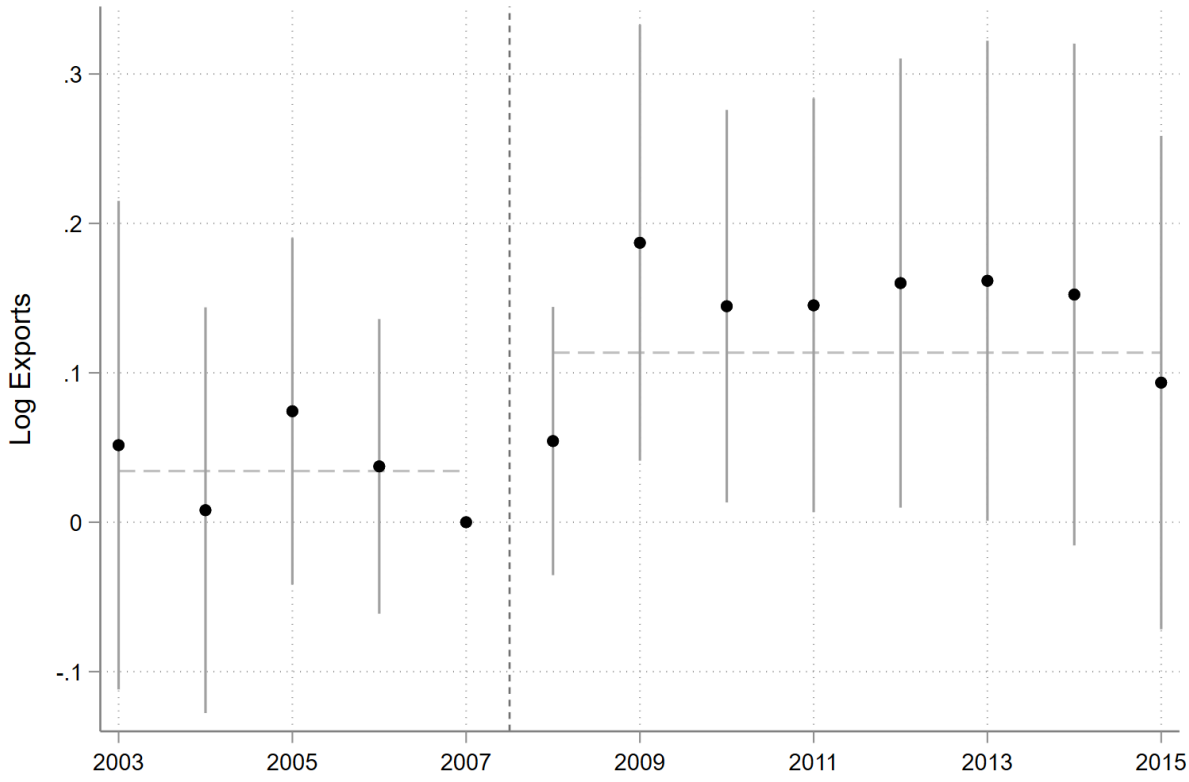


Figure C7: Drop Itau and Banco do Brasil

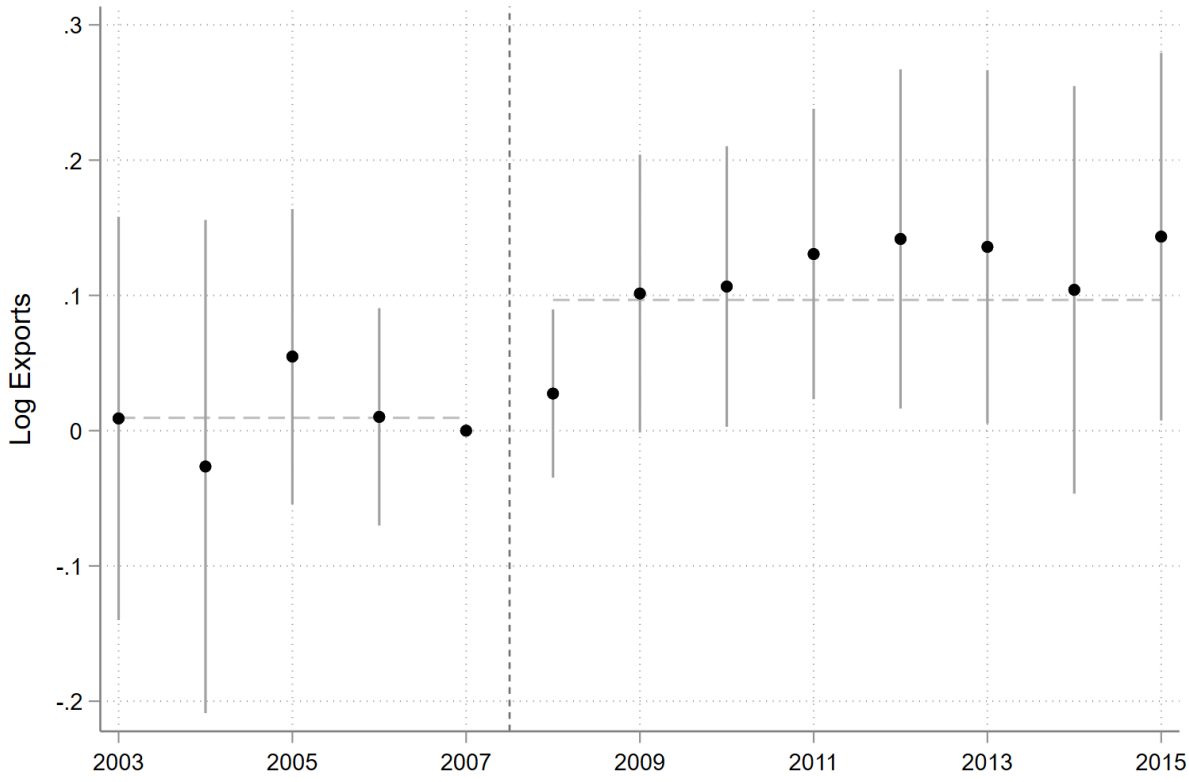
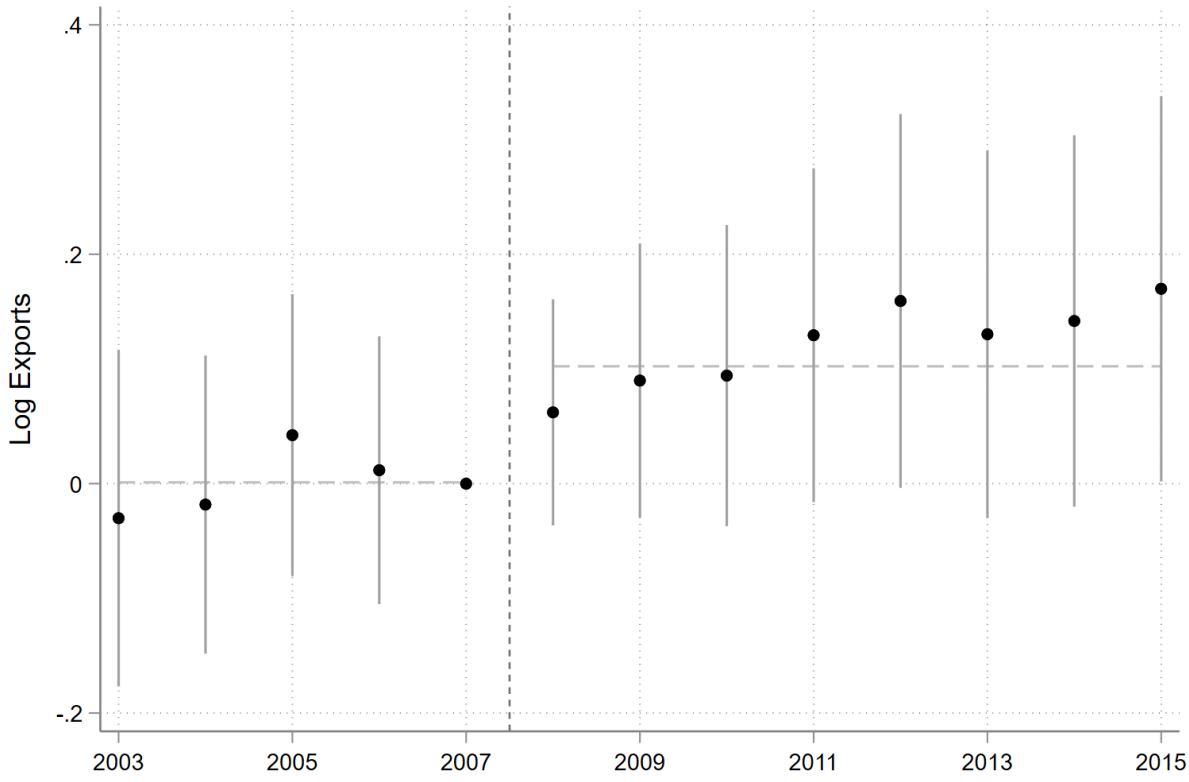


Figure C8: Unbalanced



D Firm-Level Robustness Checks

D.1 Decomposition

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.[27] 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, Itskhoki, and Konings (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 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 D1, 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.

27. 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.

D.2 Event Study - Argentina Only

I estimate an event study of the form

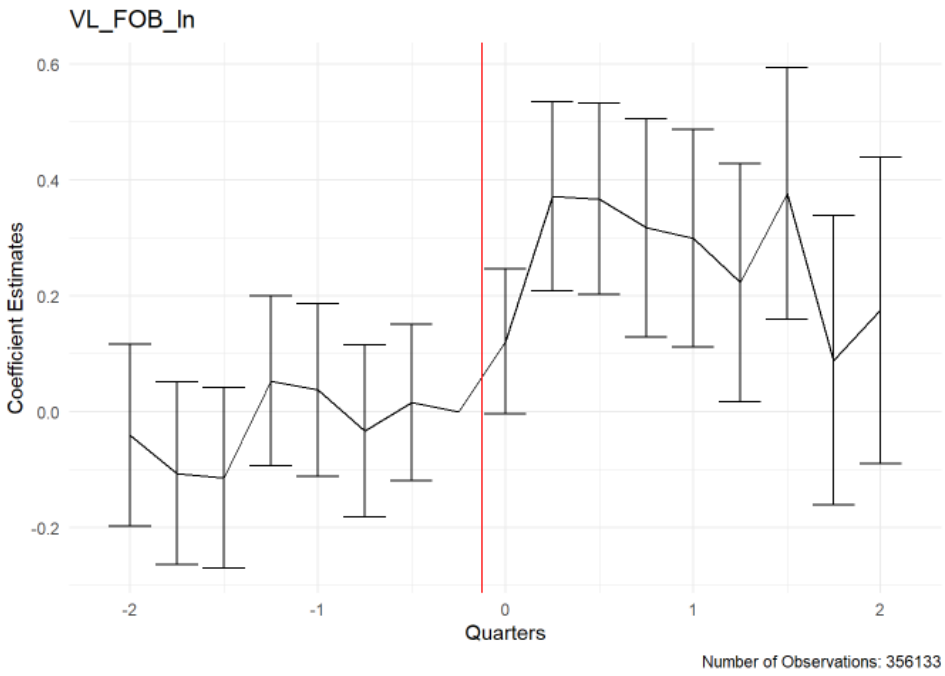
$$y_{ist} = \alpha_{is} + \alpha_t + \beta_t \iota_{ist} + \gamma_L \overline{D}_{ist} + \gamma_H \underline{D}_{ist} + \varepsilon_{ist}$$

where $\overline{D}_{ist}$ and $\underline{D}_{ist}$ are long-run dummies. The plot of the coefficients β_t is shown in Figure D1. There is no obvious pretrend, suggesting that the parallel assumption holds. Following the switch to the SML system, exports rise, with the full effect taking around 2 quarters. Exports then stay elevated.

D.3 Other Robustness Checks

Table D2 shows additional robustness checks. Columns (1) and (2) are results when conditioning on firm-sectors that export every quarter.

Figure D1: Event Study Specification



Event study coefficients for effect of SML usage.
Source: SECEX

Table D1: 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 50% 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 D2: Effects of BRL Invoicing - Full Sample

	$\ln V_{ijst}$ (1)	$\ln V_{ijst}$ (2)
ι_{ijst}	0.032	-0.078
	(0.056)	(0.064)
$\iota_{ijst} \times ARG$		0.259***
		(0.116)
Firm-HS4 FE	Y	Y
HS2-Time FE	Y	Y
Dest-Time FE	Y	Y
Obs	170,624	170,624
Adj. $\mathcal{R}^2$	0.843	0.843

The first two columns of the table reports regressions of the form $y_{ijst} = \alpha + \beta\iota_{ijst} + \gamma(\iota_{ijst} \times ARG_j) + \varepsilon_{ijst}$, 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 50% 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. α denote fixed effects indicated at the bottom of the table. **Source**: SECEX, Brazilian Central Bank

$* p < 0.1$; $** p < 0.05$; $*** p < 0.01$. Standard errors clustered at the sector-establishment level.

E Model Appendix

Importers : FONC:

$$0 = \frac{\rho}{\rho-1} Q^{\frac{1}{\rho-1}} \frac{\rho-1}{\rho} Q(\omega)^{-1/\rho} - \lambda(1+\tau_\ell^M) S_\ell^M P(\omega)$$
$$Q^{\frac{1}{\rho-1}} Q(\omega)^{-1/\rho} = \lambda(1+\tau_\ell^M) S_\ell^M P(\omega)$$

Ratio between ω and ω'

$$\left(\frac{Q(\omega)}{Q(\omega')}\right)^{-1/\rho} = \frac{(1+\tau_\ell^M) S_\ell^M P(\omega)}{(1+\tau_{\ell'}^M) S_{\ell'}^M P(\omega')}$$
$$Q(\omega)(1+\tau_{\ell'}^M)^{-\rho}(S_{\ell'}^M)^{-\rho} P(\omega')^{-\rho} = Q(\omega')(1+\tau_\ell^M)^{-\rho}(S_\ell^M)^{-\rho} P(\omega)^{-\rho}$$

Multiply both sides by $(1+\tau_{\ell'}^M)(S_{\ell'}^M)P(\omega')$ and integrate w.r.t. ω'

$$Q(\omega) \int \left((1+\tau_{\ell'}^M)(S_{\ell'}^M)P(\omega')\right)^{1-\rho} d\omega' = (1+\tau_\ell^M)^{-\rho}(S_\ell^M)^{-\rho} P(\omega)^{-\rho} \int (1+\tau_{\ell'}^M)(S_{\ell'}^M)P(\omega')Q(\omega')d\omega'$$

Defining $\mathcal{P}^{1-\rho} = \int \left((1+\tau_{\ell'}^M)(S_{\ell'}^M)P(\omega')\right)^{1-\rho} d\omega'$ where $\mathcal{P}$ is the price index, we have

$$Q(\omega)\mathcal{P}^{1-\rho} = I(1+\tau_\ell^M)^{-\rho}(S_\ell^M)^{-\rho} P(\omega)^{-\rho}$$

Simplifying gives the result in the text.

Exporters

$$E[\pi] = (E[S_\ell^X] - \tau_\ell^X) P^\ell E[Q] - C(Q)$$
$$\pi - E[\pi] = (S_\ell^X - E[S_\ell^X]) P^\ell E[Q]$$
$$(\pi - E[\pi])^2 = \sigma_\ell^2 (P^\ell E[Q])^2$$

The first-order condition is given by

$$0 = U'(\pi)\left[(1-\tau_\ell^X)\left(E[Q] + P\frac{\partial E[Q]}{\partial P}\right) - C'(E[Q])\frac{\partial E[Q]}{\partial P}\right] + \frac{1}{2}U''(E[\pi])\sigma_s^2\left(E[Q] + P\frac{\partial E[Q]}{\partial P^\ell}\right)$$

Simplifying gives

$$0 = (1 - \tau_\ell^X) \left(E[Q] + P \frac{\partial E[Q]}{\partial P} \right) - C'(Q) \frac{\partial Q}{\partial P} - \frac{1}{2} \gamma \sigma^2 \left(E[Q] + P \frac{\partial E[Q]}{\partial P} \right)$$

$$0 = (1 - \tau_\ell^X) P \left(1 + \frac{P}{E[Q]} \frac{\partial E[Q]}{\partial P} \right) - C'(Q) \frac{\partial Q}{\partial P} \frac{P}{E[Q]} - \frac{1}{2} \gamma \sigma^2 P \left(1 + \frac{\partial E[Q]}{\partial P} \frac{P}{E[Q]} \right)$$

$$0 = (1 - \tau_\ell^X) P (1 - \rho) + C'(Q) \rho - \frac{1}{2} \gamma \sigma^2 P (1 - \rho)$$